ESSAYS ON POVERTY ALLEVIATION AND HEALTH PROMOTION IN EAST AFRICA

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ESSAYS ON POVERTY ALLEVIATION AND HEALTH PROMOTION IN EAST AFRICA

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This dissertation consists of three papers on anti-poverty and health promotion interventions in East and Southern Africa.

Attempts to target health goods such as bed nets to poor populations may prove ineffective if households resell these goods. However, wealth and endowment effects militate against the sale of in-kind transfers. The first paper quantifies these effects through a randomized experiment in which households received nets for free, received a cash transfer and the opportunity to purchase nets, or received only the opportunity to purchase nets with their own resources. The results indicate that very few nets will be resold by recipient households.

The second paper concerns the intra-household allocation of mosquito nets. 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. Controlling for the number of nets acquired, those received for free were more likely to be used by young children, whereas purchased nets were more often used by those members of the household to suffer from malaria most frequently.

The net impact of food aid receipt on farm households' production decisions is theoretically ambiguous. The third paper uses household survey and meteorological data from Malawi to analyze the effect of receiving food aid on labor supply and input

use. Using a lagged weather index as an instrument for food aid receipt, it is shown that households who received food aid allocated more labor time to own farm and non-farm enterprise activities, and less time to unskilled wage labor, and spent more on seeds.

BIOGRAPHICAL SKETCH

Vivian Hoffmann grew up in Vancouver, Canada. She received a BA in Geography from the University of British Columbia, where she was active in student advocacy. Vivian spent 1999-2000 at the University of California at Berkeley. She moved to Ithaca, New York, in August 2001 to pursue graduate studies at Cornell. Vivian spent several months in Tanzania and Ethiopia as a consultant to the World Bank from 2003-2005. She returned to the region in 2006 to conduct doctoral research in Uganda. Beginning in August of 2008, Vivian will be an assistant professor in the Department of Agricultural and Resource Economics at the University of Maryland, College Park.

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CHAPTER ONE

INTRODUCTION

In 2000, the member states of the United Nations adopted eight Millennium Development Goals (MDGs). These global goals included halving, from 1990 levels, the proportion of people living in absolute poverty and living in hunger, reducing the under-five mortality rate by two thirds, and reversing the incidence of malaria, all by 2015 (United Nations General Assembly, 2000). In sub-Saharan Africa, progress toward the MDGs has been slow. While poverty in the region has declined by 8.8 percent since 1990, this is a far cry from the rate of change required to reach the target of halving poverty by 2015 (United Nations, 2007). Child mortality in sub-Saharan Africa remains the highest in the world at 166 per 1000 live births, and has shown only a nine percent decrease since 1990.

While the political will to address the challenges of global poverty appears to be rising[1], controversies remain over the details of how best to do so. For example, whether insecticide-treated bed nets, a highly cost-effective tool for malaria prevention, should be sold to households in rural Africa or given free of charge is hotly debated within the public health and donor communities (Roberts, 2007). The debate over food aid, one of the main tools in the fight against hunger, is similarly charged. Food aid and has been shown to mitigate the adverse impact of harvest failure on child health (Yamano et al., 2005). However concerns over the disincentive

[1] ONE (http://www.one.org), Make Poverty History (http://www.makepovertyhistory.org), and End Poverty Now (www.EndPovertyNow.ca), are campaigns in the US, UK, and Canada which aim to raise awareness of global poverty among the citizens of their respective countries. All three were established since 2005. According to the media database Lexis Nexis, the number of times the term "global poverty" appeared in major world publications increased from 68 in 1997 to 916 in 2007.

effects of free food distribution are repeatedly raised in the media, and have at times causes donors to scale back relief (Harvey and Lind, 2005).

This dissertation aims to contribute to the knowledge base for designing effective anti-poverty and health promotion interventions, in the context of East and Southern Africa. The first two papers report results of a randomized experiment designed to investigate the valuation and usage of insecticide-treated mosquito nets in Uganda. Insecticide-treated mosquito nets are considered a cost-effective tool for malaria prevention. How best to deliver these to vulnerable populations – through market channels or via free distribution – is a subject of fierce debate among policy makers. One concern related to free distribution is whether nets will be used by intended beneficiaries. The first paper reports findings indicating that the vast majority of nets received for free will be retained by recipient households. This is due both to the income effect of receiving a net, and to the endowment effect: people are reluctant to give up a net which they own. The second paper reports results of follow-up visits to households which obtained nets through the experiment. Nets that had been purchased were most often used by income-earning adults whereas nets that had been received free were more likely to be used for young children. This result contributes to our understanding of how decision-making heuristics not reflected in traditional economic models influence behavior, and has important practical implications for targeting health goods within the household.

The third paper addresses concerns over the possible negative effects of food aid on agricultural productivity. This paper use nationally representative household survey data from Malawi to analyze the effect of receiving food aid on agricultural production decisions. Critics charge that reliance on food aid creates dependency and diminishes recipients' incentives to work. However receiving aid in the planting season when cash is scarce may also allow households to be more forward-looking in their production decisions. Indeed, the results reported in this paper suggest that households who received food aid allocated more labor time to own farm activities, and less time to unskilled off-farm wage labor, and spent more on agricultural inputs.

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CHAPTER TWO

DO FREE GOODS STICK TO POOR HOUSEHOLDS?

EXPERIMENTAL EVIDENCE ON INSECTICIDE TREATED BEDNETS[2,3]

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. However, low market demand by the poor may be due to liquidity constraints rather than low valuation of nets. The endowment effect also militates against the resale of in-kind transfers. To what degree liquidity and endowment effects attenuate resale of ITNs donated to the poor is of central importance to the design of effective malaria prevention policy in Africa and other areas of the low-income tropics. We quantify these two effects 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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[3] The authors are PhD Candidate, Professor and Associate Professor, respectively, in the in the Department of Applied Economics, Cornell University. We thank Stephen Younger, four anonymous reviewers, and seminar participants at Cornell and the University of Maryland for helpful comments on an earlier draft. Special thanks to Gad Ruzaaza of Mbarara University of Science and Technology, the field and data entry staff for their tireless work, and the leaders and families of Rubagano Kimuli for welcoming us into their communities and homes. All remaining errors are our own.

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. The main arguments against free distribution are the high public cost of this strategy and the need for reliance on uncertain support from external donors. Proponents of a market-based approach argue that available funds are not sufficient to cover the entire population exposed to malaria, and that private markets are the only way to provide sustainable access to ITNs for all who need them. They reason that such markets will be undermined by large-scale distribution of free nets, leaving communities with even poorer access if free distribution discontinued in the future (Lines et al. 2003; Lengeler et al. 2007).

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On the other side, those advocating mass free distribution of nets claim that commercial strategies will neither be able to achieve nor sustain high levels of coverage in rural Africa (Curtis et al. 2003). They point to numerous studies showing that the cost of ITNs is often prohibitive for poor rural African households, even when nets are highly subsidized (Hanson and Jones 2000, Guyatt et al. 2002, Barat et al. 2004, Cohen and Dupas 2008).

Indeed, the positive externalities of ITN use may imply that private demand for nets will be lower than the socially optimal level of usage. When ITN usage is high, many of the mosquitoes that transmit malaria are killed and infection rates decline even among those not using nets (Magesa et al. 1991, Curtis et al. 1998, Maxwell et al. 1999, Hawley et al. 2003, Maxwell et al. 2003), with approximately equal benefit from personal protection and community-level effects (Curtis et al. 2006). In a study of demand for de-worming medications in Kenya, Miguel and Kremer (2007) demonstrate that ongoing subsidies may be necessary to control infectious diseases characterized by large positive treatment externalities.[4] The emerging consensus understanding of malaria control as a public good underlies the recent change in policy by the World Health Organization, which now recommends the full coverage of all people at risk of malaria in areas targeted for malaria prevention with ITNs (WHO 2007).

Both sides of the debate agree that some level of ITN subsidy for the most vulnerable groups—pregnant women and young children—is warranted (Müller and Albrecht 2003, Lengeler et al. 2007). This is in fact the current policy in most African countries. Under such a policy of targeted subsidies, basic economic theory predicts that at least some beneficiaries will resell their nets to others who place higher value on the nets and are able to pay for them. A local resale market may emerge, or

[4] Whether externalities are to treatment or prevention makes no difference to their conclusion.

entrepreneurs may take advantage of arbitrage opportunities afforded by spatial heterogeneity in ITN prices, buying up nets and transporting these to urban centers or across borders.

Whether these nets are retained and used by their intended beneficiaries or resold to wealthier households that would otherwise have purchased nets through the commercial market affects the efficiency of public expenditures in achieving the public health goal of high coverage for the most vulnerable groups (Lengeler et al. 2007). Further, the development of a commercial market for nets will be hindered to the degree that potential ITN buyers acquire nets through either direct receipt or resale.

The debate over ITN distribution policy echoes elements of the controversy over food aid. If food aid is acquired by households that would otherwise purchase food on the market, either by direct receipt or by purchase on a secondary resale market, the market price of food will decline, sales volumes will decrease, or both. This benefits net food buyers, but harms net sellers, many of whom are also poor. In the long run, lower food prices and marketed volumes diminish expected returns to investment in agricultural production or trade and may lead to stagnation in the rural economy, just as ITN prices due to the saturation of the market with free or subsidized nets could inhibit the development of a commercial ITN sector.

The first question is therefore whether households given nets for free or at a discounted price would otherwise have purchased these through the commercial market. If not, the next question is whether these households, whose valuation of ITNs is apparently below the market price, will resell the nets they receive to others whose valuation is higher. While the development of an active secondary market would seem a logical consequence of allocating nets through any non-market mechanism, households that are unwilling to purchase a good at a given price may simultaneously be unwilling to sell the same good at the same price.

In considering the distribution of ITNs, three factors contribute to the discrepancy between willingness to pay (WTP) and willingness to accept payment (WTA). First, poor households with limited access to cash may be unable to marshal the resources to purchase a net on the market despite high WTP given adequate resources. 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, referred to as the endowment effect, has been widely documented in economic laboratory settings. Finally, in households with more than one decision-maker, the individual receiving a free net may value the net more than the person who has primary control over the household's financial resources. Assuming that the net recipient has more control over a net that he or she receives than over a net acquired by another adult in the household, this could affect both retention and usage of nets.

Through the experiment described in this paper, we test the contribution of each of these factors to the difference between WTP and WTA payment for insecticide-treated mosquito nets. Ultimately, we seek to estimate the cumulative effect of these three mechanisms on the degree to which free nets crowd out market demand, and on equilibrium secondary market resale volume and prices, 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 among non-targeted segments of the population.

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 financial constraints, which may be correlated with gender.

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

2. Willingness to pay for and retention of ITNs

Willingness to pay

Willingness to pay 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. An exception is a recent study by Cohen and Dupas (2007), who randomized ITN prices across rural health centers in rural Tanzania, and found that demand for nets sold at $0.60 was 79 percent lower than when nets were offered for free. Noor et al. (2007) tracked ITN usage over time among households exposed to three ITN delivery models over three years. When nets were commercially marketed, children in the poorest households were less than a fifth as likely to sleep under nets as children in the least poor households. Under free mass distribution, usage was greatly increased and the gap between wealth quintiles was eliminated. 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).

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. However, the same study found lower WTP among single mothers, controlling for income (Cropper et al. 2000), suggesting that married women's higher WTP may have more to do with the division of domestic responsibilities rather than gender-specific preferences over child health. 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.

Retention of ITNs received for free

Maxwell et al. (2006) compared ITN coverage between Tanzanian villages where nets had been marketed and villages where nets had been provided universally and free of charge for the entire population. In the villages where nets had been marketed, only 9.3% of people used nets which were intact and/or had been insecticide-treated, and were therefore protective against malaria. Where nets had been provided free, over 90% of the nets were still present and were brought for re-treatment several years later. The fact that distribution was universal in the free net treatment villages may have limited opportunities for resale. However, high retention of free nets has also been documented where coverage was limited to expectant mothers attending ante-natal clinics (Guyatt and Ochola 2003). Guyatt and Ochola found an overall net retention rate of 91 percent, though this result may have been biased by their failure to locate 40 percent of the original sample for follow-up interviews.

3. Household demand for and supply of a health good

Liquidity and income effects

There are at least three reasons why demand for and resale supply of ITNs may differ. First, for a poor household without access to credit, the cost of an ITN can be prohibitive. As noted in the preceding section, numerous studies have shown financial constraints to be a significant barrier to mosquito net ownership across rural Africa. Distributing ITNs free of charge overcomes the problem of binding cash liquidity constraints, and also 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.[5]

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 a bednet and person B receives a

[5] According to the permanent income hypothesis (PIH), consumer behavior is affected by lifetime expected income (Friedman, 1957). Under this hypothesis, giving a household an ITN should have very little effect on behavior, as the value of this good is small in comparison to the lifetime earnings of even the poorest. However the empirical literature evaluating the PIH has been unable to reach a consensus, with about half of studies rejecting the model. See Browning and Lusardi (1996), Browning and Crossley (2001), and Stephens (2008) for summaries. Particularly relevant to this study is the finding by Keeler et al. (1985) that the marginal propensity to consume out of windfall income amounting to less than 20% of annual permanent income is greater than one.

cash transfer of equivalent value. If person B is then willing to pay a maximum of X for a bednet, the endowment effect implies that person A will demand Y > X to sell his or her net. Kahneman et al. attribute the endowment effect to loss aversion (the tendency to prefer avoiding losses to acquiring gains) or status quo bias. Boyce and coauthors (1992) show that 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 to which subjects ascribe moral considerations. This additional effect may exacerbate the difference between willingness to buy and sell prices for ITNs when these are promoted with reference 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 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. 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.

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 for free nets, and thus to estimate the degree to which free nets crowd out market demand, both directly and through sales of nets from targeted recipients to others.

4. Setting and Data

We conducted this research 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. We chose the two study villages, Rubagano (population approximately 1300) and Kimuli (population approximately 900), for their rural location and remoteness from markets. Hay et al. (2005) show that malaria transmission is much more intense in rural than urban areas. Remoteness from markets ensured that participants' valuation of ITNs would be affected as little as possible by a reference market price, and 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 villages 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 in Mbarara, the closest urban center, for approximately \$5.44. A motorcycle ride to Mbarara costs \$7.63.

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. Once nets are torn, which is almost a certainty in rural settings (Shirayama et al. 2007, Smith et al. 2007), they are ineffective for preventing malaria unless insecticide-treated. Because of this, and because retreatment are generally low, especially in Africa, the World Health Organization now recommends usage of only long-lasting insecticidal nets for subsidized or free distribution (WHO 2007). 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 at least once a 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. Despite the widespread experience of malaria as a costly and often fatal disease, and despite the fact that 88 percent of respondents correctly stated that malaria is transmitted through mosquito bites, only 10 of the 193 participating households were using nets before the study.

5. Methods

Sample selection, treatment assignment, and attrition

Households that included a child 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.[6] Either the head or spouse in each dual-headed household was randomly selected to be the participant for that household. Half of the single participants and a third of the

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

married female and married male participants were randomly assigned to a cash transfer treatment in which they were given cash; approximately the same number in each group were assigned to a free nets treatment. The remaining third of married participants were not given nets or cash, but were given the opportunity to purchase nets with their own resources (own cash treatment).[7] 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 a bidding session. Table 2.1a shows the number of participants assigned to each treatment by gender and marital status. All households in the cash transfer and free nets treatments sent a representative to the bidding session, but 3 of the 50 households assigned to the own cash treatment failed to participate. Participants who missed their assigned session were allowed to attend a later session.

Table 2.1a: Sample by assigned treatment, reported family structure, and gender of assigned participant

		Free nets	Cash	Own cash	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 2.1b: Sample by actual treatment, family structure and gender of participant

		Free nets	Cash	Own Cash	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

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

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 they would receive cash or bednets. The reassignment of individuals between treatments is therefore unlikely to have introduced bias.

A number of households sent a representative other than the one randomly assigned.[8] 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 2.1b shows the final number of participants (after attrition and reassignment) in each treatment by gender and marital status.

Experimental procedures

In the cash transfer treatment, we gave respondents enough local currency to purchase up to three family-sized, long-lasting insecticidal nets (LLINs) at the maximum price of $7.63 per net. In the free nets treatment, we gave respondents an equivalent number of nets. We told participants that the cash or nets, received at the beginning of the session, were compensation for their participation in the study, and that they were free to exchange or keep these as they wished. A member of the research team fluent in the local language read a statement about malaria and the

[8] We did not record the number of households initially sending an individual other than the one randomly chosen.

greater vulnerability of young children and pregnant women to the disease and 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 same team member then 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.

The auction mechanism worked as follows (see the appendix for scripts). Participants placed tokens representing currency in envelopes to indicate their bids. Those in the cash transfer and own cash treatments indicated the maximum they were willing to pay for one net, two nets, and three nets (if applicable) by placing tokens in up to three separate envelopes. In the same way, those in the free nets treatment indicated the minimum amount of cash they were willing to accept to relinquish one, two, and three nets. Research staff assisted with bids if needed, but participants were asked to keep their net bids as confidential as possible. Before bidding on the nets, three public rounds were conducted in which food items and pencils could be exchanged for cash.

