Do free goods stick to poor households?
Experimental evidence on insecticide treated bednets

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Abstract: According to economic theory, the market will allocate a good to those willing and able to pay the most for it. This suggests that efforts to target durable health goods such as insecticide-treated bed nets (ITNs) to poor populations may prove ineffective, with the poor reselling donated goods to the non-poor who value them more highly. Both wealth and endowment effects militate against the sale of in-kind transfers. The question of how much these effects attenuate incentives to resell ITNs donated to the poor is of central importance to the design of effective disease prevention policy in Africa and other areas of the low-income tropics. We quantify wealth and endowment effects of free ITN distribution through a field experiment in Uganda, in which households are randomly assigned to receive ITNs, receive cash and the opportunity to purchase ITNs, or have the opportunity to purchase nets with their own resources. Our results indicate that very few nets will be resold by recipient households.

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1. Introduction

Malaria kills over one million people annually, 90 percent of them in Sub-Saharan Africa (World Health Organization 2004). Sleeping under insecticide treated bed nets (ITNs) is a highly effective way of avoiding malaria infection. ITN use has been shown to significantly reduce illness and death from malaria across a range of transmission environments (Lengeler 2004) and is considered the most cost-effective available strategy for control of the disease (Breman et al. 2004).

The appropriate mechanism of ITN delivery in Africa – free distribution versus some degree of cost recovery – is hotly debated (Müller and Jahn 2003). Proponents of a market-based approach argue that goods received for free will not be used (PSI 2006) and that existing or potential commercial ITN markets will be undermined if free nets are widely distributed, leaving communities with even poorer access once donor funds run out (Lines et al. 2003). Indeed, recent work shows weak evidence that the act of paying for a health good may encourage its use (Ashraf et al. 2007).

Those promoting free distribution of nets argue that Africa's low population density and poor infrastructure both limit the availability of ITNs and increase consumer prices. Coupled with much lower incomes in Africa, these effects prevent private ITN markets from developing in Africa as they have in Asia. Indeed, research has shown that the cost of ITNs is often prohibitive for rural African households (Guyatt et al. 2001, Barat et al. 2004). Even when nets are subsidized, cost remains a barrier. One study of a social marketing project found that those in the poorest quartile were almost three times less likely to purchase nets than those in the richest quartile (Hanson and Jones 2000). Proponents of distributing nets for free point to the positive externalities of ITN use: when coverage levels in an area are high, large numbers of the

mosquitoes that transmit malaria are killed and infection rates decline even among those not using nets (Hawley et al. 2003).

If households that would not otherwise purchase nets through the market are given free or subsidized nets, and local demand is not saturated, economic theory predicts that at least some of these nets will be resold to other households with greater market demand. However, a given household may be unwilling to purchase a good at a given price yet when given the item, may be unwilling to sell at the same price. In considering the distribution of ITNs, three factors contribute to this discrepancy. First, an in-kind transfer adds to the household's wealth, which increases demand for all normal goods including the object of the transfer. Second, people tend to value a good they own more than the same good if owned by someone else (Kahneman et al. 1991). This tendency, called the endowment effect, has been widely documented in economic laboratory settings. Finally, in multiple-parent households, the parent receiving a free net may value the net more than the parent who has control over the household's financial resources.

Through the experiment described in this paper, we test the contribution of each of these factors to the difference between willingness to pay and willingness to sell insecticide-treated mosquito nets. Ultimately, we seek to estimate the cumulative effect of these three mechanisms on expected equilibrium secondary market resales volume and prices for ITNs so as to establish whether or not a target population's actual behavior confirms the fears of those who expect free distribution of ITNs to prove ineffective or even to undermine commercial market distribution of ITNs

Rather than rely on hypothetical questions as previous studies of demand for ITNs have done, we use an incentive-compatible experimental design following Becker, deGroot and Marschak (1964) in which participants are asked to choose between mosquito nets and a cash payout. In

addition to avoiding poorly understood hypothetical bias (Murphy *et al*. 2005), this design allows us to identify the effect of gender-specific preferences independent of the financial constraints which may be correlated with gender.

In the following section, we describe three reasons why a household's willingness to pay for a health good may differ from its supply of the same good received for free. We then review the literature on willingness to pay for and retention of free ITNs in Section 3. We outline the methods of a field experiment to measure demand and supply of free nets in Section 4. Section 5 describes results of this experiment, and Section 6 concludes.

