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Research Article

Subjective expectations in the context of HIV/AIDS in Malawi

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Research Article

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Abstract

In this paper we present a newly developed interactive elicitation methodology for collecting probabilistic expectations in a developing country context with low levels of literacy and numeracy, and we evaluate the feasibility and success of this method for a wide range of outcomes in rural Malawi. We find that respondents' answers about their subjective expectations take into account basic properties of probabilities, and vary meaningfully with observable characteristics and past experience. From a substantive point of view, the elicited expectations indicate that individuals are generally aware of differential risks. For example, individuals with lower incomes and less land rightly feel at greater risk of financial distress than people with higher socioeconomic status (SES), and people who are divorced or widowed rightly feel at greater risk of being infected with HIV than currently married individuals. Meanwhile many expectations—including the probability of being currently infected with HIV—are well-calibrated compared to actual probabilities, but mortality expectations are substantially overestimated compared to life table estimates. This overestimation may lead individuals to underestimate the benefits of adopting HIV risk-reduction strategies. The skewed distribution of expectations about condom use also suggests that a small group of innovators are the forerunners in the adoption of condoms within marriage for HIV prevention.

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1. Introduction

Sub-Saharan Africa is at the epicenter of the HIV/AIDS epidemic, and estimated adult HIV prevalence ranges from less than 0.1% in Comoros to 32.4% in Swaziland (UNAIDS 2006). Because the epidemic has become generalized, heterosexual sexual intercourse among low-risk individuals is the most common pathway of infection for rural populations (Gouws et al. 2005). Behavioral change with respect to sexual relationships, marriage/divorce, condom use and partner selection is therefore crucial for all efforts targeted at curtailing the disease (Aggleton et al. 1994; UNAIDS 1999; Cerwonka, Isbell, and Hansen 2000). However, the adoption of behavioral change in AIDS-related behaviors depends critically on individuals' subjective expectations about their own HIV infection status and life expectancy, the prevalence of HIV in the local population, and the availability of antiretroviral treatments for AIDS. Several theoretical frameworks that seek to identify the determinants of risk-taking behaviors in the context of HIV/AIDS—including, for example, rational choice theories (Philipson and Posner 1993), the health-belief-model (UNAIDS 1999), the theory of reasoned action (Ajzen and Fishbein 1980), or the information-motivation-behavioral skills (IMB) model (Fisher and Fisher 1992)—therefore emphasize (correct) expectations about AIDS risks as a central prerequisite for behavioral change. However, despite this alleged central role of expectations, very few empirical studies have used well-defined subjective expectations in their analyses of HIV-infection risks and the determinants of risk-taking behaviors. In cases where expectations and risk perceptions have been investigated, researchers often make non-verifiable assumptions, for example, with respect to the interpretation of verbal scales measuring degrees of subjective likelihood (very likely vs. not very likely), or the interpersonal comparability of subjective risk assessments (e.g., Akwara, Madise, and Hinde 2003; Prata et al. 2006; Anglewicz and Kohler 2009).

To resolve the limitations of existing approaches, economists have recently developed approaches to elicit *probabilistic expectations*: i.e., expectations that are measured on a well-defined numerical scale, that are comparable across domains, and that can be consistently interpreted as probabilities. For example, probabilistic expectations can be elicited using questions such as, "What do you think is the *percent chance* that you will live to be 75?" Survey respondents in developed countries have been shown to be willing and able to answer questions about probabilistic expectations in a meaningful way (for a recent review, see Manski 2004). But in the context of developing countries with low literacy and numeracy, a direct question about the percent chance may be overly complicated or even meaningless to respondents. Prior to the study presented in this paper, there have been very few attempts to elicit probabilistic expectations in developing countries (for an overview, see Delavande, Gine, and McKenzie 2009). Some of the exceptions include the following: Luseno et al. (2003) and Lybbert et al. (2007), who have elicited

rainfall expectations by asking household heads in Kenya and Ethiopia to allocate twelve stones into three piles, with each pile representing a different state of nature regarding the precipitation level for the coming rainy season (above normal, normal and below normal); Santos and Barrett (2006) and Hill (2006), who have used a similar technique to elicit expectations about herd size and coffee prices, respectively; McKenzie, Gibson, and Stillman (2006), who have used the percent chance wording to elicit expectations about future post-migration employment and income from Tongans intending to emigrate to New Zealand; and Delavande (2004) and Attanasio, Meghir, and Vera-Hernánde (2005), who have used a visual scale labeled from zero to ten (or hundred) to elicit probabilistic expectations about contraceptive failures and birth outcomes in Ghana or future income in Colombia. In most of the existing cases, however, these methods to elicit probabilistic expectations were implemented in populations that have a relatively high level of literacy or numeracy compared to the sub-Saharan African countries where HIV/AIDS is most prevalent, or were limited to small-scale surveys without extensive socioeconomic or demographic information.

To investigate the relevance of subjective expectations for understanding AIDS-related risk behaviors and behavioral change in Sub-Saharan Africa (SSA), we have developed an innovative interactive elicitation technique to elicit probabilistic expectations, and have implemented this technique as part of the 2006 survey of the Malawi Diffusion and Ideational Change Project (MDICP), which covers more than 3,000 adult respondents in rural Malawi. In this paper, we present this interactive technique, and evaluate its success at eliciting probabilistic expectations about HIV-related outcomes and other important life events in rural Malawi. The analyses in this paper find that the reported expectations are remarkably consistent with a basic property of probability theory (the monotonicity of nested events), and vary in meaningful ways with individual or contextual characteristics. In addition, several important substantive findings emerge from our analyses. We find that respondents have relatively well-calibrated beliefs about infant mortality, but are greatly pessimistic about their own survival—perhaps as an overreaction to the substantial increases in adult mortality that have occurred as a result of HIV/AIDS in the last decade. We also find that AIDS-related subjective expectations exhibit heterogeneity across individuals and socioeconomic groups that may partially explain the substantial variation in the extent to which rural Malawians engage in risk-taking behaviors or adopt risk-reduction strategies.