After the research team recorded all bids, one of the participants drew a ball to select the price. In the cash treatments, participants who had bid at least as much as the drawn price for a given number of nets exchanged cash for that number of nets. For example, in a three-net session in which the price drawn was p, if a participant bid at least 3p for three nets, he or she would buy all three nets for 3p. If the bid was less than 3p for three nets but at least 2p for two nets, he or she would buy two nets for 2p, and if bidding less than 2p for two but at least p for one, he or she would buy one net. Finally, if a participant bid less than 3p, less than 2p, and less than p for three, two and one net, respectively, he or she 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 at the randomly drawn price.[9] The procedure in the own cash treatment was the same as in the cash transfer treatment, except that participants were not given cash, and had the opportunity to purchase only one net.

6. Results

Balance across treatments

Before discussing outcomes across treatments and sub-groups, we check that the randomization was successful. Table 2.2 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 free nets and cash transfer 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 own cash group differs from the pooled cash transfer and free nets group, again in the number of children, and also in number of women aged 15 to 45 (p=0.08), 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 own cash 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.

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

Table 2.2: Summary statistics by treatment and gender/headship category: means with standard errors in parentheses

	Free nets	Cash	Own cash	Married women	Men	Single women
Value of per capita consumption (US $ / week)	4.74	4.79	4.69	4.57	4.92	4.78
	(0.34)	(0.33)	(0.35)	(0.34)	(0.31)	(0.35)
Age of respondent (years)	39.22	41.61	38.15	37.66	36.81	50.08***
	(1.65)	(1.84)	(2.33)	(1.55)	(1.66)	(2.47)
Respondent is female (1=yes, 0=no)	0.66	0.61	0.53	1.00	0.00	1.00
	(0.06)	(0.06)	(0.07)	(0.00)	(0.00)	(0.00)
Respondent is single (1=yes, 0=no)	0.28	0.29	0.02***	0.00	0.04*	1.00***
	(0.05)	(0.06)	(0.02)	(0.00)	(0.02)	(0.00)
# of household members aged 0-5 years	2.09	1.71**	1.34***	1.84	1.97	1.23***
	(0.13)	(0.12)	(0.16)	(0.11)	(0.14)	(0.16)
# of household members aged 6-14 years	1.69	1.77	1.55	1.80	1.53	1.75
	(0.16)	(0.17)	(0.23)	(0.18)	(0.17)	(0.18)
# of female members aged 15-45 years	0.14	0.15	0.26*	0.20	0.21	0.05**
	(0.04)	(0.04)	(0.06)	(0.05)	(0.05)	(0.04)
# of other household members	1.03	1.09	1.13	1.11	1.23	0.72***
	(0.08)	(0.10)	(0.09)	(0.06)	(0.09)	(0.14)
# of nets offered	2.55	2.49	1.00***	2.04	2.18	2.30*
	(0.07)	(0.07)	(0.00)	(0.10)	(0.10)	(0.10)
Medical & related expenditures resulting from last malaria episode (average across members, $ US)[1]	13.74	12.84		13.14	14.65	11.73
	(1.74)	(1.41)		(1.55)	(1.80)	(2.71)
N	74	69	47	77	74	39

In the first column, + indicates the difference in means between the cash and free nets treatments 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 own cash treatment and the pooled nets and cash treatments.

Valuation of free nets and the endowment effect

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 free nets 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 annual 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 free nets and cash transfer groups were $7.16 and $5.94 respectively, significantly different at $p<0.0001$.[10] Because bids were bounded from above and so many were clustered at the maximum, the differences between WTP and WTA values are likely understated.

Gender effects

Pooling the free nets and cash transfer treatments 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. This result, which is somewhat surprising in light of the previous literature on the effect of women's income on household consumption, maybe be due to the fact that 71 percent of married men and 60 percent of married women discussed what to do in the bidding session with their spouse. A participant's bid may therefore reflect the outcome of an intra-household bargaining process rather than the individual's preferences alone. While this precludes the identification of differences

[10] The number of bids per household varies from one to three, depending on the number of nets offered, which in turn reflects the household size and sleeping arrangements. In calculating these averages, each household's mean bid is treated as a single observation. We do not observe the WTA values of those unwilling to sell at the maximum price offered and so assign these a value of $7.63 as a lower bound.

across gender, our results are more likely to reflect actual household behavior than if participants' decisions had been made in isolation. The difference between single men's and single women's willingness to pay in the cash transfer treatment is large and statistically significant (Table 2.3), but as there are only two single men in this group, we caution against putting much weight on this result.

Table 2.3: Average bid by treatment, family structure, and gender of participant

		Free nets	Cash	Hypothetical own cash	Own cash
Married	Male	7.02	5.85	4.03	2.85
		(0.22)	(0.42)	(0.49)	(0.38)
	Female	7.09	6.13	4.25	1.93††
		(0.20)	(0.43)	(0.52)	(0.24)
Single	Male	7.63	1.77	.	.
		(.)	(0.95)		
	Female	7.42	6.26†††	1.09	1.09
		(0.21)	(0.49)	(.)	(.)
Total		7.16	5.94***	4.08***	2.34***
		(0.11)	(0.26)	(0.35)	(0.23)

††† indicates a difference between men and women within the household structure (married or single) category that is significant at $p<0.01$; †† indicates $p<0.05$.
*** indicates a difference between treatments (comparison is with the treatment immediately to the left) that is significant at $p<0.01$. Tests for significance across treatments are performed on all observations (married, single, female, and male) sample.

Willingness to pay out of own resources

In contrast to the high bid values of those receiving cash or nets, the group using their own cash was willing and able to pay an average of only $2.34 for one net, suggesting that poverty and binding liquidity constraints greatly limit market demand for nets. Within this treatment, men's average WTP was greater than women's by $0.92 ($p<0.05$). This reversal of the ordering of men's and women's WTP as we move from the cash transfer to the own cash 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 collected data on hypothetical WTP values from the own cash group in addition to the incentive-compatible values elicited through the bidding procedure. 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 those receiving cash were willing to pay. The hypothetical WTP values, like the bids of those who received cash or nets, do not differ significantly between men and women, reinforcing the inference that cash liquidity constrains women more than men in this setting.

Simulated market exchanges

We first note that if long-lasting insecticidal nets (LLINs) were commercially available, our results suggest they would be priced out of reach the households in this community. The nets used in this study were procured at $7.63[11], three times the average weekly value of cash consumption per capita and well above the maximum bid of $5.45 in the own cash treatment. Even the hypothetical WTP values are below this lower-bound estimate of the commercial price for 81 percent of households. The majority of respondents in the own cash treatment bid $2.72, the price of untreated nets in the local market, or less (Table 2.4). This suggests an unwillingness to pay more for the greater durability or insecticidal properties of LLINs.

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[11] This is higher than the current bulk purchase price of $5.00 paid by ministries of health and international organizations when purchasing millions of nets at a time; however we believe it is a reasonable estimate of the price a small trader might pay for a few hundred nets, and therefore provides a lower bound on the commercial price of LLINs.

Table 2.4: Cumulative demand for ITNs in the own-cash treatment

Price (USD)	Cumulative demand of households in own-cash treatment (% of households)
5.45	10.64
4.36	12.77
3.81	21.28
3.27	23.41
2.72	53.2
2.18	57.46
1.63	63.84
1.09	76.61
0.54	100.01

Turning next to the hypothetical secondary market for nets, suppose the poorest 40 percent of households (by per capita consumption) in the villages studied 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 own cash buying bids among those in the top 60% of consumption per capita, shown in the heavy downward-sloping dashed line. The poverty line implied by this cutoff is 53 cents per capita per day.

If we ignore both endowment and liquidity effects, then the supply of nets is simply the inverse of the demand for nets among the poorest 40 percent in the own cash group. This is the thin dashed 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 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 liquidity and endowment effects, which effectively extinguish that concern, as we now show.

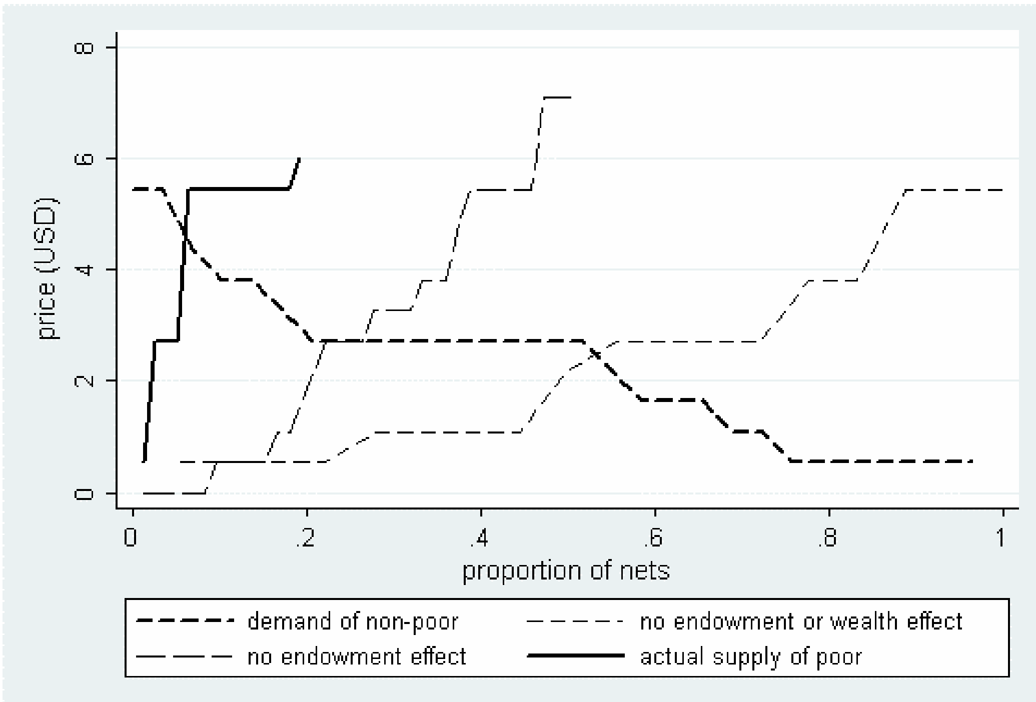

Figure 2.1. The impact of wealth and endowment effects on demand and supply for ITNs

Next we examine how income and liquidity effects change supply while leaving out the endowment effect. The long-dashed supply curve is the inverse CDF of bids among the poor who received the cash transfer. The estimated equilibrium resale price increases to $2.72, and the number of nets sold drops dramatically to 23 percent of those distributed.

Finally, we plot the actual supply of nets among the poor: the heavy solid line is the CDF of bids among the poor in the free nets treatment. This supply reflects both the fact that liquidity constraints are overcome when nets are given for free, 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.[12] 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.

Multivariate analysis

To investigate the degree to which various factors determine demand for and resale of nets, we regress bid values on household per capita consumption, household demographic composition, and age, gender, and marital status of the participant, controlling for the number of nets received. We use a tobit model bounded above at the maximum price of \$7.63 (there were no zero bids). The dependent variable is the respondent's average buying or selling bid for up to three nets.

Considering first the pooled sample (Column 1, Table 2.4), we note the most significant determinants of bid values are the treatment indicator variables. As in the comparisons of means above, those receiving nets for free were only willing to sell their nets at a price significantly higher — by \$2.48 on average, controlling for other covariates — than those who received cash were willing to pay. Those purchasing nets out of their own resources bid lower by \$4.67 relative to those who had been given cash. Household purchasing power also has a significant effect in the pooled sample. For each additional dollar of per capita weekly consumption expenditure, respondents bid an additional \$0.20 per ITN.

Next, we test whether receiving nets for free has any implications on the determinants of valuation beyond increasing the intercept through the endowment

[12] 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.

effect. Columns 2 and 3 report results of a model comparing the determinants of bid values among those in the cash receiving cash and the group receiving nets. The coefficients in Column 2 represent the effect of each variable on the buying bids of those who received cash; Column 3 shows the effect on the selling bids of those who received nets.

The behavior of those purchasing nets with cash we have supplied, while less directly relevant to policy than that of the other groups, is informative about the degree to which purchasing and selling behavior differ, independent of liquidity constraints. Buying bids are highly income elastic: for every dollar of per capita weekly consumption expenditure, participants bid an additional 31 cents for each ITN, implying an income elasticity of willingness to pay of 0.25. In contrast, the elasticity of selling bids is lower at 0.18, and is not statistically significant.

Controlling for covariates, women bid higher than men by almost $2.00 ($p<0.1$), but men are no more likely to sell nets received for free than married women. When the participant is a single parent, the endowment effect is much larger, with significantly lower buying bids and significantly higher selling bids than married participants. This is in line with our observation that married participants discussed what to do in the bidding session with their spouses, and suggests that to at least some degree their behavior was determined by this discussion.

We also find that respondents with more young children in the household bid significantly lower when purchasing nets, reflecting the well-known negative association between quantity of children and quality of children. The number of young children has no effect when the decision is whether to sell nets received for free.

Table 2.5: Determinants of bid values[1]

	Pooled sample	Received cash vs. received nets		Used own cash vs. received nets	
		cash treatment	free nets treatment	own cash treatment	free nets treatment
expenditures per capita (USD/week)	0.182**	0.314*	0.269	0.048	0.169
	(0.087)	(0.162)	(0.255)	(0.113)	(0.122)
age of participant	0.002	0.026	-0.032	0.003	-0.026
	(0.017)	(0.034)	(0.056)	(0.019)	(0.027)
participant is female	0.334	1.825	0.948	-1.004*	0.470
	(0.466)	(1.111)	(1.128)	(0.518)	(0.552)
participant is single parent	-0.295	-2.924**	2.377	-1.490	1.797*
	(0.717)	(1.415)	(1.901)	(1.924)	(0.950)
# of members aged 0-5 yrs	-0.406*	-1.173*	0.246	-0.508**	0.085
	(0.228)	(0.594)	(0.525)	(0.246)	(0.243)
# of members aged 6-14 yrs	0.106	0.119	0.086	0.109	-0.042
	(0.170)	(0.412)	(0.422)	(0.206)	(0.190)
female aged 15-45 years	-0.446	-0.597	-1.869	-0.003	-0.756
	(0.574)	(1.307)	(1.567)	(0.606)	(0.728)
# other adults	0.131	0.179	0.799	0.031	0.296
	(0.317)	(0.608)	(1.031)	(0.512)	(0.473)
number of nets offered [2]	-0.085	0.504	-1.276		
	(0.517)	(1.066)	(1.198)		
free nets treatment	2.689***				
	(0.529)				
own cash treatment	-4.744***				
	(0.936)				
constant	6.407***	4.914	5.985	7.690***	-4.638**
	(1.545)	(3.203)	(4.570)	(1.291)	(1.788)
Number of observations	186	139		119	
Adjusted R2	0.202	0.099		0.364	

* 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] Number of nets offered does not vary for the own cash treatment; all participants in this treatment were offered one net.

In the final two columns, we test for differences in the correlates of bid values when participants are spending their own cash versus when they received free nets. The income elasticity of bids is low and not statistically significant for the own cash group, suggesting that even for less-poor households, lack of access to cash may be a barrier to acquiring nets. The lower WTP among women in the own cash group, also seen in the comparisons of means, remains statistically significant at $p<0.1$ in the multivariate model. Finally, as in the cash treatment, participants with more young children in the own cash treatment are willing to pay significantly less for nets.

In sum, standard of living influences willingness to pay for a mosquito net even when cash liquidity is not a barrier, whereas willingness to sell is not significantly higher among the poor. Differences in willingness to pay across 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. Single heads, who are almost exclusively women, are more reluctant to give up nets than married women or men, but also less likely to purchase them. Finally, giving nets for free appears to overcome a negative relationship between number of children and demand for child health observed in the treatments that used own cash or cash received through the study.

7. Conclusion

That cost is a major barrier to ITN use in rural Africa is well-documented. Despite their inability to pay market prices for long-lasting ITNs, we find that very few households are willing to sell nets they have received for free. Distributing nets free of charge overcomes liquidity constraints and represents substantial income transfer for poor households. Liquidity and income effects account for 75 percent of the difference between the price participants are willing and able to pay, and the price at which they are willing to relinquish a free mosquito net.

A large literature in behavioral and experimental economics emphasizes that the decision to purchase a good is not equivalent to the decision to sell. The endowment effect — a reluctance to part with the things one owns — compounds the role of liquidity constraints and income effects in the spread between buying and selling prices. Together, these effects mean that in-kind transfers are likely to stick, at least partially, to a targeted group which would otherwise be unable or unwilling to pay for a good. This sharply reduces unintended reselling — so-called "external leakage" — to the non-poor and associated undermining of commercial market distribution channels.

A simulation of the market for nets in the rural western Ugandan villages studied 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 married men and women, possibly because decisions about how much to pay or charge for a net were made jointly by couples. However, 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.

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 very few households were willing to sell free nets, suggests that targeted distribution of free or highly subsidized nets to rural households is a viable strategy for achieving higher rates of insecticide-treated bednet usage in areas with low existing coverage. Our finding that households with more young children are willing to pay less for nets but are no less likely to sell nets received for free provides additional support for the emerging consensus that free distribution of ITNs is important for increasing coverage of the most vulnerable.