2. Household demand for and supply of a health good

Wealth effect

For a poor household without access to credit, the cost of an ITN can be prohibitive. Previous studies have financial constraints to be a significant barrier to mosquito net ownership in rural Africa (Barat et al. 2004). In the villages where the present research was conducted, ITNs are not available. However even if they were available commercially, they would likely be priced out of reach of most households. The ITNs used in this study were procured at $7.63, 2.3 times the average weekly value of food consumption per capita and 1.8 times the average weekly adult labor income.

When an ITN is received free of charge, this represents a significant income transfer in kind. Even if the transfer is entirely inframarginal, so that standard theory of the consumer predicts that in-kind and cash transfers will have identical effects (Southworth 1945), one would expect some portion of this additional income to be allocated to purchasing ITNs. As a result, the price at

which an individual is willing to sell a good received for free will be higher than the price at which the same person is willing to purchase it out of his or her own resources if no transfer is received.

Endowment effect

The endowment effect refers to the phenomenon, documented extensively in laboratory settings that, even controlling for the wealth effect, people are willing to pay less for an item than the amount they would charge for the same item conditional on owning it (Kahneman et al. 1991). For example, consider two individuals, A and B, with identical preferences. Person A receives an ITN and person B receives a cash transfer of equivalent value. If person A is then willing to pay a maximum of X for an ITN, the endowment effect implies that person B will demand at least Y > X to sell his net. Kahneman et al. (1991) attribute the endowment effect to loss aversion (the tendency to prefer avoiding losses to acquiring gains) or status quo bias.

The gap between what an individual is willing to pay in a buying mode and what s/he demands as compensation in a selling mode is greater for goods with a public good component or to which subjects ascribe moral considerations (Boyce et al. 1992, Irwin 1994). This additional effect may exacerbate the difference between willingness to buy and sell prices for ITNs when these are promoted in relation to child health.

Heterogeneity of preferences within the household

Preferences are widely believed to differ systematically between men and women. A number of studies have shown that a greater share of income in the hands of women is associated with higher household expenditures on education and food (Thomas 1990, Hoddinott and Haddad 1995), whereas men report a greater preference for status goods and capital investments (Kusago and Barham 2001).

Married women in traditional societies often have limited control over the household's financial resources. At the same time, mothers are commonly the recipients of goods distributed by government or non-governmental organizations and intended for child use. As a result, the decision to purchase and the decision to sell an ITN received for free may be made by distinct individuals within the household.

Consider a hypothetical household in which each parent acts without regard for the other's welfare. In this household, the man controls all the income from the family farm or non-farm enterprise, as well as any personal transfers he receives. His wife controls only the cash or in-kind transfers which she personally receives. If the woman values nets but her husband does not, then the household will exhibit very low market demand for ITNs. Indeed, a net given to the man might be sold for cash, if possible. However, if a net is given to the woman, it is less likely to be sold, since she both values and controls this resource. Indeed, a recent empirical study of the US Food Stamp Program (Breunig and Dasgupta 2005) suggests that heterogeneity of preferences within the household explains the higher marginal propensity to consume food out of food stamps than cash income. The same mechanism could be at play with respect to ITNs.

3. Willingness to pay for ITNs

Willingness to pay (WTP) for ITNs has been investigated in a number of African countries. Almost all existing studies of WTP rely on hypothetical questions, though some follow these with the opportunity to purchase nets at a fixed price. Across settings, wealthier households exhibit greater hypothetical and actual willingness to pay for ITNs (Onwujekwe et al. 2001, Barat et al.

2004, Noor et al. 2006). Other factors associated with net ownership are mother's education and proximity to markets (Noor et al. 2006).

Discrepancies between women's and men's WTP for nets have been found in both directions. In Ethiopia, one study found significantly higher WTP among women, and attributed this to the greater importance placed on child health by mothers than fathers, but lower WTP among single mothers, controlling for income (Cropper et al. 2000). Two other studies found significantly lower WTP among women in Sudan and Nigeria respectively (Onwujekwe et al. 2001; Onwujekwe et al. 2004). The authors speculated that this was due to women's lack of control over household finances.

Only one published study investigates the fate of free nets in an environment where nets were not universally distributed (Guyatt and Ochola 2003). The authors find an overall net retention rate of 91 percent, though this result may be biased by their failure to locate 40 percent of the original sample for follow-up interviews. The present research measures both willingness to pay for and to sell ITNs in the same population. This allows us to quantify the discrepancy between WTP and willingness to accept payment (WTA) for free nets, and to model the number of ITN sales from targeted recipients to others.