2. Background

Most decisions individuals face during their lives are characterized by uncertainty. This is especially the case when the consequences of an individual's behavior depend on the

behaviors of others, or on aspects of the environment that are difficult or impossible to observe. Social scientists therefore typically assume that individuals use available information to form subjective probability distributions (subjective *expectations*) about uncertain events, and rely on these expectations to make decisions. Knowing individuals' expectations is therefore crucial to making accurate inferences regarding the determinants of individual behaviors and their variations across persons and social groups. To illustrate the central relevance of knowing individuals' expectations for making accurate inferences about the determinants of individual behaviors, consider a young man who engages in sexual activities without using a condom. His behavior can be consistent with many alternative specifications of his preferences and expectations. For example, he may believe that he is at great risk of contracting HIV from unprotected sex, but dislikes condoms so much that he chooses not to use one. Alternatively, he might not dislike condoms that much, but believes that his partner and he have the same serostatus, and therefore chooses not to use condoms. A third hypothesis is that he believes condoms are ineffective at preventing the transmission of sexually transmitted diseases. Other plausible competing explanations could be advanced. Choice data alone (e.g., data on condom use)—that is, choice data without accompanying information on the subjective expectations related to the respective choices—do not enable researchers to discriminate between these competing explanations,which have very different policy implications.[3]

To overcome this limitation, some attitudinal researchers have used verbal questions to measure "qualitative" expectations, such as whether an event is "very likely" or "unlikely" to occur. A main difficulty with the interpretation of these verbal scales is that answers may not be comparable across respondents (King et al. 2004), and individuals may have very different perceptions about what "very likely" is. Thus, two respondents who provide the same answers based on a verbal scale might still make different decisions, even if they were to share identical tastes. Moreover, even if interpersonal comparability is improved using anchoring vignettes (King et al. 2004; Salomon, Tandon, and Murray 2004) or similar techniques, the interpretation of likelihood scales in terms of probabilistic expectations remains problematic, and is inherently coarse. Cognitive psychologists and economists have therefore started to elicit *probabilistic expectations*, which have the advantage of being measured on a numeric scale on which answers can be consistently interpreted as probabilities across different types of outcomes (Manski 2004). Several large-scale surveys—including the Survey of Economic Expectations (SEE), the Health and Retirement Study (HRS), the National Longitudinal Survey of Youth (NLSY), and the Michigan Survey of Consumers—have included questions eliciting respondents' expectations in a probabilistic form. Respondents' answers to these questions about subjective expectations have been shown to vary in a systematic manner with covariates af-

[3] See Manski (2004) for other examples of this identification problem.

fecting the underlying events, and the elicited expectations have also been found to have strong predictive power for subsequent outcomes (e.g., Dominitz and Manski 1996, 1997; Lillard and Willis 2001). For example, the subjective assessments of the probability of survival in the HRS have been found to vary systematically with other variables, such as smoking (Hurd and McGarry 1995); to evolve coherently over time in response to new information, such as the onset of a disease or the death of a parent at an early age (Hurd and McGarry 2002); and to be predictive of actual mortality (Hurd and McGarry 2002; Delavande and Rohwedder 2008).

The theoretical models guiding most of this research on subjective expectations are generally based on economic inter-temporal choice frameworks that explicitly recognize uncertainty and incorporate subjective expectations to reflect individuals' perceptions of this uncertainty. Consider, for example, an individual with an uncertain monthly income stream, and who cares about present and future consumption. Enjoying future consumption depends on survival, which is a function of current and future health. Future health outcomes are determined by a health production function that includes the current health status and various health inputs (e.g., nutrition, health care utilization, etc.; but also aspects such as sexual behaviors involving HIV infection risks). An individual may be uncertain about his/her current health, as well as the health production itself that determines relationships between health inputs and health outcomes (e.g., an individual may be uncertain about the HIV infection risk associated with sexual intercourse, either due to uncertainty about the infection risk per intercourse, or uncertainty about the HIV status of the sexual partner). There may also be uncertainty about the health production function as a result of technological change in the context of this research: for example, because antiretroviral treatment (ART) may change the health consequences of being infected with HIV. In this uncertain intertemporal context, individuals need to allocate resources (e.g., income, time) and make behavioral decisions (e.g., about sexual behaviors, condom use, etc.) to maximize expected lifecycle utility. In this model, optimal resources allocations and behaviors will depend critically on an individual's expectations about aspects such as future income streams, the health production function, survival probabilities, etc. Optimal allocations and behaviors may also change over time as expectations change, for example, as a result of new information or environmental changes (e.g., price changes or changes in the HIV prevalence in the pool of actual/potential sexual partners), and as a result of the passage of time, which shortens the remaining expected life.

In most descriptive and reduced form analyses of subjective expectations, including the analyses conducted in this paper, the link to this underlying theoretical framework is usually implicit and not fully formalized. However, some recent studies have explicitly incorporated probabilistic expectations data into structural econometric models of choice behavior in various settings. For example, Nyarko and Schotter (2002) use subjects' stated beliefs about their opponent's strategies to analyze how experimental subjects play a con-

stant sum game, Delavande (2008) estimates a random utility model of contraceptive behavior using expectations about birth control methods, Erdem, Keane, and Strebel (2005) incorporate price expectations in a dynamic discrete choice model of information search and technology choice, Hurd, Smith, and Zissimopoulos (2004) and Delavande and Willis (2007) study how subjective expectations of survival affect the timing of retirement and of claiming Social Security, and, finally, Lochner (2007) investigates criminal behavior using subjective expectations of arrest.

3. Data and context

The analyses in this paper are based on the 2006 wave of the *Malawi Diffusion and Ideational Change Project* (MDICP). The general goal of this project is to investigate the multiple processes and influences that contribute to varying degrees of HIV risks in sexual partnerships in a sub-Saharan African context, the variety of ways in which people manage risk through prevention strategies within marriage and other sexual relationships, and the potential effect of HIV risk-reduction programs on infection risks and disease dynamics. For this purpose, the MDICP has collected, and continues to collect, an unusually rich combination of panel survey data (1998, 2001, 2004, 2006, 2008, with ongoing data collection until 2010), qualitative data, and biomarkers for HIV and other sexually transmitted infections. Detailed descriptions of the MDICP sample selection, data collection, and data quality are provided on the project website at http://www.malawi.pop.upenn.edu, in a Special Collection of the online journal *Demographic Research* devoted to the MDICP (Watkins et al. 2003), and in a recent working paper that incorporates the 2004 and 2006 MDICP data (Anglewicz et al. 2009). Mortality and migration are the primary sources of attrition in the MDICP, and verbal autopsies (VAs) conducted as part of the MDICP suggest that approximately two-thirds of respondents who died between the 1998–2001 surveys had AIDS-related symptoms (Doctor and Weinreb 2003).

In 2006, the MDICP included more than 3,000 men and women between the ages of 17 and 60 who participated in a household survey and biomarker collection for HIV. Comparisons with the Malawi DHS showed that the MDICP sample population is reasonably representative of the rural Malawi population (Anglewicz et al. 2009). The 2006 MDICP collected information on, among other aspects, the following: (a) sexual relations, including the number of sexual partners, the frequency of sexual interactions, the characteristics of the last two sexual partners, and attitudes toward and reported use of condoms; (b) marriage and partnership histories; (c) household rosters and intergenerational transfers; (d) attitudes and behaviors in relation to HIV/AIDS and other sexually transmitted infections (STIs), including the acceptability of various risk reduction strategies, perceived HIV/AIDS risks, frequency of attendance at community activities such

as funerals and other community activities, and number of people known to have died of AIDS; and (e) the respondent's HIV status using HIV rapid tests that were administered to all consenting respondents after the household survey. In addition to various questions about subjective risk assessments that have been asked in the MDICP since 1998, including, for instance, the respondent's assessment of his/her own and partner's current HIV status and expected lifetime HIV risk, the 2006 wave of the MDICP also included a newly developed ***expectations module*** that was designed to elicit probabilistic expectations on HIV/AIDS related behaviors and outcomes. This expectation module was administered to more than 3,000 respondents (see Table 1 for summary statistics), and this paper provides the first detailed set of analyses of the probabilistic expectation collected as part of the 2006 MDICP.