APPENDIX - Willingness to Pay For and Usage of Insecticide-Treated Mosquito Nets: Household Questionnaire I

A. HOUSEHOLD ROSTSER & NET USE

I will ask you about each of the members of this household and ask you to show me where they sleep. Please list in order from oldest to youngest. *NOTE: A household is a group of people who live in the same house and eat together. If someone is away and will be for the next 5 weeks, do not count that person as part of the household.*

(A1) ID	(A2) Name	(A3) write X if primary respondent	(A4) Gender **M / F**	(A5) Age (yrs) at last birth day	(A6) Relation-ship to head **use codes**	(A7) Educ-ation **use codes**	(A8) Mother's educ-ation (adults only) **use codes**	(A9) Father's educ-ation (adults only) **use codes**	(A10) Shares sleeping place with which other member(s)? (IDs from A1; NA if none)			(A11) Net hanging above sleeping place? **Y / N** **observe** ***N→A12***	(A12) Inspect net: is it in good condition (free of holes)? **Y / N** **observe**	(A13) Would it be difficult to hang a mosquito net over [name's] sleeping place? (is it close to a cooking fire, are the walls difficult to reach or difficult to attach ropes to?) **ask respondent**
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

Codes

General
Y=yes N=no
NA =not applicable
DK=don't know
R=refused to answer

Relationship to household head (A6)
1=head
2=spouse
3=child of head & spouse
4=child of head only
5=child of spouse only
6=parent
7=other relation
8=no relation

Education (A7 – A9)
0=no formal education
A=adult education only
P1=primary 1
P2= primary 2
…
P7=primary 7
S1=secondary 1
…
S6= secondary 6
T= any post-secondary

Draw a diagram of the dwelling and sleeping places, marking any features that will help identify their locations, and write the ID numbers of the people who usually sleep in each place.

B. MALARIA (*PRIMARY RESPONDENT SHOULD BE PRESENT; MAY BE ASSISTED BY OTHERS*)

(B1) What are the symptoms of malaria? (do not prompt, circle the number of each cause given by respondent) 1=fever 2=chills 3=headache 4=weakness 5=vomiting 6=loss of appetite 7=convulsions 8=joint pain 9=dizziness 10=backache 11=other (specify) _______________

(B2) How does a person get malaria? (do not prompt, circle the number of each cause given by respondent) 1=mosquito bite 2=drinking bad water 3=getting wet 4=being around stagnant water 5=eating specific food 5=curse 6=God's will 7=don't know 8=other (specify)___________

								During this person's most recent malaria episode::									
B3) ID	(B4) Name (may abbreviate)	(B5) Does [name] usually get malaria every year? (Y/N) If Y → B5 If N → B6	(B6) How many times per year?	(B7) Years before [name] usually gets malaria? (100 if never)	(B8) Months since last malaria episode	(B9) Was the illness serious (possibly life threatening)? (Y/N)	(B10) Number days [name] unable to perform usual activities	(B11) Did someone take on [name]'s activities? List IDs (from B3) of up to 2 people, (99 if non hh member)				(B12) Did someone suspend their own activities to care for [name]? List IDs (from B3) of up to 2 people, (99 if non hh member)				(B13) Total cost of treatment including transport of patient, caregiver (SH)	(B14) Financial assistance from outside household if any (SH)
								ID	full days	ID	full days	ID	full days	ID	full days		
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

(B15) (a) Has any relative or friend of yours ever died of malaria? (Y/N) _______
(b) Relationship with **primary** respondent? (child, friend, etc.) __________ (c) Age at time of death _____ (d) When? (year) _______

C. HOUSEHOLD ASSETS

(C1) Does anyone in this household own or cultivate any land? (Y/N) ______ *if no → C12*
(C2) How many pieces of land/plots do people in the household cultivate? _____
(C3) How many pieces of land/plots do people in the household own but not cultivate? ____

I will now ask for details about all pieces of land either cultivated or owned by the household.

land ID	(C4) identifying feature	(C5) size units: ac=acres ha=hectares ft=sqr feet mt= sqr mtrs		(C6) How acquired? (use codes below)	(C7) if you were to sell this land today, how much would you get? (SH) **→ C9**	(C8) who **mainly** controls income from this piece of land? (ID from A1; if shared **equally** list 2 IDs)		(C9) if inherited, received as a gift, bride-price, or borrowed, who received? (ID from A1)		(C10) if purchased or rented in, who **mainly** purchased or pays rent? (ID from A1; list 2 IDs if 2 members contributed **equally**)		(C11) when acquired? 1=before member listed in C9 or C10 joined household 2=after joined household
		size	unit	***if 2 → C8*** ***if 4 → C9***								
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

C12. Does anyone in this household own livestock? (Y/N) ______ **If no, → C19**

Use a separate line for each member, type of livestock, and type of acquisition.

(C13) ID (from A1) of **primary** owner (who has right to sell?) (list two IDs if ownership **equally** shared)		(C14) type of livestock **(codes at right)**	(C15) how were these animals acquired? **(codes at right)**	(C16) when acquired? 1=before owner (C13) joined household 2=after owner joined household	(C17) number owned?	(C18) if sold today, how much would you get in total for these animals?

Acquisition codes (C6, C15)
1=purchased
2=rented in
3=received as gift
4=inherited
5=bride price
6=borrowed
7=other (specify) ______________

Livestock codes (C14)
1=local cattle
2=hybrid cattle
3=pigs
4=goats/ sheep
5=poultry
6=rabbits
7=other 1 (specify) ______________
8=other 2 (specify) ______________

Note: if more than one member owns a category of asset, or if an asset has been acquired through more than one means (C20), enter additional line as 'other' and specify asset type (lines 25-28

Does any household member have a…	(C19) Who is the **primary** owner? (who has right to sell?) ID from A1 (if ownership is shared **equally**, write two IDs)		(C20) how acquired? 1=purchased 2=rented in 3=received as gift 4=inherited 5=bride price 6=self-made 7=other (specify) ________	(C21) when acquired? 1=before owner (C19) joined household 2=after owner joined household	(C22) number owned?	(C23) if sold today, how much would you get in total for these items?
1. Sewing machine						
2. Shoe making equipment						
3. Bicycle tools						
4. Motorcycle / vehicle tools						
5. Carpentry tools						
6 .Mill for maize / millet / cassava						
7. Groundnut grinding machine						
8. Coffee pulping machine						
9. Sugar cane press						
10. Brewing equipment						
12. Brick making equipment						
13. Bicycle						
14. Motorcycle						
15. Vehicle						
16. Ox cart						

Does any household member have a…	(C19) Who is the **primary** owner? (who has right to sell?) ID from A1 (if ownership is shared **equally**, write two IDs)		(C20) how acquired? 1=purchased 2=rented in 3=received as gif t 4=inherited 5=bride price 6=self-made 7=other (specify) ________	(C21) when acquired? 1=before owner (C19) joined household 2=after owner joined household	(C22) number owned?	(C23) if sold today, how much would you get in total for these items?
17. Hoe						
18. Machete						
19. Wheel barrow						
20. Plough						
21. Beehives						
22. Chemical sprayer						
23. Tractor						
24. Milking machine						
25. other 1 __________						
26. other 2 __________						
27. other 3 _________						
28. other 4 _________						

D. INCOME-GENERATING ACTIVITIES

To primary respondent: Now I have some questions about the income-generating activities and personal expenses of all the household members. I will need to talk with each member of the household who is **18 years or older** about their own activities, and to the **parents of all children 6 years and older** about their **children's activities**.

To each individual respondent: Did [you / name of child] work as much as usual during the past 7 days? If so, please answer these questions for the **past 7 days**. If not, please answer these questions for a **typical 7-day period during this season**.
There is some work you do from which your household as a whole or another household member controls the proceeds; you may do other work from which **you alone** control the proceeds. I will ask about both types of work.

NOTE TO INTERVIEWER: After completing this section for each individual, also turn to next section to ask about personal expenses.

(D1) ID	(D2) Name	(D3) How many hours did you / [name] spend cultivating a plot from which the proceeds are **shared by the household** or controlled by **another household member**? *if zero → D6*	(D4) How much would you have to pay someone to do the same amount and quality of this work that you / [name] did in 7 days? (SH)	(D5) Who **mainly** controls the proceeds from this activity? (ID from D1; if shared **equally**, list two IDs)	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

(D6) How many hours did you / [name] spend cultivating a plot from which **you / [name] alone** control(s) the proceeds? *if zero → D13*	(D7) How much would you have to pay someone to do the same amount and quality of this work that you did in 7 days? (SH)

(D1) ID	(D8) How many hours did you / [name] spend <u>tending livestock</u> from which the proceeds are **shared by the household** or controlled by **another household member**? *if zero → D11*	(D9) How much would you have to pay someone to do the same amount and quality of this work that you / [name] did in 7 days? (SH)	(D10) Who **mainly** controls the proceeds from this activity? (ID from D1; if shared **equally**, list two IDs)	
1				
2			-	
3				
4				
5				
6				
7				
8				
9				
10				
11				

(D11) How many hours did you / [name] spend <u>tending livestock</u> from which **you / [name] alone** control(s) the proceeds? *if zero → next page*	(D12) How much would you have to pay someone to do the same amount and quality of this work that you/ [name] did in 7 days? (SH)

D13) ID	(D14) Name	(D15) How many hours did you / [name] spend <u>taking goods to market</u> from which the proceeds are **shared by the household** or controlled by **another household member**? *if zero → D18*	(D16) How much would you have to pay someone to do the same amount and quality of this work that you / [name] did in 7 days? (SH)	(D17) Who **mainly** controls the proceeds from this activity? (ID from D13; if shared **equally**, list two IDs)	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

(D18) How many hours did you / [name] spend <u>taking goods to market</u> from which **you / [name] alone** control(s) the proceeds? *if zero → D20*	(D19) How much would you have to pay someone to do the same amount and quality of this work that you did in 7 days? (SH)

D(13) ID	(D20) How many hours did you / [name] spend working on a non-farm enterprise from which the proceeds are **shared by the household** or controlled by **another household member**? *if zero → D23*	(D21) How much would you have to pay someone to do the same amount and quality of this work that you / [name] did in 7 days? (SH)	(D22) Who **mainly** controls the proceeds from this activity? (ID from D13; if shared **equally**, list two IDs)	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

(D23) How many hours did you / [name] spend working on a non-farm enterprise from which **you / [name] alone** control(s) the proceeds? *if zero → next page*	(D24) How much would you have to pay someone to do the same amount and quality of this work that you / [name] did in 7 days? (SH)

D25) ID	(D26) Name	(D27) How many hours did you spend <u>working for pay</u> for someone else? If zero → D29	(D28) How much were you paid for this work (what you did in the past 7 days)? (SH)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			

Before moving to the next section, ask each individual:

Do you do any income-generating activities which you have not already told me about?

If yes, go back and add these to the appropriate cells above.

E. INDIVIDUAL CONSUMPTION

(ADULTS OVER 18 ONLY)

	Now I am going to ask you about items you may have acquired over the last **12 MONTHS**. By acquired, I mean items you bought for yourself or were given to you. What is the **value (SH)** of all the … you have acquired in the past 12 MONTHS?				Now I am going to ask you about your personal expenditures over the **PAST 2 WEEKS**. How much did you spend on … in the past TWO WEEKS?					
ID	(E1) Name	(E2) Fabric, clothing, footwear (SH)	(E3) Jewelry, watches	(E4) Health care, including transport of self and care giver (include amount reported in Malaria section within past 12 months) (SH)	(E5) Food consumed outside the home (at restaurants, bars, on the street) (SH)	(E6) Beverages consumed outside the home (SH)	(E7) Tobacco / cigarettes (SH)	(E8) Games of chance / gambling (SH)	(E9) Sportin g events, music, disco, contribu tion, to clubs, etc. (SH)	(E10) Cosmetics, body lotions, perfume, hair / salon services, etc. (SH)
1										
2										
3										
4										
5										
6										
7										
8										

F. HOUSHOLD CONSUMPTION

(F1) How many meals do people in your household normally eat each day? _____
(F2) Was anyone listed in Section A away from meals this week? _____
If yes, who and for how many meals?

	(a)	(b)	(c)	(d)	(e)	(f)
(F3) ID						
(F4) # meals away						

(F5) How many guests did you host for meals during the past week? _____
(F6) Please list their age, sex, and number of meals taken.

Guest	(a) # meals	(b) sex	(c) age
1			
2			
3			

Guest	(a) # meals	(b) sex	(c) age
4			
5			
6			

F7. Now I will ask you how much food people, including visitors, consumed in your home during in the past week. Please try to remember as accurately as possible. Remember that your answers are confidential.

Item Description	Total amount used in 7 days	Unit of Measure kg=kilo lit=liter pc=pieces gr=gram fin=fingers oth=other	Purchased		Home-produced or gift		Specify unit if **other** in column (b)	*Calculate value per unit: is it reasonable? If not, probe.*
			Amt.	Value(SH)	Amt.	Value (SH)		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1. Matooke (peeled)								
2. Yellow bananas								
3. Maize (cobs)								
4. Maize (flour)								
5. Beans (dry)								
6. Rice (dry)								
7. Millet/sorghum (dry)								
8. Bread (loaves)								
9. Bread (buns)								

Item Description	Total amount used in 7 days	Unit of Measure kg=kilo lit=liter pc=pieces gr=gram fin=fingers oth=other	Purchased		Home-produced or gift		Specify unit if **other** in column (b)	*Calculate value per unit: is it reasonable? If not, probe.*
			Amt.	Value(SH)	Amt.	Value (SH)		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
10. Chapati								
11. Mandazi								
12. Sweet Potatoes								
13. Casava (Fresh)								
14. Cassava (Dry/Flour)								
15. Irish Potatoes								
16. Beef								
17. Goat/sheep meat								
18. Chicken								
19. Fresh Fish							cm if pieces	
20. Dry/Smoked fish							cm if pieces	
21. Eggs								
22. Fresh Milk								
23. Cooking oil / fat								
24. Avocadoes								
25. Pineapples								
26. Pawpaw								
27. Other Fruits								
28. Onions								
29. Tomatoes								
30. Eggplant (big)								
31. Eggplant (small)								
32. Dodo (bunches)								
33. Cabbage								

Item Description	Total amount used in 7 days	Unit of Measure kg=kilo lit=liter pc=pieces gr=gram fin=fingers oth=other	Purchased		Home-produced or gift		Specify unit if **other** in column (b)	*Calculate value per unit: is it reasonable? If not, probe.*
			Amt.	Value(SH)	Amt.	Value (SH)		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
34. Green peppers								
35. Other vegetables								
36. Groundnuts								
37. Sugar								
38. Coffee								
39. Tea								
40. Salt								
41. Spices (curry, etc.)								
42. Soda, mineral water								
43. Bottled beer								
44. Local beer								
45. Juice								
46. Milling expenses (kg)								

F8. During the past month, how much did people in your household spend on:	Amount (000 SH)
1. Water *(not including that recorded in D31)*	
2. Fuel for cooking	
3. Matches	
3. Batteries	
4. Electricity	
5. Kerosene & other lighting fuel	
6. Soap (for dishes, personal use)	
7. Laundry soap	
8. Toothpaste and cosmetics	
9. Air time & other communications (not handset)	
10. Newspapers, magazines	
11. Transport fares (bus, boda-boda, special hire)	
12. Fuel for boda, vehicle	
13. Medicines and medicinal herbs	
14. Clinic / Hospital / Traditional doctor fees	
15. Laundry services / house help	
16. Contributions to church / mosque / community group	
17. Funeral contributions	

F9. In the past year, how much did people in your household spend on:

1. Home repairs and improvements	
2. Tuition fees / boarding / school uniform	
3. School books and stationery	
4. Kitchen items (pots, pans, stoves etc.)	
5. Plates, cups, cutlery, etc.	
6. Buckets, jerry cans, plastic basins, etc	
7. Electronic equipment (mobile handset, radio, etc.)	
8. Repairs of electronic equipment	
9. Bulbs, switches, etc.	
10. Furniture (beds, chairs, tables, etc.)	
11. Carpets, mats	
12. Mattresses, sheets, blankets	
13. Mosquito nets	
14. Bicycles	
15. Motorbikes, vehicles	
16. Tires and other repairs for vehicles, bicycles	
17. Children's clothing and shoes	
18. Books (not for school)	
19. Household functions (weddings, parties,…)	

G1. In the next phase of this study, you will be given or have the chance to purchase a mosquito net. We will then send someone to check how you are using this net while you and your family are sleeping. Who would you prefer to do this? (*encourage respondent to consult other household members about this decision; circle the answer)*

1=someone from the community who has been selected at a community meeting
2=someone from outside the community (one of the staff from this study)

G2. Do you have a preference for the gender of the net checker? (*Circle) 1=**M** 2=**F** 3=**doesn't matter***

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

All treatments: 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 and Own Cash Treatments:

[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

Cash Transfer and Own Cash Treatments: 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 and Own Cash Treatments:
<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.