4. Setting and Data

The research was conducted in Mwizi sub-county, Mbarara district, in western Uganda. Net ownership in Mwizi is very low: only five nets per thousand people were treated with insecticide during the government's most recent net dipping campaign in 2005. The two study villages, Rubagano (population approximately 1300) and Kimuli (population approximately 900), were

chosen for their remoteness from markets. A remote location was selected so that participants' valuation of ITNs would be affected as little as possible by a reference market price. In addition, the low level of net ownership in this area (only 10 of the 193 participating households owned any nets before the experiment was conducted) means that WTP values are unlikely to be substantially biased by saturation of the demand for ITNs.

Consumption data was collected through a household survey. A household member was asked to recall the quantity and amount paid for 46 food and drink items consumed over the past week by household members. For home-produced goods, respondents were asked to state the approximate value. Respondents were also asked how much the household had spent during the past month on 15 non-durable, non-health items including water, fuel, matches, soap, and transport, and during the past year on tuition and other educational expenses, small household items, clothing, and books. The average daily value of per capita consumption calculated in this way was $0.65. This is very close to the $0.61 daily per capita household final expenditure reported by the World Bank in 2005 for Uganda. Almost all households in the sample earned at least some of their living from farming, and home produced goods accounted for 50 percent of consumption on average.

Conventional (untreated) nets are available in the weekly rural market about 2 hours' walk away from the study site at a price of approximately $2.72. These are about half as protective for preventing malaria as insecticide-treated nets (Guyatt et al. 2002). Higher-quality nets bundled with insecticide treatment kits are available for twice the price of untreated nets in the closest urban center, to which transportation costs $7.63 return.

The long-lasting Olyset® insecticidal nets offered through the experiment described here are not commercially available in Uganda. Insecticide is incorporated into the polymers of which these

are constructed, and remains effective throughout the nets' estimated 5-year lifespan. Other ITNs must be retreated with insecticide at least once a year and tear more easily than the heavy-duty Olyset nets. Since retreatment rates tend to be very low, long-lasting insecticidal nets are recommended by the World Health Organization (World Health Organization 2003). These nets have been distributed by international organizations in a few areas within Uganda, including the sub-county adjacent to Mwizi.

Malaria is a serious health problem in the study area. Respondents reported that 90 percent of household members suffer from the disease every year. The economic burden of malaria in this sample was very high: the treatment cost and forgone labor income of a single malaria episode amounted to $17.85 or 7.2 percent of the value of annual per capita non-health consumption. These figures are similar to the private costs of malaria reported in a recent review, which ranged from $15.26 in Congo to $20.56 in Rwanda (Cropper et al. 2004). The toll of malaria on lives is also large; 79 percent of respondents reported that someone they knew had died of malaria.

5. Methods

Sample selection, treatment assignment, and attrition

Households that included children aged up to five years or a pregnant woman were eligible to participate in the study. A list of all such households in each village was provided by the village chairmen. Of these, all 41 of the single-headed households identified and an additional 152 dual-headed households, representing approximately 90 percent of the total eligible, were selected to participate.[1] Either the head or spouse in each dual-headed household was randomly selected to

[1] Eleven households with children older than five years were mistakenly included in the sample. These are retained in the present analysis.

be the participant for that household. Half of the single participants and a third of the married female and married male participants were randomly assigned to receive a cash transfer; approximately the same number in each group received a transfer of insecticide-treated bednets. The remaining third of married participants were assigned to an uncompensated treatment.[2] Table 1a shows the number of participants in each treatment by headship and gender. All households sent a representative to the bidding session, but 3 of the 50 households assigned to the uncompensated treatment failed to participate. Participants who missed their assigned session were allowed to attend a later session. An effort was made to reassign the person to a session of the same treatment, however this was not always possible. Staff and respondents were unaware until a session began whether it would be a bednet 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 find 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 14 of the 190 participating households, a non-randomly assigned individual participated. Because we are interested in the actual behavior of men and women, we use the actual rather than assigned gender of participants in this analysis. Table 1 shows the final number of participants (after attrition and reassignment) in each treatment by actual gender and family structure.

Experimental procedures

In the cash transfer treatment, respondents were given enough local currency to purchase up to three family-sized, long-lasting insecticidal nets (LLINs) at the maximum price of $7.63 per net.

[2] One of these was subsequently re-classified as single since she did not live with her husband.

Participants with larger families received a larger cash transfer.[3] In the free nets treatment, respondents were given an equivalent number of nets. Participants were told that the cash or nets, received at the beginning of the session, were compensation for participation in the study, and that they were free to exchange or keep these as they wished. They were read a statement about malaria and the relative vulnerability of young children and pregnant women to the disease. 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 type of LLIN through a UN project told each group that these nets were effective at killing insects and had prevented malaria in her family during the months they had used them.