Table 1: Summary statistics for respondents participating in the 2006 MDICP expectations module

	Percentage of Respondents		
	Males	**Females**	**Total**
N	1,433	1,739	3,172
Age			
< 20	11.82	11.18	11.46
20–29	25.48	28.98	27.46
30–39	22.38	26.67	24.81
40–49	18.52	20.50	19.64
50+	21.79	12.66	16.62
Education			
low education (no schooling)	12.38	26.38	20.06
medium education (primary schooling)	66.99	64.00	65.35
high education (secondary schooling or higher)	20.63	9.62	14.59
Marital status			
married	79.05	82.04	80.69
divorced/separated/widowed	2.30	11.74	7.48
never married	18.65	6.22	11.83
Land ownership			
≤ 2 acres	36.24	47.17	42.25
2–4 acres	32.51	32.27	32.38
> 4 acres	31.25	20.55	25.37

Table 1: (Continued)

	Percentage of Respondents		
	Males	**Females**	**Total**
N	1,433	1,739	3,172
Lifetime number of sexual partners			
0	4.33	3.23	3.73
1	17.26	42.57	31.13
2	22.08	31.11	27.03
3	17.54	13.82	15.50
4+	38.78	9.27	22.61
Ever tested for HIV (prior to 2006 MDICP survey)			
no	37.67	37.86	37.77
yes, learned result	58.61	55.78	57.06
yes, did not learn result	3.72	6.36	5.17
2006 HIV status (determined after 2006 MDICP survey)			
negative	88.38	86.33	87.24
positive	3.60	6.15	5.02
no test	8.02	7.52	7.74
Region			
North (Rumphi)	31.96	31.69	31.81
Center (Mchinji)	33.29	34.24	33.81
South (Balaka)	34.76	34.07	34.38

Note: The expectation module included in the 2006 wave of the MDICP was administered to 3,237 respondents in three regions of rural Malawi. For 65 respondents, the gender variable is missing, and our analyses focus on the 3,172 respondents with known gender who answered the expectation module.

4. Interactive elicitation of probabilistic expectations

To elicit probabilistic expectations in the context of low literacy and numeracy, we have developed an innovative *interactive elicitation* technique based on asking respondents to allocate up to ten beans on a plate to express the likelihood that an event will be realized. Interviewers during the 2006 MDICP introduced this technique by reading the following text to the respondents:

> *"I will ask you several questions about the chance or likelihood that certain events are going to happen. There are 10 beans in the cup. I would like you to choose some beans out of these 10 beans and put them in the plate to express what you think the likelihood or chance is of a specific event happening. One bean represents one chance out of 10. If you do not put any beans in the plate, it means you are sure that the event will NOT happen. As you add beans, it means that you think the likelihood that the event happens increases. For example, if you put one or two beans, it means you think the event is not likely to happen but it is still possible. If you pick five beans, it means that it is just as likely it happens as it does not happen (fifty-fifty). If you pick six beans, it means the event is slightly more likely to happen than not to happen. If you put ten beans in the plate, it means you are sure the event will happen. There is no right or wrong answer, I just want to know what you think. Let me give you an example. Imagine that we are playing Bawo. Say, when asked about the chance that you will win, you put seven beans in the plate. This means that you believe you would win seven out of ten games on average if we play for a long time."*

The bean format outlined in this introductory text is visual, relatively intuitive, and fairly engaging for respondents. In addition, the format can be designed to improve the consistency of answers. Following the above introduction and any clarifying questions, respondents were first asked a training question about the probability of winning in a local board game (Bawo), followed by a question about the likelihood of a newborn baby dying before his first birthday. To evaluate whether respondents understand the concept of probability, respondents were then asked about two *nested* events: going to the market within (*a*) *two days* and (*b*) *two weeks*. If respondents understand the concept of probability, they should provide an answer for the two-week period that is greater than or equal to the one of the two-day period. Interviewers were instructed to leave the number of beans on the plate after the respondents had responded to the likelihood of going to the market within two days, thereby ensuring that s/he remembered the answer when responding to the next question about the two-week period. If the respondent violated the monotonicity

property, the interviewer was instructed to explain the incoherency of the answers with the following statement: "*As time goes by, you may find more time to go to the market. Therefore, you should have added beans to the plate.*" And the respondent was invited to reformulate the answer. For this first set of training questions, the interviewers were also instructed to prompt the respondent if s/he allocated zero or ten beans in the plate.

Respondents were then asked a series of questions related to economic outcomes, health outcomes, and risk-prevention strategies (see Appendix A for the expectations module included in the 2006 MDICP questionnaire). For the analyses in this paper, we focus on the following events: (*a*) going to market within the next *two days*; (*b*) going to the market within the next *two weeks*; (*c*) experiencing a food shortage within the next twelve months; (*d*) having to rely on family members for financial assistance in the next twelve months; (*e*) being infected with HIV now; (*f*) using a condom at the next sexual encounter with a spouse; (*g*) using a condom at the next sexual encounter with someone other than a spouse (not asked if the respondent reports having sex only with a spouse); and (*h*) the respondent dying within (*i*) *one year*; (*ii*) *five years*; and (*iii*) *ten years*. The mortality questions were designed to ensure that respondents provided answers that would allow us to construct well-defined survival curves. In particular, respondents were first asked to pick the number of beans that reflect how likely it is that they will die within a one-year period beginning today. Then, with the beans of the previous question still on the plate, they were asked to *add* more beans to reflect how likely it is that they would die within a five-year period. The same procedure was followed for the ten-year period mortality question. This ensured that respondents provided weakly increasing answers when the time horizon increased.

In our subsequent analyses, we use two related scales to represent respondents' answers to the subjective expectation questions. *First*, the direct response to the expectation questions in terms of the number of beans that the respondent put on the plate (ranging from zero to ten). *Second*, we interpret the reported number of beans as *implied subjective probabilities* by assuming that each number of beans between zero and ten corresponds to a specific probability interval between zero and one. This approach assumes that respondents choose the number of beans that best represents their subjective probability, and it reflects our beliefs that all respondents who place zero (ten) beans on the plate do not believe literally that this event has a probability of zero (one). We therefore calculate the *implied subjective probability* by assuming that respondents allocate the number of beans

as a function of their underlying subjective probability P_i as follows:

$$\begin{aligned}
\textit{zero} \text{ beans} \quad & \text{if} \quad P_i < 0.05 \\
\textit{one} \text{ bean} \quad & \text{if} \quad 0.05 \leq P_i < 0.15 \\
\vdots \quad & \quad \vdots \\
X_i \text{ beans} \quad & \text{if} \quad \frac{X_i}{10} - 0.05 \leq P_i < \frac{X_i}{10} + 0.05 \\
\vdots \quad & \quad \vdots \\
\textit{nine} \text{ beans} \quad & \text{if} \quad 0.85 \leq P_i < 0.95 \\
\textit{ten} \text{ beans} \quad & \text{if} \quad P_i \geq 0.95,
\end{aligned} \tag{1}$$

where X_i is the number of beans allocated by respondent i given his/her underlying subjective probability P_i.