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CHAPTER THREE

PSYCHOLOGY, GENDER, AND THE INTRAHOUSEHOLD ALLOCATION OF FREE AND PURCHASED MOSQUITO NETS[13,14]

Abstract:

This paper reports results from a field experiment in Uganda. 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 is attributable to the endowment effect (more nets were retained when received for free than offered for sale), and to differences in how purchased and free nets are allocated within the household. Nets received for free were more likely to be used by young children. Purchased nets, on the other hand, were used by those members of the household, often adults, believed by participants to suffer from malaria most frequently. When a married woman received nets, the probability that her children used these increased with the educational attainment of her husband.

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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 (Müller and Jahn, 2003). 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.[15] 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 that the vast majority of these are used by the women and their newborn infants (Guyatt and Ochola 2003,

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

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. Parents or guardians of young children were randomly assigned to receive either cash or ITNs, and then had the opportunity to trade the ITNs for cash or vice versa. Usage of nets was observed during nighttime checks three weeks later. Almost all (97 percent) of the individuals who acquired one or more nets were sleeping under a net, as were 93 percent of those who shared a sleeping place with this person. Nets that had been received in kind were more likely to be used by young children in accordance with information given to all participants that children are more vulnerable to malaria. Purchased nets were more likely to be used by those household members perceived to experience at least one malaria episode each year. Educational attainment of the participant had no effect on child usage, however the husband's education was associated with children's usage when a married woman received or purchased nets. This suggests that women may not be able to implement health related knowledge without the agreement of their husbands, and that men should be included in education efforts to promote child health.

In the following section I review the literature on the household economics of malaria. Findings from the behavioral economics and intrahousehold decision-making literatures raise issues 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 (2003) 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. 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 a 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 and individual decision-making

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.

Psychological effects

That income has limited fungibility runs counter to standard theory but is well established empirically (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 I conducted the present study, 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.

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 as their 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 agents experience guilt if they believe they let others down (Charness and Dufwenberg 2006). Charness and Dufwenberg's formulation of guilt aversion requires a second party who is materially affected by an agent's actions, and has expectations concerning those actions. However the Boyce et al. and Irwin experiments suggest that a desire to act morally may also influence decisions in the absence of such a second party, and that perceptions of moral obligation are highly sensitive to framing. If a mother receives a free mosquito net 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 a different member of the household, would trigger feelings of guilt.

Receiving the same information along with 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 health outcomes by targeting resources to women, based on the assumptions that mothers have particularly strong preferences for their children's health, and that they are able to exert control over income they receive. Indeed, stated preferences have been shown to differ systematically by gender (Kusago and Barham 2001), and the share of income earned by women is 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, Duflo 2003). 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).

The empirical studies cited above do not generally control for how income is derived.[16] 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 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 larger share from pensions and

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

social security relative to men, who earn a greater portion from financial and physical assets. Hoddinott and Haddad's (1995) analysis relied on attributing 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).

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, whereas targeting transfers of nets or cash to a female rather than a male guardian does not. The latter result suggests that either women's and men's preferences for child usage of nets do not differ significantly, or that the transfer of a net or cash does not change the bargaining power within the household.

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 $buy_n(W_i, X_i, Z_h, p)$, and the conditional probability of a child sleeping under one of these as $cu(n, X_i, Z_h \mid buy_n)$. 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:

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

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, respectively, 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:

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

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 liquidity and endowment effects, households are unlikely to purchase nets out of their own resources, and yet are unlikely to sell nets received for free (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 $cu\left(n, X_i, Z_h \mid retain_n\right)$ and $cu\left(n, X_i, Z_h \mid buy_n\right)$. 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.[17] 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 was chosen.[18] 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-

[17] Return transportation to Mbarara cost US $7.63.
[18] 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.

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. 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.

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.[19] 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.

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.

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

Table 3.1a 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 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 3.1c, 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.

Table 3.1a: 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 3.1b: 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 3.1c: 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 3.1d: 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 3.1e: 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

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 3.2. 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 adults ($p<0.1$).

Experimental procedure

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.[20] The transfer of nets or cash was intended to be sufficient to acquire nets for all household members.

[20] 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.

Table 3.2: Means of household and respondent characteristics, by treatment, gender and headship

	Treatment		Respondent gender and headship		
	Received nets	Receive d 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	4.85	4.88	4.82	4.81	5.04
(USD/week)	(0.36)	(0.36)	(0.38)	(0.48)	(0.40)
Share of household income under	0.40	0.36	0.39***	0.26	0.58***
respondent's control	(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	3.73	4.23	5.04	4.73	0.87***
or single female head	(0.44)	(0.48)	(0.48)	(0.56)	(0.27)
Years education of	2.81	2.87	2.97	2.71	.
spouse	(0.48)	(0.46)	(0.43)	(0.50)	(.)
Proportion of household children 5 years or younger who "suffer	0.81	0.86	0.87	0.78	0.87
from malaria every year"	(0.04)	(0.04)	(0.04)	(0.05)	(0.06)
Proportion of household members aged 15-59 who "suffer from	0.89	0.94	0.92	0.88	0.94
malaria every year"	(0.03)	(0.02)	(0.03)	(0.03)	(0.04)
HH average expenditure on last malaria episode of child 5 or younger	9.75	6.62	8.22	9.17	7.00
(USD)	(1.54)	(1.44)	(1.27)	(2.06)	(2.32)
HH average expenditure on last malaria episode of member $\geq$ 6 years	17.07	15.71	18.12	14.33	17.23
(USD)	(2.26)	(2.07)	(2.43)	(1.93)	(4.34)
# of members aged 0-5	2.20	1.95	2.26	2.18	1.60***
yrs	(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)

Table 3.2 (Continued)

	Treatment		Respondent gender and headship		
	Received nets	Received cash	Male	Female married	Female single
	(1)	(2)	(3)	(4)	(5)
# 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%

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.

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 the Appendix to Chapter 2 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.[21]

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 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

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

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.[22] 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 3.3a and 3.3b.

Table 3.3a: 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 3.3b: 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

[22] 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.

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.

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 3.4). 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—and not statistically significantly different—across treatments, at 0.40 and 0.42 among the cash and net transfer groups, respectively. 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 had received; 13.5 percent of the cash transfer group had at least one unused net.

Table 3.4: 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	0.99	0.85***
Nets obtained per capita	0.42	0.33***
Nets per capita, conditional on acquiring at least one net	0.42	0.40
Number of unused nets	0.19	0.14
Proportion with at least one net unused	0.10	0.14

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

Individual usage

Looking first at the usage rates across age and gender categories (Table 3.5), the elderly, women of child-bearing age, and other adults are the most frequent users of nets.[23] 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,

Table 3.5: 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	0.69	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

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

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

even conditional on having acquired at least one 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. Pregnant women and young children are the demographic group most vulnerable to severe malaria. Pregnancy is not reliably observed, and women of childbearing age are also income earners and often share a sleeping place with the household head, and so could be using nets for multiple reasons. In what follows I focus on the net usage of children aged five years and younger in order to more easily identify what leads households to protect those most at risk.

Table 3.6 presents results from a linear regression model in which the dependent variable is the household-level proportion of children aged five years and younger using nets in the free nets and cash transfer groups.[24] Households that did not acquire any nets through the experiment are assumed not to have changed their usage since the baseline survey. As described in Section 4, net allocation depends on two separate but related decisions. Participants decide both how many nets to purchase or retain and how to allocate any nets among household members. Both decisions clearly affect children's usage. The most basic and arguably most policy-relevant comparison across treatments does not separate the effect of these two decisions. The first column in Table 3.6 shows that child coverage in the free nets treatment is 20.5% higher on average than in the cash transfer treatment, unconditional on the number of nets obtained. This effect is significant at the one percent level, and is robust to including the number of children in the target age group and the educational attainment of the household head as controls (column 2).

[24] Qualitatively similar results obtain using a probit specification in which the dependent variable is equal to one if all children are using nets and zero otherwise.

Mode of receipt remains a significant predictor of child usage when controlling for the number of nets acquired (columns 3 and 4). However simply entering the number of nets on the right hand side is problematic since this also a choice variable and is clearly related to the decision of who will use the nets. I therefore use the number nets given or offered for sale to the household as an instrument for the number of nets acquired.

Recall that the number of nets or amount of cash given to a participant depended upon the number of people and distinct sleeping places in the participant's household 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 may be directly correlated with children's net usage. Thus, the stepwise form of the ITN transfer function is the source of exogenous variation I exploit to identify the effect of the first-stage decision of how many nets to purchase or retain.[25] 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).

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[25] A potential weakness of this identification strategy lies in the possibility that after controlling for household size, number of beds, and members per bed in a linear manner, correlation between the instrument and latent preference for child health (which may be reflected in household size and number of beds) remains. To explore this concern I test a specification that includes squared terms of these control variables. This yields results identical to those presented (available from the author).

Table 3.6: 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	OLS				Limited Information Maximum Likelihood			
Dependent variable	Proportion of ≤5s using				# of nets acquired	Proportion of ≤5s using	# of nets acquired	Proportion of ≤5s using
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Received nets in kind	0.205***	0.226***	0.122*	0.143**	0.396***	0.158**	0.439***	0.171**
	(0.070)	(0.070)	(0.066)	(0.065)	(0.130)	(0.076)	(0.128)	(0.076)
Years education of head		0.018*		0.020**			-0.016	0.020**
		(0.010)		(0.009)			(0.017)	(0.009)
# children ≤ five years of age		-0.046		-0.050			-0.196***	-0.045
		(0.036)		(0.033)			(0.073)	(0.041)
Household size					-0.118	0.021	-0.084	0.023
					(0.129)	(0.062)	(0.126)	(0.061)
Number of distinct sleeping places					0.266	-0.032	0.289	-0.037
					(0.199)	(0.102)	(0.194)	(0.099)
Members per sleeping place					0.282	-0.104	0.348	-0.113
					(0.417)	(0.209)	(0.406)	(0.202)
# of nets acquired			0.190***	0.195***		0.090		0.111
			(0.036)	(0.036)		(0.101)		(0.099)
# of nets offered					0.777***		0.772***	
					(0.155)		(0.152)	
Constant	0.594***	0.609***	0.226***	0.229**	-0.782	0.598	-0.720	0.581
	(0.051)	(0.090)	(0.084)	(0.107)	(0.813)	(0.387)	(0.792)	(0.376)
							131	131
F-statistic on excluded instrument					25.08		25.84	
Observations	131	131	131	131	131	131	131	131
Adjusted R-squared	0.055	0.072	0.215	0.243	0.351	0.152	0.384	0.193

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

The excluded instrument is a highly significant predictor of nets acquired per member, with an F-statistic greater than 25 in both specifications. Controlling for the number of nets acquired in this way, receiving nets in kind has an independent effect on children's usage (columns 6 and 8). Conditional on household size and number of distinct sleeping places, households with more young children tend to acquire fewer nets. Education of the household head is positively associated with child net usage.

Table 3.7 presents results related to the gender of the (cash or net) transfer recipient. Only households headed by a married couple are included in this analysis. Across specifications, the gender of the net recipient has no effect on children's usage. Educational attainment of the participant likewise has no effect. However, for the sub-sample of households for which the transfer recipient was a woman, the probability that all children will sleep under a net is affected by the education of the participant's husband. Spouse's education has no effect on the usage of nets obtained by men. This suggests that married women may not have sufficient power within the household to implement health-related behaviors even when they are provided with external resources. Educating fathers as well as mothers about child health may therefore be important.

Table 3.7: 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.

	OLS				Limited Information Maximum Likelihood			
Sample	Two-Parent Households	Married Women	Married Men		Two-Parent Households			
Dependent Variable	Proportion of ≤5s using				# of nets acquired	Proportion of ≤5s using	# of nets acquired	Proportion of ≤5s using
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Participant was married woman	0.076	0.017			0.110	0.090	-0.008	0.037
	(0.079)	(0.098)			(0.160)	(0.075)	(0.191)	(0.090)
Years education of participant		-0.005	-0.002	-0.002			-0.041	-0.002
		(0.015)	(0.018)	(0.026)			(0.029)	(0.015)
Years education of participant's spouse		0.022	0.034**	0.001			0.005	0.023*
		(0.015)	(0.017)	(0.028)			(0.028)	(0.013)
# children ≤ five years of age		-0.034	0.069	-0.082			-0.170**	-0.057
		(0.041)	(0.063)	(0.054)			(0.085)	(0.045)
Household size					-0.096	0.074	-0.053	0.080
					(0.158)	(0.072)	(0.155)	(0.071)
Number of distinct sleeping places					0.228	-0.092	0.199	-0.085
					(0.246)	(0.117)	(0.242)	(0.113)
Members per sleeping place					0.107	-0.314	0.001	-0.294
					(0.497)	(0.236)	(0.490)	(0.231)
# of nets acquired						0.038		0.053
						(0.121)		(0.120)
# of nets offered					0.742***		0.724***	
					(0.187)		(0.183)	
Constant	0.686***	0.726***	0.451***	0.882***	-0.186	1.037**	0.470	0.978*
	(0.057)	(0.124)	(0.166)	(0.159)	(1.018)	(0.477)	(1.036)	(0.517)
F-statistic on excluded instrument					15.68		15.60	
Observations	97	97	50	47	97	97	97	97
Adjusted R-squared	-0.001	0.001	0.068	-0.012	0.275	0.070	0.309	0.109

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

Determinants of individual net usage

Next 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. As above, 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.

Most households consist of a nuclear family in which a single guardian or couple cares for one or more children. The share of total household labor income earned by those sharing a bed with the recipient of the cash or nets transfer is 75 percent on average. This makes it difficult to separately identify the effects of individual income, headship, and net receipt on usage. I therefore control for these variables jointly with an indicator variable that is equal to one if the individual shares a sleeping place with the experimental participant. In 54 percent of sample households, no young children were sharing the bed of the individual who received the net or cash transfer.

The two other individual-level explanatory variables are indicators signifying 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 in the household-level 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 3.8, show that the strongest predictor of using a net is sharing a sleeping place with the individual who acquired the nets. Indeed, in all but four cases, those who had received or purchased nets were later found to be using a net (in two of these households the nets were not being used by anyone). When purchased with a cash transfer, nets were more likely to be used by those perceived to suffer from malaria most frequently, whereas young children were favored for use when nets were received in kind (column 2). Recall from the discussion of baseline characteristics that adults are perceived as suffering from malaria more frequently than young children.

Restricting the sample to dual-headed households, the way in which women and men allocate nets among household members does not differ significantly (column 4). This may be due to the fact that women do not control usage even when they are the ones to receive or purchase nets, as suggested by the effect of husband's education on the use of nets acquired by women.

Table 3.8: 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.

	Effect of free receipt		Effect of female recipient	
	(1)	(2)	(3)	(4)
	nets acquired per member	using net at time of visit	nets acquired per member	using net at time of visit
Individual attributes				
shares bed with participant	-0.001	0.263***	-0.012	0.257***
	(0.012)	(0.043)	(0.009)	(0.045)
child of participant ≤ 5 years old	-0.034**	0.009	-0.023*	-0.011
	(0.015)	(0.040)	(0.013)	(0.042)
usually gets malaria each year	-0.054**	0.116**	-0.057**	0.198***
	(0.026)	(0.058)	(0.023)	(0.067)
Interactions				
free * shares bed with participant	-0.001	-0.021		
	(0.015)	(0.077)		
free * child of participant ≤ 5 years old	0.026	0.173**		
	(0.019)	(0.075)		
free * usually gets malaria each year	0.018	-0.214**		
	(0.030)	(0.107)		
female participant * shares bed with participant			0.009	-0.091
			(0.016)	(0.090)
female participant * child of participant ≤ 5 years old			0.003	0.011
			(0.018)	(0.075)
female participant * usually gets malaria each year			0.039	-0.078
			(0.031)	(0.125)
Household controls				
participant received nets free	0.046*	0.073		
	(0.027)	(0.063)		
participant is female			-0.020	0.149***
			(0.028)	(0.061)
household size	-0.055***	0.097**	-0.049***	0.131***
	(0.017)	(0.048)	(0.019)	(0.048)
members per bed	-0.032	-0.274*	-0.045	-0.423**
	(0.063)	(0.155)	(0.062)	(0.166)
beds	0.015	-0.130*	0.009	-0.185***
	(0.026)	(0.067)	(0.026)	(0.067)
number of nets available	0.119***		0.111***	
	(0.026)		(0.032)	
number of nets per member		0.762		0.992
		(0.645)		(0.742)
Number of observations	757		598	
probability > Chi-squared	0.000		0.000	
Number of households	129		95	

Marginal effects. Standard errors, clustered by household, in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

8. Discussion

The results presented here show that the determinants of mosquito net usage are contingent on how nets are acquired. Young children, whose vulnerability to malaria is highlighted in a message accompanying net distribution, are more likely to use nets received for free.

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. This raises the question of whether knowledge of future monitoring affected usage differentially in the two groups. Future research could avoid this possible Hawthorne effect by monitoring which individuals' beds have nets hanging over them in an unannounced daytime follow-up visit.

9. Conclusions

The experiment described here suggests that distributing nets for free leads to a greater number of children covered than offering nets for sale, even when parents are given adequate resources to purchase nets for the entire household. 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, even controlling for the number of nets acquired, children are still more likely to use nets received for free.