The auction mechanism worked as follows (see the appendix for scripts). One of the experimenters explained the bidding procedure, and told participants the possible prices that could be drawn as he placed one ping-pong ball representing each possible price in a bucket. Participants were given tokens representing currency, which they placed in envelopes to indicate their bids. Those receiving the cash transfer indicated the maximum they were willing to pay for one net, two nets, and three nets by placing currency tokens in envelopes and passing these to a member of the staff, who recorded the bids. In the same way, those receiving bednets indicated the minimum amount of cash they were willing to accept to relinquish one, two, and three nets. Staff were available to assist with bids if needed, but participants were asked to keep their net bids as confidential as possible. Before bidding for the nets, three public paid rounds were conducted in which food items and pencils could be exchanged for cash.

After all bids had been recorded, one of the participants drew a ball to select the price. In the cash transfer treatment, participants who had bid at least as much as the drawn price for a given

[3] The 190 by 180 centimeter nets offered are designed to accommodate a couple and a baby or up to four small children. Each household received $7.63 times the minimum of: {the number of household members/2, rounded up to the nearest integer; number of distinct sleeping places; 3}

number of nets exchanged cash for that number of nets. For example, in a three-net session[4] in which the price drawn was p, if a participant bid at least $3p$ for three nets, he would buy all three nets for $3p$. 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 at least p for one, he would buy one net. Finally, if he bid less than $3p$, less than $2p$, and less than p for three, two and one net, respectively, he would keep the cash and receive no nets. Transactions for the free net sessions followed the same logic, with participants selling back the nets they had received as compensation at the randomly drawn price.[5] The procedure in the uncompensated treatment was the same as in the cash transfer treatment, except that participants did not receive a cash transfer. This group was told two weeks ahead of time that they would have the opportunity to purchase a single mosquito net with their own money, and were given a small monetary inducement of approximately $0.50 to come to the session.

The difference between an individual's buying bid and selling offer for a good can be attributed to both a wealth effect and an endowment effect. The endowment effect is typically measured as the difference between compensated buying and selling prices (Knetsch 1989). However, an asymmetry in payoffs between the in-kind and cash transfer treatments complicates the interpretation of this difference. Depending on the randomly chosen price, those in the cash transfer treatment could purchase nets at a price lower than the value of the per-net transfer they had received (recall that households were given enough cash to purchase nets for their entire family at the maximum possible price). Those in the free net treatment, on the other hand, could only earn cash by selling a net. This implies that the optimal bid for an individual with given preferences is lower in the cash transfer condition, independent of the endowment effect. The bias introduced by this effect will be negligible if the value of transfer is small relative to

[4] Participants were assigned to one-net, two-net or three-net sessions according to the formula in footnote 4.
[5] 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.

participants' initial wealth levels. In this low-income setting, however, the distortion may be significant.

In addition, poor households have a higher marginal value of cash than wealthier households. This implies that the chance to win both cash and nets by bidding low in the compensated buying condition is particularly appealing to the poorest households. The experimental design therefore creates a spurious positive relationship between consumption level and compensated buying bids. Without ex ante knowledge of preferences, we were unable to avoid this asymmetry. Instead, we limit the multivariate analysis below to the free nets and uncompensated buying treatments. We present results from the cash transfer treatment with the caveat that the difference between these bids and those of the in-kind transfer group includes but cannot be solely attributed to an endowment effect. To complement this approach, we also estimate the wealth effect of the ITN transfer using the relationship between ITN selling bids and per capita consumption.

Finally, we test for a difference between men's and women's valuation of nets to determine if systematic differences in preferences within the household are likely to create a gap between household demand for and supply of nets. The effect of gender within the uncompensated treatment offers indirect evidence as to whether binding liquidity constraints differentially affect men's and women's demand for ITNs in this setting.

6. Results

Balance across treatments

Before discussing outcomes across treatments and sub-group, we check that the randomization was successful. Table 2 gives the means and standard errors of relevant variables for each

treatment group and each gender/headship category. The only variable that varies significantly across the compensated treatments at the five percent level (p=0.044) is number of children in the household aged five years or younger. This presents some concern, since a message focused on child health was given to respondents and may have had a differential impact on those with more young children. We include this variable in the multivariate analysis below in order to isolate its effect in determining willingness to pay for or retain nets. The uncompensated group also differs from the free net group, again in the number of children, as well as (by design) in the proportion of single parents and number of nets offered for sale. The lower number of children in the uncompensated group (p=0.002) is due to the fact that these sessions were held on the last day of fieldwork and thus did not allow for re-sampling to replace households that did not meet eligibility criteria.