In addition to providing various summary statistics of these implied probabilities, we will also use a standardized boxplot-like diagram to display the *distribution* of subjective probabilities. This boxplot-like graph displays the mean and median of the reported expectations, as well as the 10th, 25th, 75th, and 90th percentiles of the distribution (see also Appendix Figure B1). The median and percentiles of the distribution of subjective probabilities are calculated assuming a uniform distribution of the underlying subjective probabilities P_i within each interval in Eq. (1). The mid-point of each interval in Eq. (1) is used in calculations of the average (implied) subjective probability.[4]

The first question in the expectation module asked respondents about the likelihood that they would win if they were playing Bawo with the interviewer. Bawo is a common board game played in Malawi. It is a strategy game, and can be as complex as checkers or chess.[5] Table 2 presents the distribution of answers in terms of the number of beans allocated by respondents, and Figure 1 depicts the distribution of the *implied subjective probabilities*.

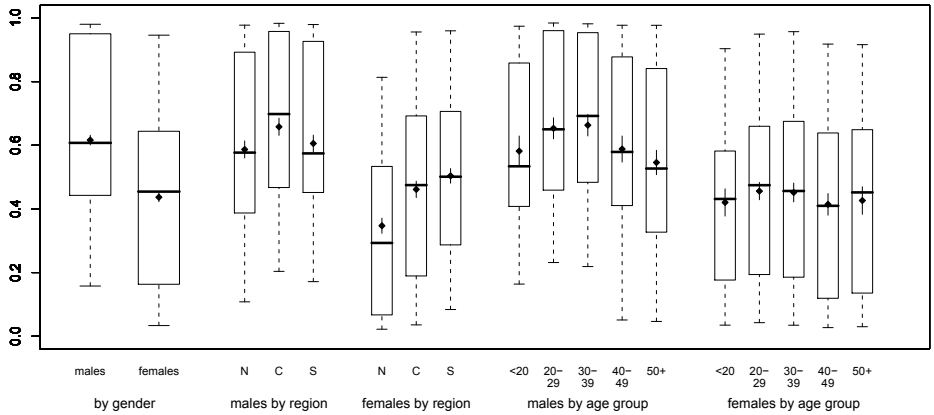
The elicited respondents' expectations about winning in a game of Bawo reveal a considerable heterogeneity in beliefs, as is expected given that the probability of winning depends on many factors, such as the respondent's and the interviewer's skill and experience. The inter-quartile range for both men and women in Figure 1 is .48–.51: 25% of men believe that they have a less than 44% chance of winning, while 25% believe that they are highly likely—with a subjective probability of more than 95%—to win. Women are less optimistic about winning in Bawo, and the distribution is shifted downward compared to men, but with a similarly high variance: 25% of women believe that they have

[4] This midpoint of the interval in Eq. (1) is equal to the number of beans, X, divided by ten, except for zero beans, where the midpoint is .025, and ten beans, where the midpoint is .0975.

[5] For details about rules and potential strategies, see Agbinya (2004).

a less than 16% chance of winning, while 25% believe that they will win with a subjective probability of more than 64%. The average implied probability of winning is 62% for men and 44% for women, with the difference being statistically different (Figure 1).[6] This gender difference is consistent with the fact that men play Bawo more often than women, and thus tend to be more experienced; the gender difference is also in agreement with the large body of literature reporting that women have lower expectations of success than men in many areas of achievement (e.g., Erkut 1983; Mura 1987). In addition to this gender difference, Figure 1 reveals a slight age pattern: males aged 20 to 39 report a higher subjective probability of winning in a Bawo game against the interviewers than males in younger or older age groups, perhaps reflecting higher skills in this age group, or generally more optimistic perceptions of young adult men in their own abilities.

Figure 1: Distribution of respondents' subjective probability of winning if playing bawo, by gender, region, and age group



Notes: Region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka).

The reported probabilities of winning in a game of Bawo reveal some important features of subjective expectations that continue to characterize many of the outcomes, which are analyzed as follows: (a) subjective probabilities often exhibit considerable variation between respondents, who differ substantially in their assessments of the likelihood of various events; (b) they vary importantly and meaningfully across subpopulations defined

[6] The mean answer in terms of beans is 6.16 for men compared to 4.35 for women, and the difference is statistically significant using a t-test ($t = 16.74$, p-value < 0.001).

by age, gender, region, and as we show later, also by marital status, socioeconomic status, and health; (c) mean and median answers are often close to each other, indicating that the distribution of beliefs tends to be symmetric, with the exception of respondents' expectations about currently being infected with HIV, which is highly skewed.

Table 2: Subjective probability of wining when playing Bawo with the interviewer, by gender

Number of beans	implied subjective probability	gender		Total
		men	women	
0	0 to .05	5.9	15.0	10.9
1	.05 to .15	3.7	8.8	6.5
2	.15 to .25	4.8	9.5	7.4
3	.25 to .35	4.8	8.1	6.6
4	.35 to .45	6.3	7.9	7.2
5	.45 to .55	19.1	18.1	18.5
6	.55 to .65	9.4	8.2	8.8
7	.65 to .75	7.2	6.2	6.7
8	.75 to .85	8.4	5.8	7.0
9	.85 to .95	5.3	2.6	3.8
10	.95 to 1	25.1	9.9	16.7
Total (Percent)		100	100	100
Implied subjective probability				
Mean		0.62	0.44	0.52
10^{th} percentile		0.16	0.03	0.05
25^{th} percentile		0.44	0.16	0.25
Median		0.61	0.45	0.51
75^{th} percentile		0.95	0.64	0.79
90^{th} percentile		0.98	0.95	0.97
N		1,433	1,739	3,172

5. Response patterns

This expectation module included in the 2006 wave of the MDICP was administered to 3,237 respondents in three regions of rural Malawi. For 65 respondents, the gender variable is missing, and our analyses focus on the 3,172 respondents with known gender who answered the expectation module. Table 3 reports the responses in terms of number of beans to the questions about going to the market, experiencing a food shortage, having to rely on family members, infant mortality, being infected with HIV, condom use, and mortality. As these responses are based in a newly developed interactive approach to elicit probabilistic expectations in developing country contexts, we include in our analyses a careful evaluation of this approach. Before embarking on the substantive analyses of these subjective probabilities covering several domains of respondents' lives, we begin in this section with an evaluation of the quality of the elicited expectation data, including item non-response, focal answers, and the internal consistency of respondents' answers about nested events. We then provide detailed descriptions of respondents' subjective expectations about common events, HIV infection, and prevention strategy and mortality, and evaluate how these subjective probabilities vary with respondents' characteristics or reported behaviors.