Almost universally, the person who received or purchased nets slept under a net. More than half of the time, there were no children sharing a bed with this person. This finding lends support to calls for nets to be targeted more broadly than to the vulnerable groups of young children and pregnant women, since scarce nets appear to first be used by the household head (Teklehaimanot *et al*. 2007).

Who else in the household used a net depended on how nets were acquired. When nets were purchased, those perceived to suffer from malaria on a regular basis were more likely than others to use them. Nets received for free were more likely to be used by young children, in accordance with a message given to all participants about the particular vulnerability of this group. This finding suggests that mode of distribution can be used to influence the intra-household allocation of a good.

Giving or selling nets specifically to women, on the other hand, did not achieve higher child coverage. Husband's education level was a significant determinant of child usage when nets were received by married women, suggesting that these women do not fully control resources they bring into the home.

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 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.

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CHAPTER FOUR

FOOD AID AND AGRICULTURAL PRODUCTION: EVIDENCE FROM MALAWI[26,27]

Abstract:

Food aid may influence farm households' production decisions through several mechanisms. The net impact of these effects is theoretically ambiguous. We use nationally representative household survey and meteorological data from Malawi to analyze empirically the effect of receiving food aid on labor supply and input use. Using a lagged weather index as an instrument for food aid receipt, we find that households that received food aid allocated more labor time to own farm and non-farm enterprise activities, and less time to unskilled wage labor, and spent more on seeds. The results suggest that aid relaxes the immediate budget constraint, allowing households to allocate resources to activities that maximize income over a longer time horizon.

1. Introduction

Food aid constitutes a significant share of total food availability in poor food deficit countries such as Malawi. According to FAO statistics, food aid amounted to 4.3% of national cereal production in Malawi over the period 2001-2004. Concern is often raised by national policy makers as well as donors about the disincentive effects of free food distribution on agricultural production.[28] To what extent such

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[28] See, for example, Peter Greste, "Ethiopia's food aid addiction", February 2, 2006, BBC online.

disincentive effects exist is an important question if, as examples in Harvey and Lind (2005) suggest, donors scale back relief entitlements to avoid dependency among recipients.

While fears of aid dependency assume that the receipt of aid will cause households to scale back their production activities, the direction in which aid affects production is theoretically ambiguous. Since leisure is a normal good, an increase in transfer income may lead to a decrease in total hours worked, with a resulting decline in production. However aid may also be used to purchase additional farm inputs or re-allocate time to own production activities with future payoffs rather than working for relatively low wages to cover immediate costs. Further, income from aid may allow households to insure against future production risk through savings, facilitating the adoption of higher-risk livelihood strategies.

In the long run, households that receive aid repeatedly may come to expect it in the future. As with a one-time transfer, this may cause households to reallocate time from productive activities to leisure. On the other hand, expected income from aid could be perceived as a safety net against downside production risk, again allowing households to engage in riskier livelihood strategies such as own farm production rather than wage labor. This effect will be stronger the more responsive aid is to negative production shocks.

Finally, food aid may influence production through agricultural output prices and its effect on the political economy of agricultural market reform and public investment in agriculture. To the extent that food aid depresses agricultural output prices, this will adversely affect the welfare of net sellers, and in the long run create disincentives for production of the affected commodities.[29]

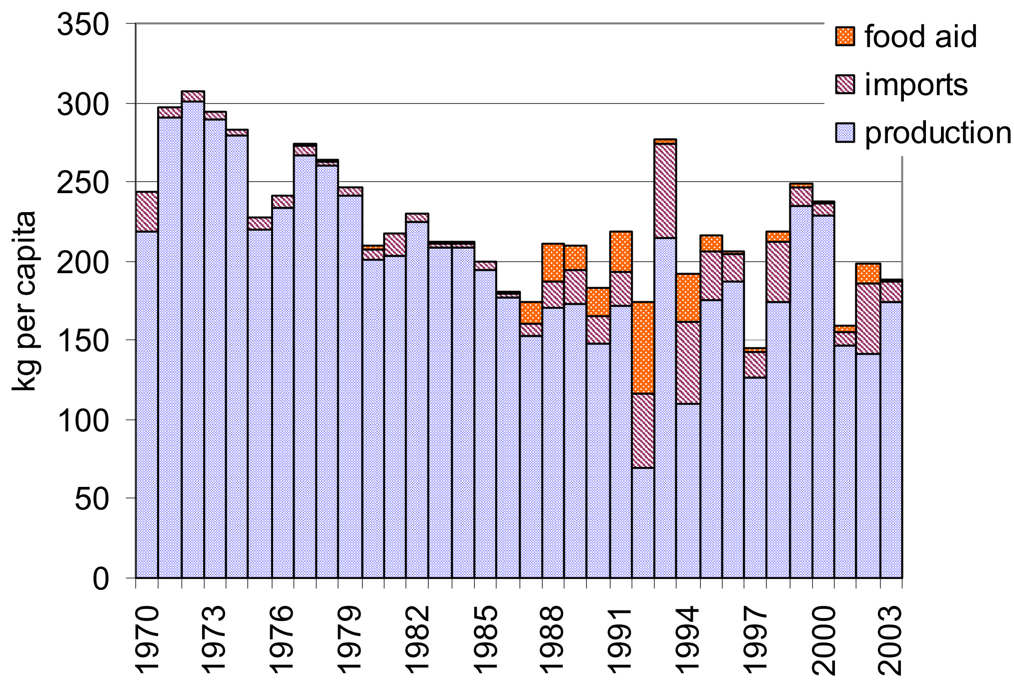
[29] The early empirical literature on this point, reviewed by Maxwell and Singer (1979), shows evidence of price effects in a minority of countries studied. A more recent paper by Kirwan and McMillan (2007) finds no evidence of price effects in Ethiopia.

The focus of this paper is on the immediate effect of receiving food aid on household production behavior. The existing empirical evidence on this question is slim and inconclusive; it is mostly based on case studies and descriptive statistics (Lappe and Collins, 1979; Stevens, 1979; Jackson and Eade, 1982; Maxwell *et al*, 1994). The only study we know of that uses econometric techniques is by Abdulai *et al* (2006), who use an Ethiopian dataset of 1,470 households. Controlling for other household characteristics and using lagged aid as an instrument for current aid, they find that receipt of food aid within the past year is not associated with a decrease in household labor supply, and that a positive labor supply effect may even be present.

The current paper makes two main contributions. First, we use a four year lagged weather index as an instrument for food aid receipt. We prefer this instrument to lagged aid receipt, which is likely to be correlated with unobserved, time-invariant characteristics associated with chronic need. Second, we use nationally representative data from Malawi. Much of the existing literature on the microeconomic effects of food aid focuses on Ethiopia, where most food aid is given as payment for labor on community development projects (Jayne *et al*., 2002). The vast majority of Malawi's food aid, on the other hand, is distributed for free without any work requirement. The effect on production behavior of receiving free food has not to our knowledge been studied in a developing country context.

2. Food Aid in Malawi

Agriculture accounts for 39 percent of Malawi's GDP and is almost exclusively the domain of smallholders (Øygard, 2005). Maize is the dietary staple and accounts for up to 70 percent of calorie consumption. According to the most recent national Integrated Household Survey (IHS2), 77 percent of cropped land is under maize. The vast majority of agriculture in Malawi is rain-fed, meaning that production is closely correlated with rainfall. During the 2005 drought, maize production fell by 30 percent from its 2004 level. In years of severe negative rainfall shocks, which have become increasingly common, cereal imports through both commercial and aid channels act as a partial buffer to the wide fluctuations in production (Figure 4.1).



Source: FAOSTAT

Figure 4.1. Per capita cereals production, imports, and food aid receipts, 1970-2003

In recent years, the main food security programs in Malawi have been subsidized or free distribution of agricultural inputs and free distribution of food as drought relief. Our study focuses on the receipt of food, and not the agricultural inputs program. More than one-quarter of households in Malawi received some free food (usually maize) during 2001-2003. The vast majority of social protection transfers were in the form of free food aid; including other social protection programs (food for work, direct cash transfers, and supplemental feeding) as well as free food aid, 30 percent of households received some sort of ex-post transfer during these three years. Food aid is allocated primarily through the general distribution program supported by the World Food Program, which typically distributes 50 kilogram bags of maize to households monthly for some set number of months.

Food aid can potentially affect decisions about income activities, including farming, in several ways. The mechanism that receives perhaps the most attention is the classic moral hazard effect of food aid as an insurance contract. From this perspective, the expectation that aid will compensate for inadequate agricultural output generated by the household may result in less household investment in production activities, including cutting back on both purchased inputs and labor. The more responsive aid is to income shortfalls, the more the household can expand its expected intertemporal budget set by investing less in production and relying instead on transfers. This same mechanism may have a positive effect on production if higher-risk activities have higher average returns. When markets for insurance and credit are missing, the ability to smooth consumption over time is limited to self-insurance through savings. As argued by Eswaran and Kotwal (1990), poorer households, who lack savings, will thus choose low-risk income-generating strategies in order to minimize their exposure to low income and consequent low consumption draws. Aid that is targeted to provide insurance against income risk would increase the attractiveness of higher risk production technologies to households otherwise unable to insure. To the extent that riskier technologies have higher expected returns than those with low risk, food aid would thus increase expected non-transfer income, particularly among the poor. A growing empirical literature has documented income-smoothing through the use of low-return, low-risk agricultural crop portfolios among poorer households (Rosenzweig and Binswanger, 1993; Dercon, 1996). As argued by Carter and Barrett (2006), such income-smoothing behavior creates a positive relationship between wealth and marginal returns that can trap a household in poverty. To the degree that food aid functions (and is perceived) as a reliable safety net, it could potentially serve as an avenue out of this stochastic poverty trap.

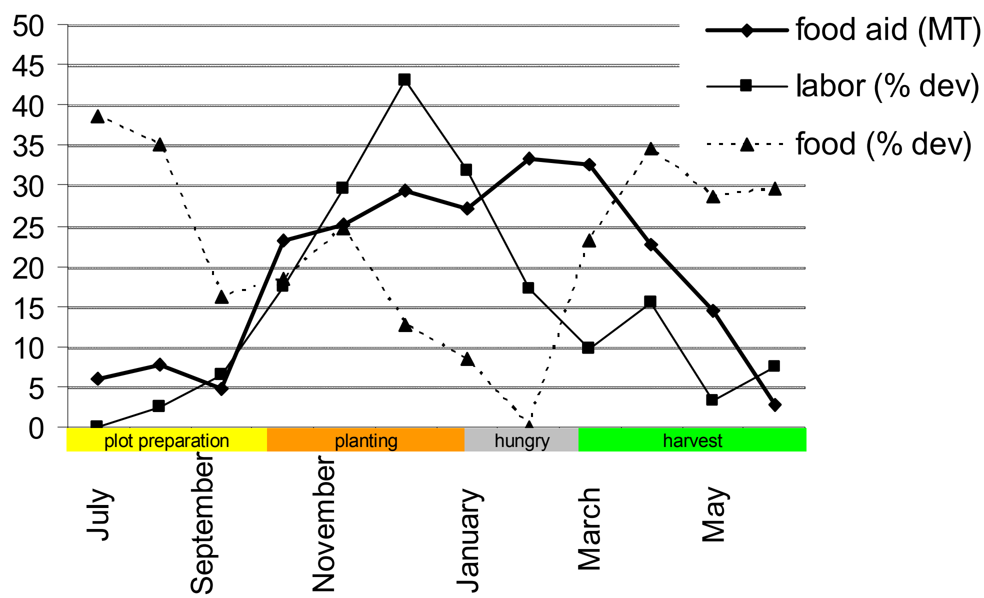
The inconsistent and unpredictable nature of food in Malawi and elsewhere suggests that, for better or worse, few households are likely to rely on future aid when making production decisions. Although evidence from Ethiopia shows inertia in food aid distribution at the regional level (Jayne *et al.*, 2002), household-level analysis reveals that aid receipts are highly unpredictable (Lentz and Barrett, 2005; Little, 2005). A recent assessment of emergency free food distribution in Malawi (Sharma, 2005) noted that while distribution guidelines specified that the "poorest of the poor" were to receive food, and recommended that households with certain characteristics be prioritized for assistance[30], only one community focus group identified poverty as a targeting criterion, while 7 of the 42 believed that targeting was random. Further, nearly a third of the households living in program areas were not aware that a food aid program was operating in their area. This uncertainty about aid targeting criteria, and even ignorance of its availability, suggest that the moral hazard and insurance effects of aid as currently distributed are unlikely to affect behavior.

Turning to the effects of received (rather than expected) aid, timing is critical. Due to the reliance of agriculture on rainfall, the demand for agricultural labor, in which 89 percent of the working population is engaged, is highly seasonal (Wodon

[30] These were child-, elderly-, and female-headed households, those with chronically ill or HIV/AIDS affected members, those having suffered two or more years of successive crop failures, and those currently receiving benefits under the Therapeutic Feeding Program.

and Beegle, 2006). While there is some regional variation, agricultural labor demand peaks from November to January when the main crops are planted, weeded and fertilized (Figure 4.2). The maize harvest occurs from March in the South to May in the North, and is followed by a period of relative slack.

Consumption likewise varies with the agricultural year, with the lowest levels from December through February in the period immediately preceding the harvest. Figure 4.2 illustrates this variation using data from the Malawi Integrated Household Survey 2. The survey was conducted over the course of a year, with data on food expenditures collected using a week-long recall module. We estimate the seasonal



Sources: Agricultural year , Beegle and Wodon (2006); food aid, WFP; food expenditure & labor, IHS2.

Figure 4.2. Seasonality of labor, food expenditures, and food aid disbursements

variation in food expenditures by regressing real food expenditures on month of interview dummies and district fixed effects. The coefficients on the month dummies plotted in Figure 4.2 represent the average percentage deviation of weekly food expenditures from a February baseline, controlling for regional variation.

In a 2003-2004 survey of 2030 households, 62.5 percent of households identified lack of inputs such as fertilizer or pesticides as the reason for not cultivating all of their land (Tango International, cited in *ibid*). After inputs, labor was the second most important constraint, cited by 44.5 percent of respondents. Previous work by Peters (1996) found that the poor work disproportionately more often on others' farms during the food deficit, pre-harvest months, leaving less time to work on the home farm.

Since food aid is distributed during this same period, we would expect that food aid might relax the labor constraint and, to the extent that the input constraint stems from lack of cash, the input constraint. Using a linear programming model, Bezuneh *et al.* (1988) show that food for work program participants in rural Kenya have net returns 52 percent higher than non-participants due to such an effect. The majority of food aid disbursed by the World Food Program in Malawi over the 2002-2003 agricultural year was well-timed to alleviate both time and cash constraints (Figure 4.2).

3. Theoretical Framework

A simple agricultural model serves to illustrate the microeconomic effects of aid transfers on agricultural production. A representative household derives utility each period from consumption c_t and leisure ℓ_t. The utility function is concave in both arguments, and strictly increasing in consumption, with infinite marginal utility at $c_t=0$. Utility is additively separable across seasons and years, and is discounted by a factor $\beta < 1$ across periods. At the beginning of each period, the household chooses how much time to allocate to own production activities $L_{f,t}$, wage labor $L_{w,t}$, and how much of its income to allocate to consumption c_t (at price $p_{c,t}$), own farm enterprise inputs m_t ,(at price $p_{m,t}$) and savings s_t. The household's objective at any given period τ is to maximize expected lifetime utility from that period forward.

$$E\sum_{t=\tau}^{\infty}\beta^{t-\tau}U(c_t,\ell_t) \tag{1}$$

The household has access to a concave agricultural production technology f, which can be used to transform purchased inputs m_t , family labor $L_{f,t}$ and hired labor $L_{h,t}$ (for simplicity we assume these are equivalent and denote their sum L_t) into following-period output y_{t+1} , subject to an exogenous shock which is realized at time t+1. Output can be consumed by the household or sold at the same price as the consumption good, p_c.

$$y_{t+1}=f(L_t,m_t,\gamma_{t+1}) \tag{2}$$

At the beginning of each period, the household realizes its stochastic non-wage income $p_{c,t}\cdot y_t$ and transfer income ϕ_t, which includes food aid. In addition, the household has at its disposal savings from the previous period s_{t-1} and may choose to allocate some of its time to wage labor $L_{w,t}$, paid immediately at wage w_t . Savings s_t is constrained to be non-negative, *i.e.* borrowing is not possible.[31] Since utility is strictly increasing in consumption, the budget constraint binds with equality:

$$p_{c,t}\cdot(c_t-y_t)+p_{m,t}\cdot m_t+s_t=s_{t-1}+\phi_t+w_t\cdot(L_{w,t}-L_{h,t}) \tag{3}$$

[31] This reflects reality for most households in Malawi. In a nationally representative survey only 12 percent of households claimed to have no need for farming or business credit over the past year, and only 11 borrowed for these purposes (IHS-2, 2005).

A time constraint limits leisure to be less than or equal to the total time endowment *T* minus the time spent on own farm production and wage labor. Again from the assumption that utility is strictly increasing in consumption, the time constraint binds:

$$\ell_t + L_{f,t} + L_{w,t} = T \tag{4}$$

Assuming that the production technology satisfies the Inada conditions ensures that own enterprise production labor and inputs are non-zero. For simplicity, we assume efficient labor markets such that households buy and sell exactly as much labor as they wish. A non-negativity constraint on leisure completes the model.