Compensated supply and demand

The high reported costs of malaria in Mwizi are reflected in high compensated demand for ITNs. Seventy-three percent of the respondents who had received the in-kind transfer were unwilling to accept the maximum price of $7.63 in exchange for even one of their nets. This price represents 3.1 percent of annual per capita non-health consumption, and 6.9 percent of per capita cash expenditures. Of those given cash and the opportunity to purchase nets, 49 percent were willing to pay the full price for the nets. The average bids among the in-kind and cash transfer groups were $7.17 and $5.94 respectively, significantly different at p<0.0001.[6] Because bids were bounded from above and so many were clustered at the maximum, the differences between WTP and WTA values are likely understated, at least partly offsetting the previously noted bias in the opposite direction.

[6] The number of bids per household varies from one to three, depending on the number of people in the household. In calculating these averages, each household's mean bid is treated as a single observation, with those unwilling to sell at any of the prices offered assigned the maximum price of $7.63.

Pooling the two compensated conditions and splitting the sample by gender, women's bids are slightly higher at $6.71 compared with $6.28 for men, but this difference is not statistically significant. Excluding the mostly female single-headed households narrows this gap to $0.26, which is also statistically insignificantly different from zero.

Uncompensated demand

In contrast, the uncompensated group was willing and able to pay an average of only $2.34 for one net. Here men's average WTP was *greater* than women's by $0.95 ($p<0.05$). This reversal of the ordering of men's and women's WTP as we move from the compensated to the uncompensated buying treatment suggests that although women value nets as much as or more than men, they have less access to cash with which to purchase them. This serves as a caution that correlation between gender and cash liquidity can complicate inference with respect to gender-differentiated preferences.

Because two weeks' notice may not have been ample time to marshal resources, we also elicited hypothetical WTP values from the uncompensated group. Respondents were asked how much they would be willing to pay for a net if they had unlimited time to save. These values are higher, $4.08 on average, but still much lower ($p<0.0001$) than the price at which recipients of the in-kind transfer were willing to sell their nets. The hypothetical WTP values, like the compensated WTP values, do not differ significantly between men and women, reinforcing the inference that cash liquidity constrains women more than men in this setting.

Multivariate analysis

To investigate whether poor households are more likely to sell ITNs they receive for free, we regress the selling bids of the in-kind transfer group on household per capita consumption, controlling for the number of sleeping places in the household, the number of nets received,

education of the respondent, age of the household head, family structure, and the gender of the respondent. We use a tobit model bounded above at the maximum price of $7.63 (there were no zero bids). The dependent variable is the bid for the first of up to three nets sold.[7] Table 3 shows the regression results.

Considering first the pooled male and female sample, we note that neither income nor education is significantly correlated with willingness to sell a net received for free. Older heads and their spouses are willing to accept lower offers to sell their nets and single heads are less likely to accept a low offer. Both of these effects are driven by female participants. As in the univariate results, we see no difference between married men's and women's valuation of nets in the compensated treatments.

Gender differences

Although average willingness to trade nets for cash is statistically equivalent across gender, the determinants of net retention differ for men and women. In the second and third columns of Table 3, we see that consumption level significantly affects only men's bids; poorer women are not significantly more likely to sell nets than other women. Men whose household per capita weekly consumption is a dollar lower are willing to accept 21 cents in exchange for a bednet. The point estimate on consumption expenditure for women is a third of the size and statistically insignificant.

Turning to the uncompensated buying group, men's bids are greater than women's by over a dollar. Households with more young children are, somewhat surprisingly, willing to pay less for mosquito nets than other households. In sum, men's standard of living influences their willingness to sell a mosquito net, albeit only modestly. Differences in willingness to pay across

[7] Using the household average bid rather than the bid for the first net sold gives similar results.

gender seem mainly to capture liquidity constraints, with men able to pay more for nets from their own resources but no less likely to sell them than women. Finally, single heads, who are almost exclusively women, are more reluctant to give up nets than married women or men.

Wealth and endowment effects

The total difference in bids between the group receiving the in-kind transfer and those receiving no transfer was $4.83. Limited access to cash is likely to have constrained the bids of the no-transfer group. However, even the hypothetical bids (the amount respondents claimed they would be willing to pay if given adequate time to save) entered by this group were lower than the selling prices among the in-kind transfer group by $3.09 on average.[8]

The difference in uncompensated buying and compensated selling bids may be partially attributable to the wealth effect of the transfer. Using the estimated effect of consumption on bid values from the in-kind transfer group, we can approximate this wealth effect. The average value of the in-kind transfer (evaluated using the mean selling bid) was $18.64 per household or $2.92 per capita. According to the permanent income hypothesis, a transfer of this size, equal to 63 percent of average weekly expenditures, should have very little impact since it will be used to maximize utility over the agent's lifetime. However, empirical evidence shows that the marginal propensity to consume out of windfall income is much higher than the permanent income hypothesis predicts (Thaler 1990). We calculate bounds on the wealth effect using the alternative assumptions that the transfer is spent over the course of one day and two weeks.[9] Using the point estimate on expenditures per capita from the pooled (male and female) free nets group, the estimated wealth effect is between 14 cents and $1.98, leaving an unexplained gap of $2.85 to

[8] Both hypothetical and auction bids were truncated at the maximum auction price of $7.63.