5.1 Item non-response

Out of the 3,185 respondents with known gender to whom the expectation module was administered, 3,172 answered the first training question of the module. Throughout the module, the response rate of the expectations questions is remarkably high: non-response ranges from 0.4% to 1.3% for the questions related to everyday life and HIV. Item non-response is the highest on the mortality questions, but is still extremely low (from 1.85 to 2%). This compares to the 2% non-response rate on the mortality questions elicited by the HRS (Hurd and McGarry 1995), and is lower than in the Survey of Health Ageing and Retirement in Europe (SHARE), where country-specific non-response rates range from 2% to 17% (Delavande and Rohwedder 2008). Overall, item non-response is at the low end compared to other surveys eliciting probabilistic expectations. For example, expectations about future income had a non-response rate of 4% in the SEE, and 25% in a Colombian survey (Attanasio, Meghir, and Vera-Hernánde 2005).

Table 3: Subjective probabilities of various common events

Number of beans	implied subjective probability	Going to the market within		Experiencing food shortage in the next 12 months	Rely on family for financial assistance in the next 12 months	Baby dying before 1st birthday
		2 days	2 weeks			
0	0 to .05	6.0	1.1	11.2	22.2	18.4
1	.05 to .15	9.6	1.3	7.7	11.7	22.4
2	.15 to .25	17.7	2.5	10.2	11.9	17.7
3	.25 to .35	15.0	6.3	8.9	8.6	10.7
4	.35 to .45	14.6	7.0	9.2	6.8	7.3
5	.45 to .55	14.5	12.4	17.3	13.2	17.6
6	.55 to .65	7.9	14.1	8.2	6.7	2.8
7	.65 to .75	4.9	15.3	7.4	4.9	1.3
8	.75 to .85	3.5	13.3	7.1	4.9	0.9
9	.85 to .95	1.8	6.7	3.0	2.4	0.4
10	.95 to 1	4.5	20.1	9.8	6.8	0.7
Total (Percent)		100	100	100	100	100
Implied subjective probability						
Mean		0.39	0.67	0.46	0.36	0.25
10th percentile		0.09	0.33	0.05	0.02	0.03
25th percentile		0.20	0.51	0.21	0.07	0.08
Median		0.36	0.69	0.47	0.30	0.20
75th percentile		0.53	0.88	0.68	0.56	0.43
90th percentile		0.75	0.98	0.94	0.83	0.53
N		3,170	3,157	3,145	3,163	3,171

Table 3: (Continued)

Number of beans	Being infected with HIV now	Using condom at next sexual encounter with spouse	Using condom at next sexual encounter with someone other than spouse	Own Mortality: Probability of dying within 1-year	Own Mortality: Probability of dying within 5-years	Own Mortality: Probability of dying within 10-years
0	66.7	64.3	10.1	29.1	6.0	2.0
1	9.6	7.5	1.5	24.2	8.4	2.0
2	7.5	6.7	3.8	16.2	16.2	4.9
3	4.8	4.4	3.6	8.9	16.6	8.0
4	2.3	2.9	3.4	5.4	12.2	10.0
5	5.6	6.1	11.2	13.2	20.2	24.9
6	0.5	2.6	8.2	0.8	7.1	10.1
7	0.5	0.9	5.3	0.4	5.9	11.2
8	0.9	1.4	8.8	0.5	3.3	9.8
9	0.7	0.5	7.4	0.3	0.9	4.9
10	1.0	2.7	36.6	0.9	3.3	12.2
Total (Percent)	100	100	100	100	100	100
Implied subjective probability						
Mean	0.12	0.16	0.67	0.20	0.39	0.58
10^{th} percentile	0.01	0.01	0.05	0.02	0.10	0.27
25^{th} percentile	0.02	0.02	0.47	0.04	0.22	0.43
Median	0.04	0.04	0.78	0.14	0.37	0.54
75^{th} percentile	0.14	0.20	0.97	0.31	0.53	0.77
90^{th} percentile	0.41	0.52	0.99	0.50	0.71	0.96
N	3,162	2,583	582	3,125	3,125	3,123

5.2 Focal answers

Expectations questions have been found to exhibit heaping at focal answers of 0%, 50% and 100% (e.g., see Hurd and McGarry 1995), and responses of 50% have been shown to reflect uncertainty (Bruine de Bruin et al. 2000). In Malawi, the pattern of focal answers—zero, five, and ten beans—is quite similar to those found in surveys conducted in developed countries. From Table 2 we can see that for the Bawo question, focal answers represent about 46% of the overall answers. This compares to 44% for the income expectations in the SEE (Dominitz and Manski 1997), 46% for the probability of getting the flu next year in the NLSY 1997 (Fischhoff et al. 2000), and 56% for the probability of working past age 62 in HRS 2002. The mortality expectations exhibit less heaping than in the HRS (even though the two surveys are not directly comparable due to the difference in age groups). For example, 39% of the MDICP respondents provided a focal answer when asked about their 10-year mortality (Table 3). If we restrict the HRS sample to respondents aged 64 and 65 in 1992, we find that half of them provided either 0%, 50% or 100% when asked about the probability of being alive at age 75.[7] We have little benchmark data from developing countries. However, Attanasio, Meghir, and Vera-Hernánde (2005) report that, in Colombia, 15% of their sample answered 50% when asked about the probability that their income would be above a threshold.

Overall, the pattern of focal answers in Table 3 is sensible. For example, as the length of time for the probability of going to the market increases, the proportion of respondents answering with zero beans decreases sharply, while the proportion of those responding with ten beans increases substantially. There is a similar pattern for the mortality questions. Moreover, for events with a low likelihood, like the one-year mortality of a baby or their own HIV infection, the proportion of responses at zero beans is far greater than those at ten beans.

5.3 Consistency of subjective expectations with probability theory

After the completion of the survey, interviewers were asked to evaluate whether the respondents understood the concept of likelihood or chance.[8] In 34% of the interviews, the interviewer reported that the respondent fully understood; in 35%, that s/he mostly understood; in 30%, that s/he understood after a while. In about 1% of the interviews, the

[7] Source: author's computation ($N = 227$). We use HRS 1992 because respondents were asked to provide a number between zero and ten, as in the present survey. In later waves, respondents were asked to provide a number between zero and hundred.

[8] Interviewers were asked to evaluate: "Did the respondent understand the concept of likelihood or chance in the questions on expectations (X1 to X5)?", with responses ranging from 1 = "fully understood" to 5 = "Did not understand at all".

interviewers thought that the concept remained unclear until the end, or that the respondent did not understand at all.