The first order conditions are standard. The immediate consumption value of wage labor, the discounted expected marginal consumption value of own farm labor, and the marginal value of leisure plus the shadow value of its inequality constraint $\lambda_{\ell,t}$ are equated:

$$\frac{\delta u_t}{\delta c_t} \cdot \frac{w_t}{p_{c,t}} = \beta E\left[\frac{\delta u_{t+1}}{\delta c_{t+1}} \cdot \frac{\delta y_{t+1}}{\delta L_t}\right] = \frac{\delta u_t}{\delta \ell_t} + \lambda_{\ell,t}. \tag{5}$$

The expected value product of inputs in the next period is equated with the opportunity cost of inputs in terms of current consumption:

$$\frac{\delta u_t}{\delta c_t} \cdot \frac{p_{m,t}}{p_{c,t}} = \beta E\left[\frac{\delta u_{t+1}}{\delta c_{t+1}} \cdot \frac{\delta y_{t+1}}{\delta m_t}\right]. \tag{6}$$

Finally, the marginal utility of consumption minus the shadow value of credit is equal to the expected marginal utility of consumption in the following period:

$$\frac{\delta u_t}{\delta c_t} - \lambda_{s,t} = \beta E\left[\frac{\delta u_{t+1}}{\delta c_{t+1}}\right]. \tag{7}$$

This simple model captures several of the possible ways in which food aid might affect agricultural household behavior. From the budget and time constraints (3) and (4), and noting that y_t has been determined in the previous period (conditional on the exogenous production shock), we can see that a positive shock to transfer income $d\phi_t$ results in a commensurate increase in the sum of expenditures on current consumption, own farm inputs, time devoted to leisure and savings carried over to the next period:

$$d\phi_t = d(p_{c,t} \cdot c_t) + d(p_{m,t} \cdot m_t) + ds_t + d[w_{t,t}(\ell_t + L_{f,t} + L_{h,t})]. \tag{8}$$

Barring a simultaneous large positive shock to production, current consumption will increase. We trace the implications of this adjustment on production decisions through the first order conditions.

Note that the effect of the aid shock may be mitigated through price adjustments. In this partial equilibrium analysis, we do not attempt to model these, but rather simply acknowledge their possible existence. As shown by equation (5), the decrease in $\frac{\delta u_t}{\delta c_t}$ as c_t increases may be offset by an aid-induced decrease in $p_{c,t}$ and/or an increase in the wage rate w_t. Assuming the fall in marginal utility of consumption is not completely offset in this way, current leisure time will increase if the non-negativity constraint on leisure is not binding.

The expected marginal utility value of own farm labor also falls. This could occur through an increase in expected consumption in the following period, an increase in own enterprise labor in the present, or both. Analogously, equation (6) predicts an increase in the purchase of own farm cash inputs and / or an increase in next period's consumption level.

The degree to which production activities are affected by the aid shock depends in part on whether the credit constraint binds. When the household has no unmet demand for credit, expected marginal value of consumption at t+1 may adjust entirely by increasing savings. When this is not the case, the shadow value of credit will decrease with the aid shock, leading to a smaller adjustment in $\beta E\left[\frac{\delta u_{t+1}}{\delta c_{t+1}}\right]$, and thus a larger adjustment in $\frac{\delta y_{t+1}}{\delta L_t}$ and $\frac{\delta y_{t+1}}{\delta m_t}$. Which behaviors are affected by the receipt of aid, and to what degree, are empirical questions to which we now turn.

4. Data

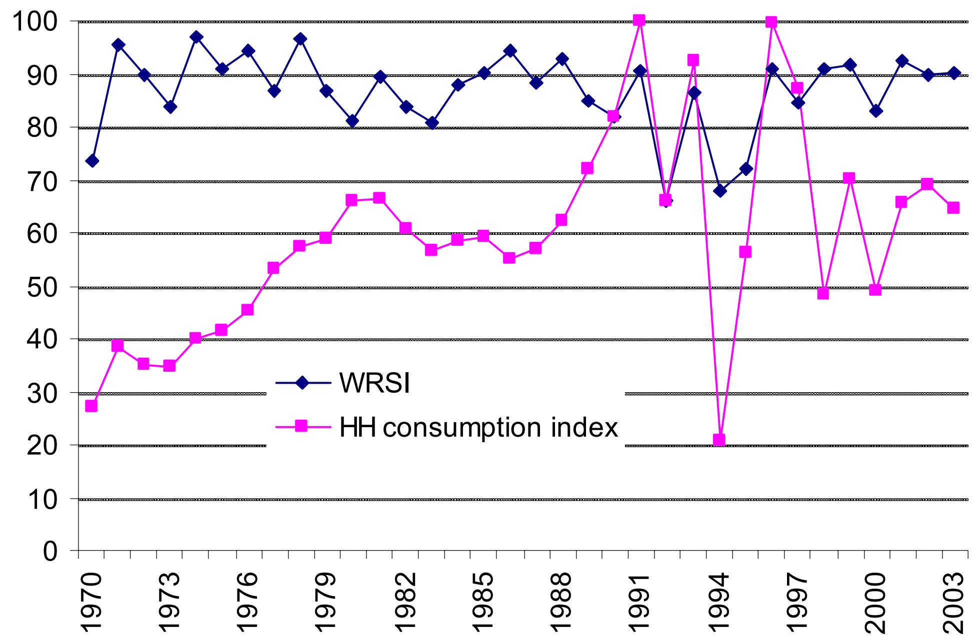
We use data from the Second Integrated Household Survey (IHS2), a nationally representative survey of 11,280 households in 564 communities across Malawi collected over a one-year period from March 2004 to March 2005. Information on the survey design and methodology are given in the IHS2 Basic Information Document (NSO, 2005). The IHS2 includes detailed input data (crop-specific) for the most recent completed cropping year (roughly July to June), including expenditures on seeds and fertilizer. About half of households interviewed gave this information for the 2003-2003 year, and half for 2003-2004.

A time use module covers the past seven days. From this we calculate the number of hours per able-bodied adult spent on various income-generating activities. Respondents are asked to recall whether their household received any food aid in each of 2001, 2002, and 2003, and to state the volume or value of this aid in 2003. We do not observe the timing of aid within years. This results in some measurement error since most aid is distributed from October to February. Aid reported in 2003 may have be received in January in response to a shock in the 2001-2002 agricultural year, or in December after the 2003 harvest was realized.

We merge IHS2 household survey data with weather data from 21 rainfall stations around the country. We use the United States Geological Service / Famine Early Warning System Network (USGS/FEWS-NET) water requirement saturation index (WRSI) for maize. The WRSI is a crop water accounting system developed by the Food and Agriculture Organization for use with station data to monitor water supply and demand for a rain-fed crop throughout the growing season (Frere and Popov, 1986). WRSI is calculated using rainfall observations over ten-day intervals and assumptions about time of planting and soil water holding capacity. At the end of the growing season, the WRSI is expressed as the percentage of total crop water requirement satisfied by rainfall or available soil moisture throughout the growing season. A value of 100 implies full satisfaction of the requirement, with lower values indicating the degree of shortfall.

Figure 4.3 plots maize WRSI averaged over all 21 rainfall stations over the period from 1970 to 2003. Real household consumption expenditure per capita, taken from national accounts data (IMF, 2006) closely track the movement of WRSI over time. The index of consumption expenditures shown in the figure normalizes the all-time high of this series in 1991 to 100.

Table 4.1 shows the percentage of households benefiting from the main safety net programs for the three years preceding the survey. Including food for work, direct cash



Sources: Household consumption data, International Financial Statistics (IMF); WRSI, Famine Early Warning System Network (USAID)

Figure 4.3. WRSI and Household Consumption Data (National Accounts)

Table 4.1. Receipt of program benefits (percent of households reporting)

	Receipt by year			Receipt during 2001-2003			
	2001	2002	2003	At least once	1 time	2 times	3 times
Free food/maize distribution	10.0	15.1	12.5	26.5	17.8	6.3	2.4
Food/Cash-for-work	1.0	1.8	3.5	5.5	4.9	0.5	0.1
Starter pack (TIP), rainy season	31.7	36.8	40.5	54.1			
Starter pack (TIP), dimba season	1.8	2.6	3.6	5.5			
Starter pack (TIP), rainy & dimba					22.7	13.9	20.9

Source: IHS2

transfers, and supplemental feeding as well as free food aid, 30 percent of households received some sort of ex-post transfer during the past three years. The vast majority of these transfers were in the form of free food aid, received by more than one quarter of all households in the years 2001-2003. However, very few households – only 2.4 % – received food aid in each of these years, echoing the finding in qualitative work that aid is an unreliable safety net. The mean (median) amount of free food received per capita in 2003 by households that received any was 33 kg (21 kg) and amounted to 4.1% of the value of food consumption among beneficiaries.

5. Empirical Strategy

Receipt of food aid is likely correlated with many of the same unobserved variables that determine labor supply and input use. Ability, intertemporal preferences, and preferences for leisure may all be correlated with poverty, on which food aid is at least partially targeted. Social connections may increase access to credit for inputs as well as the probability of receiving aid. Omitted variables at the community level may also be a problem. For example, communities with lower returns to farm labor or fertilizer due to poor local soil conditions may receive more emergency assistance than otherwise equivalent communities.

To deal with this problem, we employ an instrumental variables (IV) strategy. We exploit an apparent mis-prediction of regional need by the major food aid donor in Malawi in 2002-2003. The United States Agency for International Development (USAID), which contributed 82% of food aid to Malawi in 2002 and 98% in 2003, uses food security assessments generated by the Famine Early Warning Systems Network (FEWS-NET) to target food aid. FEWS-NET in turn bases its assessments on a variety of data, including meteorological forecasts. In March of 2002, an El Niño-induced drought was forecast for Southern Africa for the 2002-2003 growing season, and relief agencies warned that the impending drought would exacerbate a mounting food security crisis in the region (IFRC, 2002).

The last year before 2002 with below-average WRSI was 2000. FEWS-NET may therefore have used WRSI values from this year to inform its forecast of regional need in 2002-2003.[32] Indeed, the spatial distribution of weather shocks within Malawi does appear to repeat. For example, WRSI in the 2004 was highly correlated across space with WRSI in 2000; controlling for long-term mean WRSI, the partial correlation between these two years is significant at $p<0.01$.

The OLS regressions reported in Table 4.3 show the partial correlation of aid receipt in the years 2001-2003 and WRSI in 2000. Controlling for long-term mean and standard deviation of WRSI, the shock in 2000 was indeed correlated with households' receipt of aid in 2002 and 2003. We argue that a weather shock four to five years ago is unlikely to affect current labor allocation or input use, and that excluding WRSI in 2000 from the first stage of the model is therefore valid. The decaying effect over time of lagged WRSI on consumption and agricultural input use can be seen in Tables 4.5a and 4.5b. While 2002 and 2003 WRSI are significant determinants of labor hours and consumption value in 2004-2005, the effect of 2001 WRSI on these outcomes is not statistically distinguishable from zero.

We examine the effect of receiving aid in 2003 on consumption, labor supply and agricultural input use. Three different adult labor supply variables are used: hours per adult in the past week devoted to own farm activities (a relatively high-risk income generating strategy with delayed returns), to unskilled wage labor (immediate returns with lower risk), and the total hours spent on income-generating activities, which include skilled wage labor as well as own farm, enterprise, unskilled wage labor, and ganyu labor. Ganyu is an institution through which relatively better-off households in a community pay those currently in need for piecework labor (Ravallion and Lokshin,

[32] I am working on getting confirmation of this hypothesis from FEWS-NET.

Table 4.2: Historical relationship of safety nets programs with lagged WRSI shock (OLS)

	Received Food Aid			Received Free Inputs		
	2001	2002	2003	2001	2002	2003
WRSI 2000 (scale of 0-10)	-0.004	-0.011**	-0.015**	0.003	-0.001	-0.007
	(0.004)	(0.005)	(0.006)	(0.009)	(0.009)	(0.010)
Mean WRSI, 1962-2003	-0.043***	-0.055***	-0.051***	-0.047**	-0.071***	-0.071**
	(0.012)	(0.015)	(0.015)	(0.021)	(0.022)	(0.025)
Standard dev. WRSI, 1962-2003	-0.043**	-0.072**	-0.089***	0.052	0.008	0.014
	(0.021)	(0.027)	(0.027)	(0.040)	(0.041)	(0.047)
Constant	0.557***	0.803***	0.806***	0.634***	0.977***	1.062***
	(0.136)	(0.158)	(0.154)	(0.214)	(0.220)	(0.254)
Number of observations	10,789	10,794	10,812	10,816	10,817	10,819
Number of clusters	21; 541	21; 541	21; 541	21; 541	21; 541	21; 541
Adjusted R2	0.007	0.007	0.008	0.019	0.019	0.020

Standard errors in parentheses, clustered by enumeration area and meteorological station.
* p< 0.10; ** <0.05; ***<0.01

Source: IHS2 and USGS/FEWS-NET

Table 4.3: Amount and source of food aid to Malawi, 2001-2003

Year	Total (MT)	Percent of which from:			
		US	Europe	Asia	WFP & Other
2001	48,451.30	63%	15%	5%	4%
2002	156,240.00	83%	8%	6%	3%
2003	22,735.90	98%	1%	0%	1%

Source: FAOSTAT

2005). Since ganyu may serve as a form of social assistance rather than a traditional labor market, we exclude ganyu from our definition of unskilled wage labor.

Values of the instrument are identical for all households within a given enumeration area (EA). To correct for the downward bias of standard errors on the instrumented variable which would otherwise result (Moulton 1990), we use Stata's cluster command. This provides an unbiased estimate of the variance-covariance matrix in the presence of cluster-correlated data (Williams 2000). There is clustering at both the EA level and the meteorological station level. However, 21 stations are too

Table 4.4. Regression summary statistics

	Mean	Standard deviation	Minimum	Maximum
Dependent variables				
consumption expenditure (USD pc / yr)	183.75	140.59	13.07	2564.62
income generating hrs/wk/able-bodied adult	21.94	14.63	0.00	123.00
own farm hrs/wk/able-bodied adult	14.64	12.48	0.00	76.00
unskilled wage hrs/wk/able-bodied adult	1.81	6.59	0.00	60.00
expenditure on seed last season (USD)	1.65	4.15	0.00	94.53
expenditure on fertilizer last season (USD)	15.85	43.12	0.00	719.39
Received food aid 2003	0.20	0.40	0.00	1.00
Water requirement saturation index (WRSI), scale of 0-2				
WRSI at nearest met station 2000	8.24	1.05	5.30	9.90
WRSI 2001	9.31	0.67	7.90	10.00
WRSI 2002	8.89	1.24	5.40	10.00
WRSI 2003	9.17	1.01	6.10	10.00
WRSI 2004	7.68	1.86	4.60	10.00
mean WRSI, 1963-2004	8.57	0.95	6.34	9.75
long-term standard deviation of WRSI, 1963-2004	1.33	0.50	0.51	2.30
Household controls				
household size	4.72	2.37	1.00	27.00
female head	0.27	0.44	0.00	1.00
# members 65+ years of age	0.24	0.52	0.00	3.00
disabled household member	0.11	0.31	0.00	1.00
chronic illness of adult	0.24	0.43	0.00	1.00
education of head (yrs)	3.77	3.62	0.00	18.00
# rooms in dwelling	2.60	1.26	0.00	10.00
land owned (ha)	1.23	0.99	0.00	15.38
livestock (TLU)	0.61	1.83	0.00	41.10
Community controls				
time to trading center (hrs)	0.90	0.66	0.00	4.34
larger market in community	0.33	0.47	0.00	1.00
ADMARC in community	0.19	0.39	0.00	1.00
EA population density, 1998 (population per km squared / 100)	0.44	1.96	0.01	40.58
district population density, 1998	0.80	1.24	0.12	6.55
district headcount poverty rate, 1998	0.65	0.10	0.47	0.82