[9] While we did not collect systematic data on the use of cash transfers, anecdotal evidence suggests that these were spent quickly. One participant told survey staff that she would buy a mattress with the money she received. Several others were seen proceeding immediately from the experimental sessions to the bar next door, where they purchased drinks for themselves and others.

$4.69 between the average selling bid of those receiving the in-kind transfer and the average buying bid of those receiving no transfer. Similarly, the unexplained difference between the average selling bid and hypothetical buying bid is between $1.11 and $2.95. This residual difference represents the endowment effect. While our estimate of the endowment effect is sensitive to assumptions, we note that it remains substantial even under the rather extreme assumption that all windfall income is consumed immediately. An alternative estimate of the endowment effect is the difference in bids among the cash transfer and in-kind transfer groups, equal to $1.23 on average. As noted earlier, this estimate is on the one hand exaggerated by an asymmetry in payoffs, and on the other is attenuated by the bounding from above of many bids. In sum, our various and admittedly imperfect measures of the endowment effect all show it to be present, suggesting that the phenomenon may play an important role in discouraging the resale of free mosquito nets.

Simulated market exchanges

Suppose the poorest 40 percent of households (by per capita consumption) in the villages studied all receive free ITNs to cover all of their household members. Recipient households may decide to use the nets they have received or sell them to others in the community. Figure 1 illustrates the demand, supply, and resulting market equilibrium for nets under three different sets of assumptions about the willingness of recipients to sell. The demand for nets in each case is the same: the cumulative density function (CDF) of the uncompensated buying bids among those in the top 60% of consumption per capita, shown in the heavy upward-sloping dashed line. The poverty line implied by this cutoff is 53 cents per capita per day.

If we ignore both the endowment effect and the wealth effect, then the supply of nets is simply the inverse of the uncompensated demand for nets among the poorest 40 percent. This is the thin dotted line in Figure 1. The intersection of this hypothetical supply with demand occurs at $2.42,

approximately one-third of the retail price of the nets. At this price, over half (54 percent) of the nets distributed will be resold to non-target households. This is precisely the scenario that concerns many skeptics of free ITN distribution to the poor: ITNs will not stick to intended recipients and the predictable reselling will undermine commercial market distribution of ITNs. However, this naïve scenario neglects well-established wealth and endowment effects, which effectively extinguish that concern, as we now show.

Next we examine how the wealth effect changes supply while leaving out the endowment effect. The green supply curve is the inverse CDF of bids among the poor who received the cash transfer. The estimated equilibrium resale price increases slightly to $2.72, and 36 percent of nets are sold.

Finally, we plot the actual supply of nets among the poor: the orange line is the CDF of bids among the compensated poor in the free nets condition. This supply reflects both the wealth effect of having received a net, and the endowment effect of the in-kind nature of the transfer. Taking into account both of these effects, the estimated equilibrium resale price of ITNs jumps to $4.63 — over 60 percent of the retail price — and only 6 percent of nets are resold by beneficiaries.[10] Even this scenario represents an upper bound on the number of sales, since we do not take into account the transaction costs associated with finding a willing buyer or seller. Without controlling for other factors such as income, poor women are no less likely to sell their nets than are poor men. We therefore do not show poor women's supply separately.

[10] If we use the hypothetical bids from the uncompensated group to construct demand, 69%, 40%, and 20% of nets are sold in scenarios 1-3, respectively.

6. Conclusions

A large literature in behavioral and experimental economics emphasizes that the decision to purchase a good is not equivalent to the decision to sell. Both wealth and endowment effects imply that the price a household will charge for a good it receives for free is greater than the price it would be willing to pay to acquire that same good. This means that in-kind transfers may stick, at least partially, to a targeted group which would otherwise be unable or unwilling to pay for a good. These effects can sharply reduce unintended reselling — so-called "external leakage" — to the non-poor and associated undermining of commercial market distribution channels. This question matters for public policy, such as in current debates over the best means for distributing insecticide-treated bed nets to poor people in order to prevent mosquito-borne diseases such as malaria.