A more direct test to evaluate whether respondents understand the concept of probabilistic expectations is to analyze nested events. Nested events are subsets of each other, and thus imply an ordering of the subjective probabilities. In our interactive approach, we used two questions about the respondent's likelihood of going to the market to test this consistency of expectations: going to the market within two days, and going to the market within two weeks. A remarkably high number of respondents said that the probability of "going to the market within two days" was less than or equal to the likelihood of "going to the market within two weeks". Only 19 respondents out of 3,221 (0.6%) violated the property of the probability of nested events. Note that the design of the question did not force this high consistency rate. While interviewers were instructed to leave on the plate the beans expressing the likelihood of going to the market within two days, they did not ask respondents to add more beans for the two-week period. One may wonder if this very high consistency rate results from the fact that respondents provided the same answers to both questions. However, only about 6% of the respondents gave the same answer to both questions. Adding two and three beans was the most common action taken by respondents when the length of time increases from two days to two weeks (29% added two, and 25% added three beans; see Appendix Table B1 for a full tabulation). This consistency of the implied probabilities of going to the market within two days and two weeks provides strong support for the assumption that respondents understood the concept of likelihood. The mortality expectations contain another set of nested events: respondents were asked about the probability of dying within one year, five years, and ten years. The mortality questions deal with an event that, unlike going to the market, respondents do not experience regularly. Out of the 3,180 respondents who answered the questions for the three time horizons, only 1.41% violated the monotonicity property of the probabilities. This high level of consistency is, however, due in part to the question design, which aimed at obtaining consistent answers (see Section 4).

5.4 Tendencies to be optimistic or pessimistic

As a final robustness check for the elicited subjective expectations, we investigate whether respondents had a tendency to be systematically pessimistic or optimistic; that is, whether they had a propensity to always choose a high or low number of beans, regardless of the outcome considered. Table 4 presents the distribution of respondents by quartiles for various pairs of questions. Given the design of the mortality questions, there is a mechanical tendency for respondents who provide a large one-year mortality risk to also provide a large five-year mortality risk. For example, about 80% of the respondents whose answer about the five-year mortality is in the upper quartile also have their answer about the

one-year mortality in the upper quartile. When we compare the answers of the five-year mortality with the infant mortality, there is not such a clear pattern, even though we can observe that, among respondents who are optimistic about their own mortality (those with answers in the first quartile), half also have their answer in the first quartile for infant mortality. However, if we compare the Bawo question with the survival, there is clearly no tendency to report similar answers to both questions. This pattern holds more generally across all questions: while individual's responses to questions in a similar domain—such as mortality—are correlated, there is an absence of a marked correlation in the responses to questions that are not substantively related (Appendix Table B2). This lack of a marked correlation across substantively unrelated questions indicates that respondents evaluated each question separately, taking into account question-specific information rather than following a similar response pattern—such as "always pick five beans"—across all questions.

5.5 Comparison with verbal scale

Table 5 compares respondents' answers to the question, "In your opinion, what is the likelihood (chance) that you are infected with HIV/AIDS now?" with the number of beans provided when asked how likely they think it is that they are currently infected with HIV/AIDS. It shows that respondents who estimate a higher likelihood of being infected using the verbal scale are also more likely to provide a higher number of beans. For example, the modal answer is zero beans among respondents who said "no likelihood", one bean among those who said "low likelihood", and five beans among those who said "medium likelihood." However, Table 5 also highlights that there is a great variation in what probability respondents associate with "low likelihood" or "medium likelihood." For example, a bit more than a quarter of the respondents who said "low likelihood" allocated one bean and another quarter allocated two beans, 18% allocated four beans, and 12% allocated zero beans. This suggests that the bean measure may be more informative in comparing risk rankings across individuals.

5.6 Measurement error

One may wonder whether the variation observed in the elicited number of beans is driven partly by measurement error. While it is impossible to evaluate what respondent's "true" beliefs are, and thus the extent of measurement error, we can investigate whether measurement error is fully responsible for the observed heterogeneity in reported beliefs. First, we can note that the verbal scale, which may be less prone to measurement error, generates similar variation in reported beliefs, and that the correspondence between the two scales is coherent (see Section 5.5). This suggests that heterogeneity in beliefs truly exists. Sec-

ond, we can compare the standard deviation of the distributions of beliefs for different outcomes. If respondents were randomly answering the beans questions, the standard deviations would be very similar independent of the events considered. As an example, we test using an F-test for equality of the standard deviation of the distributions associated with the likelihood of going to the market within two weeks, and the likelihood of experiencing a food shortage within the next twelve months. The respective sample standard deviations are 2.45 and 3.04, and we can reject equality of the standard deviations at 1%. Finally, the systematic variation of the percentiles of the distributions with observable characteristics suggests that respondents report meaningful answers.

Table 4: Tendencies to by systematically optimistic or pessimistic: Distribution of survey response across different subjective probabilities

	Five-year mortality				
	1st quartile	**2nd quartile**	**3rd quartile**	**4th quartile**	**Total**
One-year mortality					
1st quartile	**69.12**	17.26	13.31	1.57	29.09
2nd quartile	30.04	**40.98**	13.31	2.35	24.15
3rd quartile	0.32	41.20	**50.87**	14.29	25.18
4th quartile	0.53	0.56	22.50	**81.79**	21.58
Total	100.00	100.00	100.00	100.00	100.00
Infant mortality					
1st quartile	**55.93**	41.54	30.16	27.59	40.78
2nd quartile	16.37	**20.27**	18.10	15.83	17.73
3rd quartile	11.65	20.60	**20.00**	21.63	17.95
4th quartile	16.05	17.59	31.75	**34.95**	23.53
Total	100.00	100.00	100.00	100.00	100.00
Win if play Bawo					
1st quartile	**33.61**	31.59	30.79	28.53	31.42
2nd quartile	23.95	**25.03**	30.16	24.45	25.62
3rd quartile	21.85	22.47	**21.11**	24.45	22.41
4th quartile	20.59	20.91	17.94	**22.57**	20.55
Total	100.00	100.00	100.00	100.00	100.00

Note: The diagonal elements in each panel are indicated in *bold*.