Table 4.5a. OLS and Tobit regressions, standard errors clustered by EA

	Cons. expenditure [a] (USD pc/yr)	Total labor [a] (hrs/week)	Own farm labor [b] (hrs/wk)	Unskilled wage labor [b] (hrs/wk)	Expenditure on seed [b] (USD)	Expenditure on fertilizer [b] (USD)
received aid 2003	7.658	-0.356	-0.422	-2.181	0.010	2.178
	(5.414)	(0.662)	(0.670)	(2.599)	(0.346)	(2.883)
WRSI 2001 (0-10)	-6.486	-1.059	-1.132	3.417	0.886**	2.281
	(6.747)	(1.289)	(1.329)	(2.893)	(0.425)	(4.857)
WRSI 2002 (0-10)	2.421	-1.461**	-0.764	-4.684**	-0.153	-7.063**
	(4.819)	(0.689)	(0.706)	(2.013)	(0.264)	(3.064)
WRSI 2003 (0-10)	-6.142	-2.134***	-2.867***	3.953**	-0.140	4.330
	(5.407)	(0.647)	(0.691)	(1.988)	(0.279)	(3.373)
WRSI 2004 (0-10)	0.973	-1.188**	-0.488	-0.483	0.169	3.090
	(3.112)	(0.487)	(0.517)	(1.282)	(0.173)	(2.181)
long-term mean WRSI	-4.883	6.529***	6.818***	-0.938	-0.982	10.228
	(15.549)	(1.875)	(1.975)	(4.748)	(0.676)	(7.991)
long-term std. dev. WRSI	11.965	2.727	6.747**	-17.821**	-3.477***	26.459*
	(27.327)	(3.106)	(3.306)	(8.732)	(1.163)	(14.254)
household size	-29.371***	-0.146	0.044	1.511***	0.155***	0.238
	(1.348)	(0.119)	(0.112)	(0.433)	(0.051)	(0.595)
female head	-14.476***	-3.415***	-2.996***	-9.774***	-0.754***	-5.165**
	(4.928)	(0.646)	(0.630)	(2.732)	(0.278)	(2.320)
# members 65+ years of age	-12.985***	-3.804***	-2.846***	-6.498**	-0.735***	-5.348**
	(3.530)	(0.538)	(0.580)	(2.883)	(0.246)	(2.075)
disabled household member	-6.866	-6.444***	-5.319***	-6.855*	0.324	-7.845**
	(4.586)	(0.833)	(0.864)	(3.818)	(0.406)	(3.269)
chronic illness of adult	10.690*	-0.965	-0.366	-4.555*	0.375	0.062
	(6.382)	(0.658)	(0.619)	(2.470)	(0.312)	(2.748)
education of head (yrs)	4.978***	-0.035	-0.216***	0.010	0.154***	2.147***
	(0.765)	(0.077)	(0.078)	(0.304)	(0.040)	(0.355)
# rooms in dwelling	13.790***	-0.660***	-0.138	-1.675	0.192	6.221***
	(2.515)	(0.238)	(0.229)	(1.028)	(0.126)	(1.307)
land owned (ha)	14.685***	0.215	1.804***	-4.247**	1.891***	16.370***
	(4.054)	(0.511)	(0.525)	(2.080)	(0.329)	(3.485)
land owned (ha) squared	0.400	-0.047	-0.177***	0.252	-0.208***	0.328
	(0.591)	(0.049)	(0.063)	(0.223)	(0.057)	(0.515)
livestock (TLU)	12.419***	-0.337	0.098	-0.487	0.558***	8.238***
	(2.413)	(0.239)	(0.224)	(1.056)	(0.175)	(1.916)
TLU squared	-0.381***	0.011	-0.002	0.037	-0.018**	-0.388***
	(0.088)	(0.008)	(0.007)	(0.034)	(0.008)	(0.116)
time to trading center (hrs)	-12.038***	-0.370	0.961	-4.486*	-0.389	-0.103**
	(4.152)	(0.602)	(0.598)	(2.533)	(0.339)	(0.048)
larger market in community	0.501	0.369	-1.112	1.780	-0.116	-3.023
	(7.821)	(0.825)	(0.884)	(2.902)	(0.399)	(4.041)

Table 4.5a (Continued)

	Cons. expenditure [a] (USD pc/yr)	Total labor [a] (hrs/week)	Own farm labor [b] (hrs/wk)	Unskilled wage labor [b] (hrs/wk)	Expenditure on seed [b] (USD)	Expenditure on fertilizer [b] (USD)
ADMARC in community	-2.908	0.652	-0.311	2.070	0.996**	-3.346
	(7.681)	(1.000)	(1.016)	(3.020)	(0.489)	(5.091)
EA population density	14.935***	0.175	-2.123***	0.731	0.102	1.736
	(5.223)	(0.529)	(0.694)	(1.181)	(0.155)	(1.550)
EA pop. density squared	-0.349**	-0.002	0.050**	-0.004	-0.003	-0.062
	(0.141)	(0.017)	(0.024)	(0.042)	(0.006)	(0.057)
district pop. density	6.540**	-1.105***	-1.401***	1.430	0.138	1.199
	(2.643)	(0.314)	(0.373)	(0.930)	(0.134)	(1.559)
district poverty rate 1998	110.343***	2.867	-0.693	9.226	-3.107	91.978***
	(34.648)	(5.197)	(5.330)	(15.222)	(2.282)	(25.803)
constant	263.853*	17.751	-1.708	-44.888	-0.202	-237.882***
	(136.633)	(16.805)	(18.018)	(46.600)	(5.658)	(82.800)
Number of observations	3,702	3,514	3,514	3,514	3,702	3,702
Number of clusters	440	438	438	438	440	440

Quarter of year and region fixed effects.
Cluster-robust standard errors in parentheses. * significant at 10%; ** 5%, *** 1%. [a]OLS, [b]Tobit.

Table 4.5b. OLS and Tobit regressions, standard errors clustered by EA and met station

	Cons. expenditure [a] (USD pc/yr)	Total labor [a] (hrs/week)	Own farm labor [b] (hrs/wk)	Unskilled wage labor [b] (hrs/wk)	Expenditure on seed [b] (USD)	Expenditure on fertilizer [b] (USD)
received aid 2003	8.846	-0.461	-0.504	-1.786	0.027	2.060
	(5.476)	(0.656)	(0.657)	(2.573)	(0.345)	(2.950)
WRSI 2001 (0-10)	-4.099	-0.160	-0.615	3.097	0.578	5.557
	(6.522)	(1.201)	(1.313)	(2.578)	(0.338)	(3.599)
WRSI 2002 (0-10)	4.721	-1.768**	-0.958	-4.299**	-0.114	-5.033*
	(4.761)	(0.680)	(0.724)	(1.955)	(0.250)	(2.791)
WRSI 2003 (0-10)	-2.012	-2.184***	-2.925***	4.454**	-0.284	7.344***
	(5.136)	(0.593)	(0.661)	(1.904)	(0.210)	(2.599)
WRSI 2004 (0-10)	7.070**	-1.172**	-0.825	0.514	0.150	5.752***
	(2.987)	(0.482)	(0.537)	(1.333)	(0.160)	(1.889)
long-term mean WRSI	-7.470	6.058***	6.682***	-1.786	-1.012	6.296
	(14.791)	(1.874)	(1.991)	(4.681)	(0.633)	(6.776)
long-term std. dev. WRSI	25.532	1.478	6.065*	-18.710**	-4.015***	31.731***
	(24.829)	(3.038)	(3.358)	(8.721)	(1.144)	(11.326)
household size	-29.305***	-0.110	0.082	1.586***	0.157***	0.231
	(1.363)	(0.116)	(0.109)	(0.437)	(0.052)	(0.584)
female head	-10.745**	-3.312***	-3.163***	-9.140***	-0.701**	-3.444
	(4.861)	(0.655)	(0.685)	(2.703)	(0.272)	(2.305)
# members 65+ years of age	-11.065***	-3.866***	-3.127***	-6.281**	-0.697**	-4.685**
	(3.712)	(0.539)	(0.593)	(2.920)	(0.246)	(2.047)
disabled household member	-3.592	-6.504***	-5.657***	-6.782*	0.411	-6.538**
	(4.911)	(0.835)	(0.884)	(3.858)	(0.400)	(3.220)
chronic illness of adult	15.510**	-1.305*	-0.886	-3.946	0.391	1.525
	(6.071)	(0.660)	(0.626)	(2.438)	(0.307)	(2.679)
education of head (yrs)	6.037***	-0.060	-0.353***	0.168	0.166***	2.266***
	(0.763)	(0.079)	(0.083)	(0.302)	(0.040)	(0.359)
# rooms in dwelling	14.463***	-0.817***	-0.392	-1.551	0.240*	6.007***
	(2.505)	(0.236)	(0.242)	(1.046)	(0.125)	(1.285)
land owned (ha)	9.773**	0.126	2.281***	-5.329**	1.843***	14.636***
	(4.492)	(0.493)	(0.569)	(2.095)	(0.322)	(3.142)
land owned (ha) squared	0.877	-0.043	-0.228***	0.363	-0.204***	0.494
	(0.522)	(0.049)	(0.079)	(0.215)	(0.057)	(0.473)
livestock (TLU)	11.857***	-0.303	0.192	-0.736	0.535***	8.195***
	(2.322)	(0.247)	(0.231)	(1.092)	(0.171)	(1.871)
TLU squared	-0.377***	0.010	-0.004	0.044	-0.017**	-0.400***
	(0.085)	(0.009)	(0.007)	(0.035)	(0.008)	(0.111)
constant	217.182	18.768	-1.223	-48.246	2.114	-251.859***
	(132.918)	(16.416)	(18.157)	(47.984)	(5.201)	(61.872)
Number of observations	3,717	3,527	3,527	3,527	3,717	3,717
Number of clusters	21; 440	21; 440	21; 438	21; 438	21; 438	21; 438

Region fixed effects. Cluster-robust standard errors in parentheses. * significant at 10%; ** 5%, *** 1%.
[a]OLS, [b]Tobit.

few to for the asymptotic properties of this estimator, which rely on a large number of clusters, to be valid. Acknowledging that neither of method is ideal, we present two sets of results: the first with standard errors clustered by EA and the second with standard errors clustered by EA and meteorological station. For the latter, we exclude community-level controls and quarter of year dummies to conserve degrees of freedom.[33]

Food aid is not the only transfer program in Malawi likely to affect agricultural production decisions. Over half of the households in Malawi received free inputs through the Starter Pack or Targeted Inputs Program from 2001-2003 (Table 4.1). Correlation in the targeting of these two programs could potentially confound our results. We therefore limit our analysis to households that received free inputs in 2003. The estimated effects of receiving food aid can therefore be interpreted as additional to any possible effect on production behavior of the free inputs program.

6. Results

We begin by treating aid receipt as exogenous. Tables 4.7a and 4.7b report the results of OLS regressions for consumption expenditures and total labor hours and Tobit regressions for specific labor activities and input use, for which a significant number of observations are zero. Under the assumption of treatment exogeneity, receiving aid has no significant effect on any of the outcomes considered. Because the inclusion of aid receipt in these models may bias the estimated coefficients on controls, we reserve discussion of these for the two-stage models.

[33] Estimating cluster-robust standard errors with M clusters allows identification of no more than M-1 (plus a constant) parameters.

Table 4.6. IV First stage regressions: Received food aid in 2003 (OLS)

SEs clustered by:	Enumeration Area (EA)			EA and met station	
Model:	consumption	labor	inputs	cons & inputs	labor
WRSI 2000	-0.040***	-0.039***	-0.043***	-0.043***	-0.042***
	(0.013)	(0.012)	(0.013)	(0.013)	(0.013)
WRSI 2001 (0-10)	0.010	0.006	0.005	-0.025	-0.027
	(0.021)	(0.021)	(0.022)	(0.023)	(0.022)
WRSI 2002 (0-10)	0.023	0.030*	0.023	0.031*	0.038**
	(0.017)	(0.017)	(0.017)	(0.016)	(0.015)
WRSI 2003 (0-10)	0.039***	0.039***	0.045***	0.042***	0.041***
	(0.015)	(0.015)	(0.015)	(0.013)	(0.013)
WRSI 2004 (0-10)	-0.010	-0.008	-0.008	-0.009	-0.007
	(0.011)	(0.010)	(0.011)	(0.011)	(0.010)
long-term mean WRSI	-0.064*	-0.078**	-0.055	-0.044	-0.059
	(0.036)	(0.035)	(0.038)	(0.039)	(0.038)
long-term std. dev. WRSI	-0.034	-0.040	-0.008	0.000	-0.014
	(0.069)	(0.068)	(0.071)	(0.066)	(0.066)
household size	0.002	0.002	0.003	0.002	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
female head	0.055***	0.049***	0.058***	0.060***	0.054***
	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)
# members 65+ years of age	0.070***	0.067***	0.074***	0.076***	0.072***
	(0.014)	(0.016)	(0.014)	(0.014)	(0.016)
disabled household member	0.071***	0.069***	0.073***	0.073***	0.072***
	(0.023)	(0.025)	(0.023)	(0.023)	(0.024)
chronic illness of adult	0.052***	0.056***	0.056***	0.066***	0.069***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)
education of head (yrs)	-0.001	-0.000	-0.000	-0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
# rooms in dwelling	0.011	0.013*	0.012	0.014**	0.016**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
land owned (ha)	0.006	0.007	0.008	0.007	0.008
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
land owned (ha) squared	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
livestock (TLU)	-0.013**	-0.013**	-0.015**	-0.015**	-0.016**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
TLU squared	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
time to trading center (hrs)	-0.025**	-0.027**	-0.023*		
	(0.013)	(0.012)	(0.013)		
larger market in community	0.009	0.009	0.011		
	(0.023)	(0.023)	(0.024)		
ADMARC in community	-0.009	-0.010	-0.011		
	(0.026)	(0.025)	(0.027)		
EA population density	-0.017	-0.016	-0.016		
	(0.010)	(0.010)	(0.010)		
EA pop. density squared	0.000	0.000	0.000		
	(0.000)	(0.000)	(0.000)		
district pop. density	0.029***	0.027***	0.027***		
	(0.010)	(0.009)	(0.010)		

Table 4.6 (Continued)

SEs clustered by:	Enumeration Area (EA)			EA and met station	
district poverty rate 1998	-0.116	-0.133	-0.105		
	(0.128)	(0.125)	(0.132)		
constant	0.689**	0.749**	0.578*	0.623*	0.695**
	(0.318)	(0.316)	(0.335)	(0.334)	(0.333)
Number of observations	3,702	3,514	3,702	3,717	3,527
Number of clusters	440	438	440	21; 440	21; 438
F-statistic, WRSI 2000=0	10.25	10.33	11.10	10.68	10.63

Table 4.7a. 2SLS second stage, standard errors clustered by EA

	Cons. expenditure (USD pc/yr)	Total labor (hrs/week)	Own farm labor (hrs/wk)	Unskilled wage labor (hrs/wk)	Expenditure on seed (USD)	Expenditure on fertilizer (USD)
received aid 2003	51.694	64.785**	58.437**	-11.555**	9.199**	-4.209
	(111.086)	(26.633)	(23.773)	(5.796)	(3.926)	(26.756)
WRSI 2001 (0-10)	-7.522	-2.317	-2.185	0.371	0.128	0.010
	(6.924)	(2.011)	(1.791)	(0.436)	(0.269)	(2.322)
WRSI 2002 (0-10)	2.014	-2.561**	-1.806	-0.183	-0.022	-6.543***
	(5.218)	(1.276)	(1.195)	(0.284)	(0.167)	(1.651)
WRSI 2003 (0-10)	-6.903	-3.324***	-3.613***	0.557**	-0.106	0.038
	(6.320)	(1.209)	(1.148)	(0.276)	(0.187)	(1.854)
WRSI 2004 (0-10)	0.718	-1.712**	-1.039	-0.023	-0.014	0.077
	(3.068)	(0.849)	(0.736)	(0.206)	(0.128)	(0.905)
long-term mean WRSI	-1.677	12.163***	11.410***	-0.766	-0.274	8.307**
	(20.372)	(4.084)	(3.872)	(0.813)	(0.478)	(3.658)
long-term std. dev. WRSI	13.909	6.047	8.907	-2.279*	-1.545*	12.205**
	(29.543)	(5.718)	(5.439)	(1.322)	(0.835)	(5.759)
household size	-29.461***	-0.319	-0.267	0.027	0.005	0.179
	(1.355)	(0.273)	(0.234)	(0.061)	(0.044)	(0.371)
female head	-16.981**	-6.770***	-5.203***	-0.347	-0.810**	-2.068
	(8.472)	(1.795)	(1.558)	(0.449)	(0.325)	(2.003)
# members 65+ years of age	-16.112*	-8.224***	-6.182***	0.124	-0.952***	-1.726
	(8.294)	(2.151)	(1.922)	(0.447)	(0.319)	(2.045)
disabled household member	-10.068	-11.047***	-8.517***	0.245	-0.444	-2.930
	(9.897)	(2.558)	(2.304)	(0.588)	(0.388)	(2.602)
chronic illness of adult	8.330	-4.704**	-3.863**	0.016	-0.517*	-1.115
	(7.513)	(1.969)	(1.743)	(0.427)	(0.278)	(2.013)
education of head (yrs)	4.993***	-0.048	-0.189	-0.025	0.074***	1.003***
	(0.784)	(0.142)	(0.128)	(0.043)	(0.026)	(0.215)
# rooms in dwelling	13.400***	-1.321**	-0.795	-0.037	0.124	3.282***
	(2.882)	(0.588)	(0.509)	(0.133)	(0.099)	(0.843)
land owned (ha)	14.434***	-0.231	1.007	-0.481*	0.755***	6.409***
	(4.078)	(0.979)	(0.820)	(0.267)	(0.185)	(1.958)
land owned (ha) squared	0.508	0.116	0.007	0.018	-0.037	1.075***
	(0.707)	(0.136)	(0.111)	(0.031)	(0.024)	(0.380)

Table 4.7a (Continued)

	Cons. expenditure (USD pc/yr)	Total labor (hrs/week)	Own farm labor (hrs/wk)	Unskilled wage labor (hrs/wk)	Expenditure on seed (USD)	Expenditure on fertilizer (USD)
livestock (TLU)	12.877***	0.365	0.753	-0.245*	0.471***	4.900***
	(2.692)	(0.570)	(0.508)	(0.133)	(0.140)	(1.390)
TLU squared	-0.385***	0.004	-0.008	0.006	-0.012***	-0.178***
	(0.090)	(0.016)	(0.013)	(0.004)	(0.005)	(0.062)
time to trading center (hrs)	-11.001**	1.326	2.375**	-0.996***	0.180	-0.028
	(4.414)	(1.298)	(1.117)	(0.308)	(0.198)	(0.020)
larger market in community	-0.264	-0.792	-1.850	0.372	-0.242	-0.685
	(7.557)	(1.719)	(1.539)	(0.442)	(0.278)	(1.902)
ADMARC in community	-2.320	1.638	0.509	0.068	0.637*	-0.645
	(7.532)	(1.882)	(1.727)	(0.500)	(0.356)	(2.465)
EA population density	15.657***	1.197	-0.080	-0.209	0.207*	0.024
	(5.511)	(1.047)	(0.818)	(0.267)	(0.125)	(0.637)
EA pop. density squared	-0.361**	-0.019	0.008	0.010	-0.005	0.001
	(0.144)	(0.030)	(0.024)	(0.011)	(0.004)	(0.016)
district pop. density	5.161	-3.005***	-2.735***	0.457**	-0.184	0.920
	(4.365)	(1.096)	(0.911)	(0.221)	(0.173)	(1.327)
district poverty rate 1998	112.798***	7.700	3.671	-1.677	-0.359	28.571**
	(35.865)	(9.280)	(8.495)	(2.145)	(1.628)	(12.899)
constant	244.864	-14.829	-27.276	9.498	0.918	-45.476
	(161.495)	(30.420)	(29.814)	(6.605)	(3.939)	(36.534)
Number of observations	3,702	3,514	3,514	3,514	3,702	3,702
Number of clusters	440	438	438	438	440	440

Quarter of year and region fixed effects.
Cluster-robust standard errors in parentheses. * significant at 10%; ** 5%, *** 1%.