In the rural western Ugandan villages studied, wealth and endowment effects result in very few households selling ITNs that they received for free. A simulation of the market for nets shows that only 6 percent of all nets distributed would be sold in an artificially frictionless market; if we were to account for the transactions costs of market exchange, this estimate would fall further. The small number of exchanges arises from a combination of low uncompensated market demand for nets and high compensated demand among net recipients.

In principle, non-unitary decision-making processes at the household level may also cause buying and selling prices to diverge. In this sample, however, the average compensated valuation of ITNs does not differ significantly between men and women. Men, however, exhibit relatively high income elasticity of supply for ITNs, whereas poor women are no more likely to sell nets than richer women. This suggests that when targeting free nets to poor families, less leakage will occur if these nets are given to women. Further, women are less able to pay for nets out of own

cash resources than are men, implying that marketing nets to poor women will be relatively ineffective because of their low purchasing power, minimizing potential commercial displacement due to free ITN distribution.

While the sample in this study is not statistically representative, it is quite typical of the rural Ugandan population. No participants were able and willing to pay even the wholesale price of a long-lasting insecticidal net using their own resources. This, together with the fact that very few households are wiling to sell free nets, suggests that targeted distribution of free or highly subsidized nets to poor households, most likely through mothers, is a viable strategy for achieving higher rates of insecticide-treated bednet usage among the rural poor in Uganda.

Tables and Figures

Table 1a: Sample by assigned treatment, reported family structure, and gender of assigned participant

		Free nets	Cash transfer	Uncompensated	Total
Married	Male	25	25	25	75
	Female	25	27	25	77
Single	Male	1	2	0	3
	Female	20	18	0	38
Total		71	72	50	193

Table 1b: Sample by treatment, actual family structure and gender of actual participant

		Free nets	Cash transfer	Uncompensated	Total
Married	Male	24	25	22	71
	Female	29	24	24	77
Single	Male	1	2	0	3
	Female	20	18	1	39
Total		74	69	47	190

In the first column, + indicates the difference in means between the cash transfer and in-kind group is significantly different from zero with p-value < 0.1; * < 0.05, ** < 0.01; in the third column, the same symbols these indicate significant differences in means between the no-transfer group and the pooled in-kind and cash transfer groups.

Table 2: Summary statistics by treatment and gender/headship category: means with standard errors in parentheses

	Free nets	Cash transfer	Uncompensated	Married women	Men	Single women
Value of per capita consumption (US $ / week)	4.74 (0.34)	4.79 (0.33)	4.69 (0.35)	4.57 (0.34)	4.92 (0.31)	4.78 (0.35)
Years education of respondent[1]	2.80 (0.40)	3.23 (0.42)		2.66 (0.47)	5.06*** (0.46)	0.68*** (0.22)
Age of head (years)	39.22 (1.65)	41.61 (1.84)	38.15 (2.33)	37.66 (1.55)	36.81 (1.66)	50.08*** (2.47)
Respondent is female (1=yes, 0=no)	0.66 (0.06)	0.61 (0.06)	0.53 (0.07)	1.00 (0.00)	0.00 (0.00)	1.00 (0.00)
Respondent is single (1=yes, 0=no)	0.28 (0.05)	0.29 (0.06)	0.02*** (0.02)	0.00 (0.00)	0.04* (0.02)	1.00*** (0.00)
# of nets offered	2.55 (0.07)	2.49 (0.07)	1.00*** (0.00)	2.04 (0.10)	2.18 (0.10)	2.31* (0.10)
# of household members aged 0-5 years	2.09 (0.13)	1.71** (0.12)	1.34*** (0.16)	1.84 (0.11)	1.97 (0.14)	1.23*** (0.16)
Household size	6.01 (0.25)	5.78 (0.25)	5.38 (0.34)	6.13 (0.26)	5.96 (0.25)	4.72*** (0.26)
Medical & related expenditures resulting from last malaria episode (average across members, $ US)[1]	13.74 (1.74)	12.84 (1.41)		13.14 (1.55)	14.65 (1.80)	11.73 (2.71)
N	74	69	47	77	74	39

[1] Data not collected for uncompensated treatment.