Table 5: Comparison of probabilistic expectation and likelihood-based verbal scale about the likelihood of being infected with HIV

Probabilistic expectation:		***Response on verbal scale***					
Number of beans	**subjective probability**	**No likelihood**	**Low likelihood**	**Medium likelihood**	**High likelihood**	**Don't know**	**Total**
0	0 to .05	88.84	11.43	6.29	1.89	23.81	66.75
1	.05 to .15	5.75	27.06	1.26	0.00	28.57	9.50
2	.15 to .25	3.03	25.71	5.03	1.89	19.05	7.47
3	.25 to .35	1.32	18.32	5.66	0.94	9.52	4.78
4	.35 to .45	0.40	9.24	5.66	0.00	0.00	2.31
5	.45 to .55	0.35	7.39	71.07	6.60	19.05	5.57
6	.55 to .65	0.04	0.17	3.77	8.49	0.00	0.54
7	.65 to .75	0.04	0.50	0.63	10.38	0.00	0.51
8	.75 to .85	0.04	0.00	0.00	25.47	0.00	0.89
9	.85 to .95	0.04	0.00	0.63	18.87	0.00	0.70
10	.95 to 1	0.13	0.17	0.00	25.47	0.00	0.98
Total (Percent)		100.00	100.00	100.00	100.00	100.00	100.00
Implied subjective probability							
Mean		0.04	0.22	0.44	0.79	0.20	0.12
10^{th} percentile		0.01	0.04	0.20	0.53	0.02	0.01
25^{th} percentile		0.01	0.10	0.45	0.70	0.05	0.02
Median		0.03	0.20	0.49	0.83	0.14	0.04
75^{th} percentile		0.04	0.31	0.52	0.95	0.29	0.14
90^{th} percentile		0.07	0.43	0.54	0.98	0.50	0.42
N		2,277	595	159	106	21	3,158

6. Expectations about common events

This section provides detailed descriptions of the expectations questions about common events occurring in the respondents' lives or environments.

6.1 Going to the market

Table 3 reports the actual allocation of the number of beans and summary statistics of the elicited subjective probabilities. The most common answers are two, three, four, and five beans for the shorter time frame; and ten and seven beans for the longer time frame. The average answer is 3.9 beans for the two-day period (3.7 for women and 4.1 for men), and 6.7 beans for the two-week period (6.5 for women and 7.0 for men).[9]

The elicited expectations about going to the market are highly consistent with the reports about market activities collected in other parts of the MDICP survey. For instance, men report going to the market more often: the mean answer for men is 7.7 trips per month, compared to 5.4 for women.[10] A similar pattern exists with age. Further evidence that the elicited probabilities about going to the market correspond with actual behaviors is obtained from an individual-level regression of a respondent's answer—measured in terms of the number of beans—on the reported number of trips in the last month—measured as the number of trips or the quintile of the distribution of trips—controlling also for gender, region, and age (Appendix Table B3). Individuals who have been to the market more frequently in the previous month report a higher probability of going in the next two weeks. Compared to those who made no more than two trips to the market in the previous month, having been to the market three to four times is associated with 0.77 additional beans (an increase in subjective probability of 7.7 percentage points), having been to the market five to nine times is associated with 1.2 additional beans (an increase in subjective probability of 12 percentage points), and having been to the market more than tentimes is associated with 2.4 additional beans (an increase in subjective probability of 24 percentage points). The answers to the market questions also appear on average to be relatively well-calibrated. The median number of trips in the past month is four. This may roughly correspond to one trip per week. If there are five open days per week, one would expect a 40% chance of an individual going to the market in the next two days, which is the median answer provided by respondents. The median answer for the likelihood of going to the market in the next two weeks is seven beans, or a 70% chance. This answer may seem low compared to the median number of trips in the past month, though it may be consistent with the stochastic nature of going to the market.

[9] The gender difference is statistically significant for the two week period ($t = 5.61$, p-value < 0.001.)
[10] The difference is statistically significant at 5%.

6.2 Food shortage and financial assistance

Food shortages have become a common problem for rural Malawians in recent years. In particular, in 2005, due to a prolonged dry spell and problems with the distribution of fertilizer, Malawi experienced its lowest crop production in seven years. The production in 2005 of the most important staple crop, maize, was the lowest in a decade, and 26% below the already relatively poor 2004 harvest (European Commission 2005). While food aid distribution programs alleviated some of the consequences of this famine, the impact on rural households was nevertheless severe. Transfers among family members are an important mechanism for coping with the consequences of crises such as famine, drought, crop failure, death, etc. (van de Ruit and Vandemoortele 2005; Weinreb 2006). Analyses of the family roster and transfer questionnaire collected as part of the 2006 MDICP survey reveal, for example, that 45% of family members (excluding children below age 15) received a little or some financial assistance in the past two years, and 14% received a great deal of help.

Given the volatility of food availability and the prevalence of transfers among family members, respondents were asked during the expectation module about the likelihood of experiencing a food shortage within the next twelve months, and the likelihood of having to rely on family members for financial assistance in the next twelve months. Figure 2 shows the distribution of the respondents' subjective probabilities for these two events, and Table 3 reports the actual allocation of the number of beans along with summary statistics for the elicited subjective probability.

The average subjective probability of experiencing a food shortage within the next twelve months is 46% (men, 43%; women, 49%). The most common answers to the question were five, two, and zero beans (Table 3), suggesting that most of the respondents do not believe another food shortage to be highly likely in the coming year, which is consistent with FAO assessments about the 2006/07 harvest season (FAO 2007). Females estimate a higher likelihood of food shortage than men (Figure 2a), and this difference remains even after controlling for age, schooling, marital status, subjective likelihood of food shortage, and other socioeconomic characteristics.[11] Subjective probabilities about having to rely on family members for financial assistance are generally lower than the expected likelihoods of experiencing a food crisis, but follow a similar pattern by gender. While there is no marked age pattern in the expectations of a food shortage, younger and older respondents report—consistent with observed transfer patterns—a higher likelihood

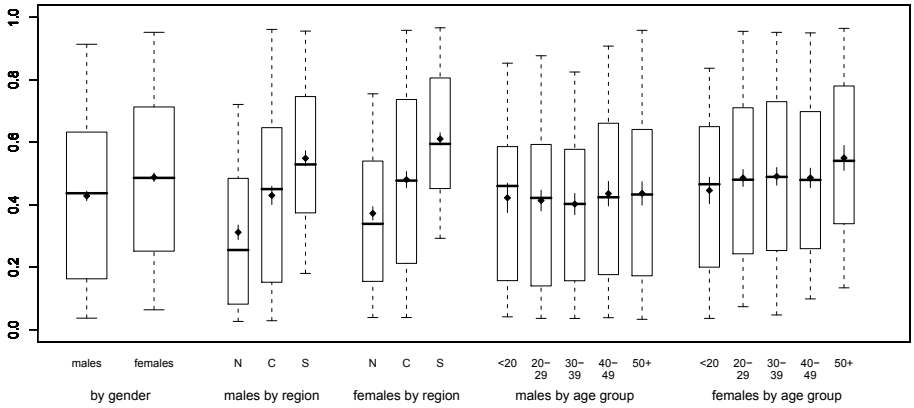
[11] This gender difference is consistent with several related findings in the literature, including that *(i)* women are less optimistic regarding outcomes—such as stock market returns—over which they have little control (Dominitz and Manski 2004, 2005, 2007), *(ii)* men want to appear as "good providers" during interviews (Miller, Zulu, and Watkins 2001), and the possibility that women are indeed at a greater risk of food shortage

of having to rely on family members for financial assistance.[12] The average likelihood is 36% in the next year, which appears to be consistent with the finding that 59% of the respondents received financial help in the past two years.