Table 4.7b. 2SLS second stage, standard errors clustered by EA and met station

	Cons. expenditure (USD pc/yr)	Total labor (hrs/week)	Own farm labor (hrs/wk)	Unskilled wage labor (hrs/wk)	Expenditure on seed (USD)	Expenditure on fertilizer (USD)
received aid 2003	108.616	53.388**	48.216**	-10.884*	8.172**	10.614
	(111.721)	(23.206)	(21.914)	(5.600)	(3.617)	(22.503)
WRSI 2001 (0-10)	-3.383	0.420	-0.110	-0.103	0.260	0.898
	(6.826)	(1.800)	(1.696)	(0.349)	(0.219)	(1.541)
WRSI 2002 (0-10)	2.941	-3.105**	-2.151*	-0.108	-0.056	-6.141***
	(5.756)	(1.145)	(1.097)	(0.276)	(0.142)	(1.663)
WRSI 2003 (0-10)	-4.320	-3.407***	-3.699***	0.510*	-0.096	0.913
	(6.421)	(1.064)	(1.026)	(0.254)	(0.150)	(1.340)
WRSI 2004 (0-10)	6.125*	-1.780**	-1.345*	0.081	-0.002	0.832
	(2.999)	(0.851)	(0.763)	(0.209)	(0.110)	(0.726)
long-term mean WRSI	-1.842	9.884**	9.618**	-0.529	-0.428	8.219**
	(18.465)	(3.616)	(3.508)	(0.737)	(0.433)	(3.277)

Table 4.7b (Continued)

	Cons. expenditure (USD pc/yr)	Total labor (hrs/week)	Own farm labor (hrs/wk)	Unskilled wage labor (hrs/wk)	Expenditure on seed (USD)	Expenditure on fertilizer (USD)
long-term std. dev. WRSI	26.088	2.530	6.306	-2.180*	-1.733**	15.182***
	(25.579)	(4.764)	(4.595)	(1.232)	(0.774)	(4.861)
household size	-29.586***	-0.293	-0.248	0.036	0.013	0.141
	(1.406)	(0.248)	(0.212)	(0.060)	(0.041)	(0.364)
female head	-17.115*	-6.449***	-5.137***	-0.238	-0.761**	-2.455
	(8.803)	(1.599)	(1.418)	(0.457)	(0.302)	(1.852)
# members 65+ years of age	-18.859*	-7.836***	-5.991***	0.180	-0.876***	-2.644
	(9.153)	(1.970)	(1.833)	(0.452)	(0.296)	(1.820)
disabled household member	-11.083	-10.526***	-8.243***	0.258	-0.359	-3.828
	(10.192)	(2.275)	(2.110)	(0.580)	(0.371)	(2.392)
chronic illness of adult	8.609	-5.180**	-4.353**	0.198	-0.521*	-1.474
	(8.757)	(1.973)	(1.797)	(0.486)	(0.294)	(2.013)
education of head (yrs)	6.019***	-0.095	-0.309**	0.001	0.078***	1.055***
	(0.788)	(0.123)	(0.112)	(0.042)	(0.024)	(0.205)
# rooms in dwelling	13.323***	-1.516***	-1.023**	0.019	0.127	3.059***
	(3.122)	(0.531)	(0.483)	(0.141)	(0.095)	(0.821)
land owned (ha)	9.201*	-0.259	1.345*	-0.575**	0.767***	5.839***
	(4.746)	(0.816)	(0.687)	(0.263)	(0.173)	(1.773)
land owned (ha) squared	1.108	0.085	-0.058	0.031	-0.042*	1.157***
	(0.655)	(0.111)	(0.094)	(0.029)	(0.022)	(0.381)
livestock (TLU)	13.133***	0.425	0.863*	-0.292**	0.457***	5.084***
	(2.802)	(0.520)	(0.472)	(0.140)	(0.131)	(1.320)
TLU squared	-0.395***	-0.001	-0.014	0.008*	-0.012**	-0.184***
	(0.089)	(0.015)	(0.013)	(0.004)	(0.004)	(0.060)
constant	184.130	-3.546	-17.513	8.540	1.448	-59.672**
	(153.270)	(26.470)	(26.166)	(6.276)	(3.684)	(28.123)
Number of observations	3717	3527	3527	3527	3717	3717
Number of clusters	21; 440	21; 440	21; 438	21; 438	21; 438	21; 438

Region fixed effects. Cluster-robust standard errors in parentheses. * significant at 10%; ** 5%, *** 1%.

Turning now to the first stage of these, WRSI in 2000 is indeed significantly correlated with receipt of food aid in 2003, with an F-statistic of between 10.25 and 11.1, depending on which controls are included and which assumptions are made about the error structure (Table 4.7). A 10% shortfall in WRSI in 2000 decrease implied a 0.4% conditional increase in the probability of receiving aid in 2003. WRSI in 2003 is correlated with aid receipt, but in the opposite direction: better growing conditions are associated with higher probability of receiving food aid. The program's stated targeting criteria of targeting female-headed households, the elderly, and those with chronically ill members appear to have been effectively implemented, with all three of these characteristics increasing the probability of receiving food aid. Households with disabled members were also more likely to receive aid. Somewhat surprisingly, households living in dwellings with more rooms were more likely to receive aid, controlling for household size, which had no effect. Livestock ownership was negatively associated with aid receipt.[34] Finally, higher population density at the district level, though not within the enumeration area, was associated with aid receipt.

Because of the sensitivity of Tobit models to distributional assumptions, we present results of both a linear two stage least squares model (Tables 4.8a and 4.8b), and an IV Tobit specification for the censored dependent variables (Tables 4.8a and 4.8b). All of the IV specifications use a linear first stage equation to predict the binary variable indicating receipt of food aid in 2003, as this generates consistent second-stage estimates and is less vulnerable to misspecification bias than a nonlinear first stage functional form (Angrist and Krueger, 2001). For the most part, similar results obtain with the Tobit and linear specifications.

Implicit in the use of 2000 WRSI as an instrument for aid is the assumption that a 2000 weather shock does not affect agricultural input choice in 2002-2003 or 2003-2004, or labor supply in 2004-2005. The results shown in Tables 4.8a through 4.9b provide suggestive evidence to support this assumption. While WRSI in 2003 is correlated with most of the dependent variables, and WRSI in 2002 is correlated with some, WRSI three years ago in 2001 is not significantly correlated with any input or

[34] Livestock holdings are measured in 2004-2005, so this may be endogenous; we are less concerned with establishing causal relationships in the first stage than we are with including appropriate controls in the second stage regressions.

Table 4.8a. IV Tobit second stage, standard errors clustered by EA

	Own farm labor (hrs/wk)	Unskilled wage labor (hrs/wk)	Expenditure on seed (USD)	Expenditure on fertilizer (USD)
received aid 2003	66.266**	-69.704	28.027**	-77.909
	(26.804)	(48.838)	(11.135)	(64.515)
WRSI 2001 (0-10)	-2.434	4.679	0.268	4.014
	(1.983)	(3.410)	(0.750)	(5.514)
WRSI 2002 (0-10)	-1.890	-3.494	-0.402	-6.339*
	(1.340)	(2.390)	(0.476)	(3.311)
WRSI 2003 (0-10)	-4.096***	4.985**	-0.757	6.125
	(1.294)	(2.522)	(0.558)	(4.123)
WRSI 2004 (0-10)	-1.040	-0.039	-0.088	3.760
	(0.830)	(1.376)	(0.351)	(2.344)
long-term mean WRSI	12.600***	-6.533	0.883	4.974
	(4.299)	(7.195)	(1.424)	(9.159)
long-term std. dev. WRSI	10.150*	-20.847*	-2.919	24.863
	(6.131)	(10.780)	(2.382)	(15.144)
household size	-0.139	1.682***	0.067	0.486
	(0.266)	(0.486)	(0.115)	(0.666)
female head	-6.438***	-6.358*	-2.455***	-0.356
	(1.786)	(3.827)	(0.904)	(4.546)
# members 65+ years of age	-7.363***	-1.848	-2.853***	0.704
	(2.175)	(4.274)	(0.940)	(5.108)
disabled household member	-10.040***	-2.208	-1.739	-1.873
	(2.656)	(5.771)	(1.065)	(5.941)
chronic illness of adult	-4.177**	-0.605	-1.248*	4.711
	(1.960)	(3.906)	(0.749)	(4.819)
education of head (yrs)	-0.229	0.012	0.158**	2.146***
	(0.147)	(0.341)	(0.066)	(0.397)
# rooms in dwelling	-0.808	-1.000	-0.071	6.966***
	(0.579)	(1.175)	(0.256)	(1.587)
land owned (ha)	1.337	-3.776*	1.608***	16.977***
	(0.938)	(2.197)	(0.495)	(3.747)
land owned (ha) squared	-0.009	0.081	-0.119	0.119
	(0.125)	(0.255)	(0.081)	(0.552)
livestock (TLU)	0.815	-1.220	0.913***	7.262***
	(0.581)	(1.265)	(0.312)	(2.101)
TLU squared	-0.008	0.044	-0.023**	-0.376***
	(0.015)	(0.038)	(0.011)	(0.113)
time to trading center (hrs)	2.692**	-6.156**	0.219	-0.133**
	(1.269)	(2.809)	(0.567)	(0.057)
larger market in community	-2.291	2.952	-0.656	-1.433
	(1.761)	(3.392)	(0.802)	(4.535)
ADMARC in community	0.677	1.169	1.434	-4.728
	(1.991)	(3.548)	(0.903)	(5.997)
EA population density	-1.095	-0.329	0.548	0.498
	(1.100)	(1.541)	(0.341)	(2.052)
EA pop. density squared	0.033	0.014	-0.012	-0.040
	(0.034)	(0.049)	(0.011)	(0.067)
district pop. density	-3.356***	3.355**	-0.701	3.623
	(1.020)	(1.692)	(0.462)	(2.463)

Table 4.8a (Continued)

	Own farm labor (hrs/wk)	Unskilled wage labor (hrs/wk)	Expenditure on seed (USD)	Expenditure on fertilizer (USD)
district poverty rate 1998	4.312	4.599	-2.078	89.104***
	(9.678)	(17.553)	(4.179)	(27.724)
constant	-34.820	-11.303	-8.572	-214.186**
	(33.425)	(61.105)	(11.733)	(91.237)
Number of observations	3,514	3,514	3,702	3,702
Number of clusters	438	438	440	440

Quarter of year and region fixed effects.
Cluster-robust standard errors in parentheses. * significant at 10%; ** 5%, *** 1%.

Table 4.8b. IV Tobit second stage, standard errors clustered by EA and met station

	Own farm labor (hrs/wk)	Unskilled wage labor (hrs/wk)	Expenditure on seed (USD)	Expenditure on fertilizer (USD)
received aid 2003	53.140**	-58.445	23.609**	-22.327
	(24.633)	(45.588)	(9.828)	(55.854)
WRSI 2001 (0-10)	-0.044	2.499	0.678	5.423
	(1.900)	(2.951)	(0.586)	(3.760)
WRSI 2002 (0-10)	-2.287*	-2.832	-0.533	-4.585
	(1.225)	(2.331)	(0.397)	(2.985)
WRSI 2003 (0-10)	-4.146***	5.552**	-0.835*	7.908**
	(1.140)	(2.377)	(0.441)	(2.954)
WRSI 2004 (0-10)	-1.438	1.041	-0.097	5.978***
	(0.869)	(1.438)	(0.284)	(1.997)
long-term mean WRSI	10.492**	-5.517	0.378	4.867
	(3.864)	(6.378)	(1.233)	(7.488)
long-term std. dev. WRSI	7.101	-19.269*	-3.868*	31.512**
	(5.108)	(10.178)	(2.031)	(11.314)
household size	-0.104	1.778***	0.090	0.298
	(0.239)	(0.489)	(0.101)	(0.599)
female head	-6.290***	-5.898	-2.214**	-1.900
	(1.619)	(3.874)	(0.808)	(4.135)
# members 65+ years of age	-7.072***	-2.035	-2.547***	-2.770
	(2.052)	(4.170)	(0.841)	(4.565)
disabled household member	-9.673***	-2.688	-1.351	-4.692
	(2.406)	(5.703)	(0.947)	(5.181)
chronic illness of adult	-4.739**	0.182	-1.235	3.221
	(2.008)	(4.214)	(0.768)	(4.708)
education of head (yrs)	-0.388***	0.195	0.164***	2.270***
	(0.129)	(0.328)	(0.057)	(0.362)
# rooms in dwelling	-1.085*	-0.830	-0.036	6.293***
	(0.543)	(1.204)	(0.234)	(1.469)
land owned (ha)	1.894**	-4.915**	1.663***	14.758***
	(0.786)	(2.160)	(0.448)	(3.175)
land owned (ha) squared	-0.100	0.229	-0.138*	0.440
	(0.109)	(0.233)	(0.076)	(0.488)
livestock (TLU)	0.915*	-1.498	0.837***	7.893***
	(0.530)	(1.321)	(0.275)	(2.051)
TLU squared	-0.014	0.055	-0.021**	-0.397***
	(0.014)	(0.038)	(0.009)	(0.111)

Table 4.8b (Continued)

	Own farm labor (hrs/wk)	Unskilled wage labor (hrs/wk)	Expenditure on seed (USD)	Expenditure on fertilizer (USD)
constant	-23.283	-25.744	-5.358	-243.688***
	(28.889)	(59.361)	(10.328)	(65.674)
Number of observations	3527	3527	3717	3717
Number of clusters	21; 438	21; 438	21; 440	21; 440

labor variable. This suggests that any correlation of WRSI four years ago in 2000 with the dependent variables will be only through the effect of aid.

We find that having received food aid in 2003 increases labor supply to own farm activities and total income generating activities in 2004/2005. Aid may also decrease unskilled wage labor supply, but this effect is significant only in the linear model.

Aid receipt has a positive effect on seed expenditures, but surprisingly no effect on the purchase of fertilizer. The sign on aid in the fertilizer regression is not even stable across specifications. One possible explanation is that returns to fertilizer vary significantly depending on soil quality, with negligible returns at low levels of soil organic matter (Marenya and Barrett, 2008). Perhaps the soils of farmers in our sample are too degraded for fertilizer to be profitable.

The magnitudes of the estimated effects, particularly on the labor supply variables, are implausibly large. This may be due to fact that the excluded instrument, with an F-statistic of just over 10 in the first stage, is relatively weak.

7. Conclusion

Using nationally representative data from Malawi, we have investigated the effect of food aid on the agricultural production decisions of smallholders. Echoing previous findings from Ethiopia, we fail to find evidence of a disincentive effect of aid on total labor supply. Rather, households that recently received aid allocated more time to own farm production activities, and indeed more time on income-generating activities overall. Households that received aid also spent more on purchased seeds for their farms.

These results suggest that food aid may alleviate a liquidity constraint during the planting season, allowing households to devote more of their limited resources to own farm production with a delayed payoff rather than work for a low but immediate wage. Contrary to the received wisdom that food aid may have disincentive effects on smallholder agricultural production, our findings point to one mechanism through which this type of aid may actually increase smallholder productivity.

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