Table 3: Determinants of bid values[1]

		Free nets treatment		Uncompensated
Sample	All	Male	Female	
model	(tobit)	(tobit)	(tobit)	(OLS)
Value of per capita consumption (US $ / week)	0.097 (0.061)	0.211* (0.121)	0.070 (0.076)	0.048 (0.097)
Years education of respondent [2]	-0.017 (0.060)	-0.105 (0.069)	0.011 (0.091)	
Age of head (years)	-0.027* (0.015)	0.059 (0.047)	-0.033* (0.017)	0.005 (0.015)
Respondent is female (1=yes, 0=no)	-0.126 (0.411)			-1.044** (0.451)
Respondent is single (1=yes, 0=no)	1.066** (0.450)	-0.008 (1.433)	1.036** (0.507)	-1.301 (1.516)
# of household members aged 0-5 years	-0.140 (0.175)	0.094 (0.226)	-0.194 (0.264)	-0.578** (0.223)
Household size	0.151 (0.116)	-0.072 (0.201)	0.130 (0.154)	0.079 (0.113)
# of nets offered [3]	-0.247 (0.354)	0.020 (0.453)	-0.423 (0.472)	
Constant	7.381*** (0.926)	4.781*** (1.226)	8.282*** (1.244)	2.846*** (0.929)
Observations	74	25	49	47
(Pseudo)[4] R-squared	0.032	0.096	0.041	0.139

* indicates coefficient is different from zero with p-value < 0.1; ** < 0.05, *** < 0.01.

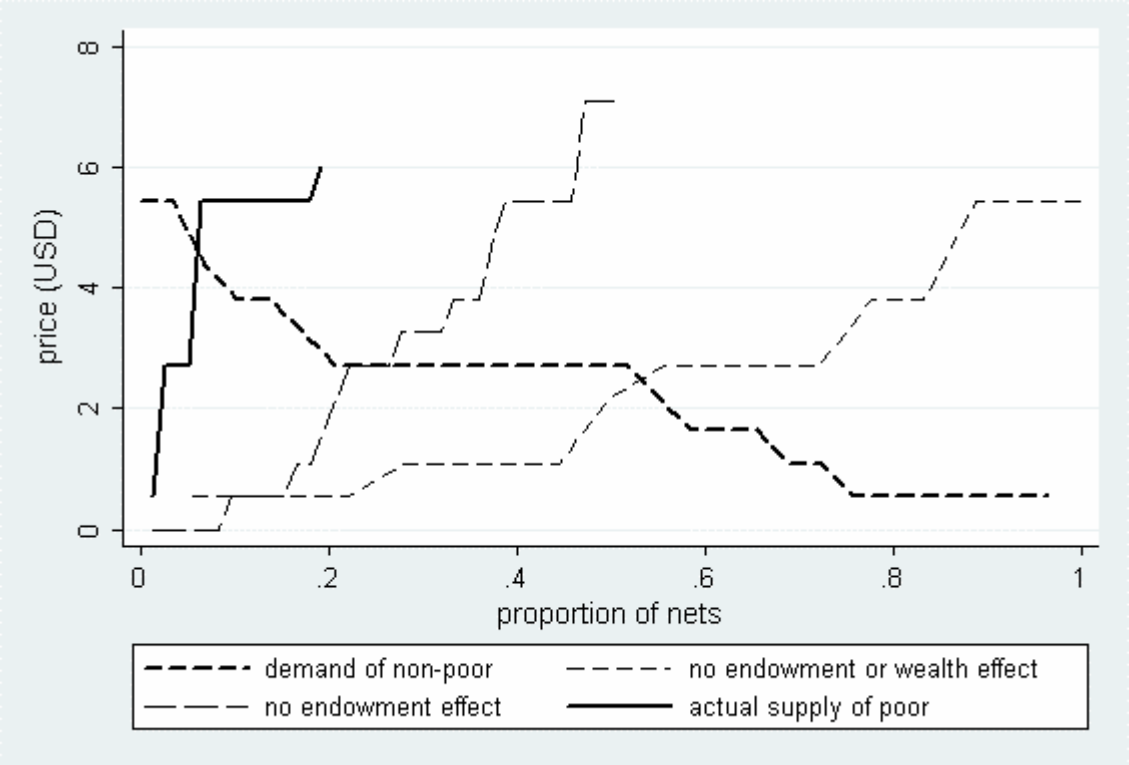
[1] For the in-kind transfer nets group, we estimate tobit models with an upper limit of the maximum price ($7.63). Bids among the uncompensated group were not clustered at either zero or the maximum; we therefore estimate this model using OLS.

[2] Data on education was not collected for the uncompensated group.

[3] Number of nets offered does not vary for the uncompensated group; all participants in this treatment were offered one net.

[4] Because the in-kind transfer models are estimated using a tobit model, pseudo R-squared are shown; the actual R-squared value is given for the uncompensated group.

Figure 1. The impact of wealth and endowment effects on demand and supply for ITNs



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