The subjective probabilities in Figure 2 also indicate that there is considerable heterogeneity among respondents in their assessments of the likelihood of facing a food crisis or of having to rely on family members. This heterogeneity may be related in part to different experiences during the most recent food crisis in 2005, and it may also be related to a considerable variance in the susceptibility to a food crisis as a result of differences in land ownership, soil conditions, crop choices, etc. Our analyses of variation in these expectations by socioeconomic status below suggest that the latter factors are important, and that they systematically influence expectations.

Figure 2: Distribution of respondents' subjective probability of (*a*) experiencing a food shortage within the next twelve months, and (*b*) having to rely on family members for financial assistance in the next twelve months, by gender, region, and age group

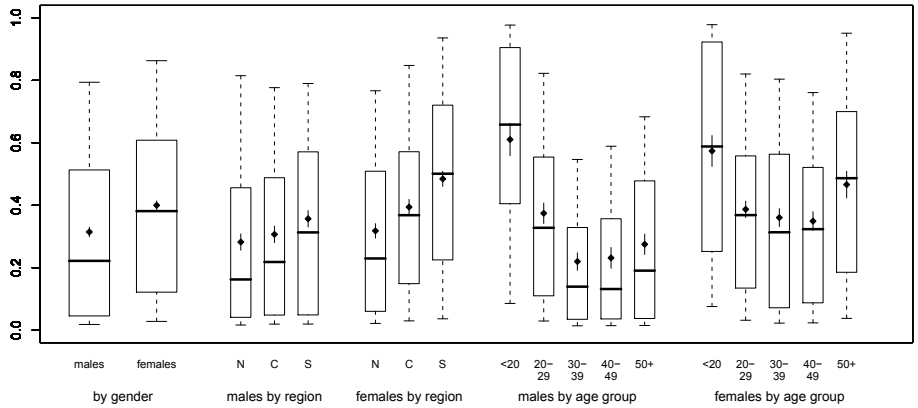
(a) Experiencing a food shortage within the next twelve months



[12] We can reject the null hypothesis of equal means for each age category at 5%.

Figure 2: (Continued)

(b) Having to rely on family members for financial assistance in the next twelve months



Notes: Region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka).

Figure 2 also reveals marked regional differences, and respondents in the northern region report the smallest probabilities of experiencing food shortages or of having to rely on family members for financial assistance. This pattern is consistent with the regional variation in the most recent drought in 2005: the worst affected part of the country was the southern region, followed by the central region and then the northern region (European Commission 2005; USAID 2005b).[13] The subjective expectations about food shortage and financial assistance reported follow exactly the regional variation in the drought.

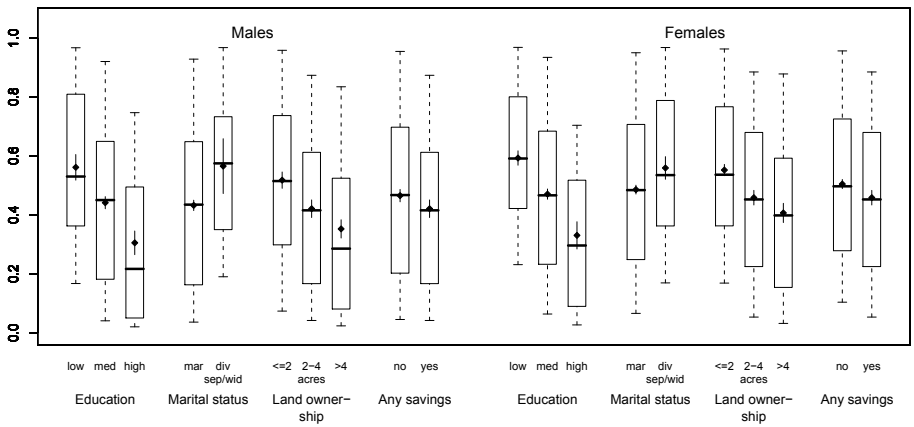
Figure 3a reveals that respondents' subjective assessments of probability of food shortages vary meaningfully with respondents' socioeconomic status (SES). For example, respondents who have more education, are married, own relatively large amounts of land, and have any savings all rate the probability of experiencing a food shortage lower than their counterparts who have less education, are divorced/separated/widowed, own little land, or do not have savings. A very similar—albeit less pronounced—pattern exists with

[13] The southern region was the hardest hit by the drought, with over 70 % of the affected population being in the southern region. The high population density in the southern region made the problems particularly acute (USAID 2005b). Balaka, where our field work is located in the southern region, experienced severe food shortages as early as the beginning of 2005 (USAID 2005a), and had the highest price of maize at local markets of the country in July 2005 (USAID 2005b).

respect to the expectation of having to rely on family members for financial assistance within the next twelve months. In summary, Figure 3a provides a clear indication that individuals with higher socioeconomic status are less concerned about experiencing a food shortage or of having to rely on family members for assistance in the near future, consistent with the finding that higher SES individuals are less vulnerable to food and financial crises.[14] These marked socioeconomic differences in subjective expectations regarding food shortages, or of having to rely on family members for financial assistance, are in sharp contrast to the subjective probability of winning in a game of Bawo, where—except for a modest education gradient—socioeconomic differences are absent (Figure 3c). This pattern is expected if the ability to win in a game of Bawo against the interviewer depends on individual-specific aspects of the respondent and the interviewer that do not rely on marital status, land ownership, or similar factors.

Figure 3: Distribution of ever-married respondents' subjective probability of (*a*) experiencing a food shortage within the next twelve months, and (*b*) having to rely on family members for financial assistance in the next twelve months, and (*c*) winning a game of Bawo played against the interviewer, by gender and socioeconomic status

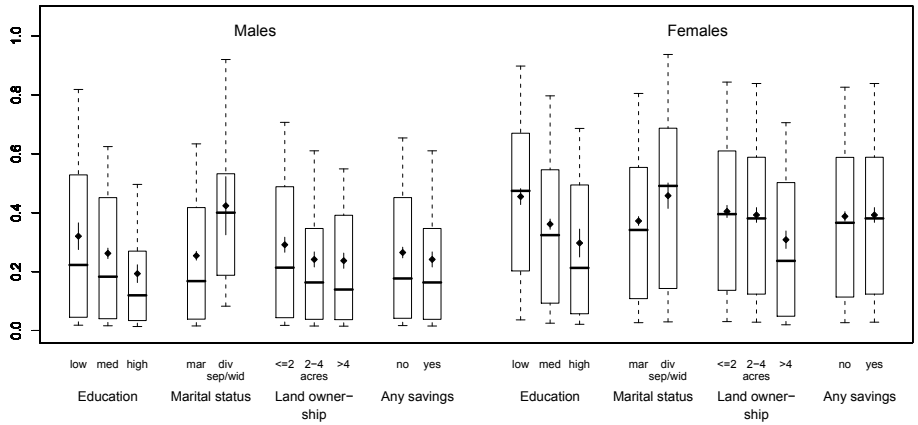
(a) Experiencing a food shortage within the next twelve months



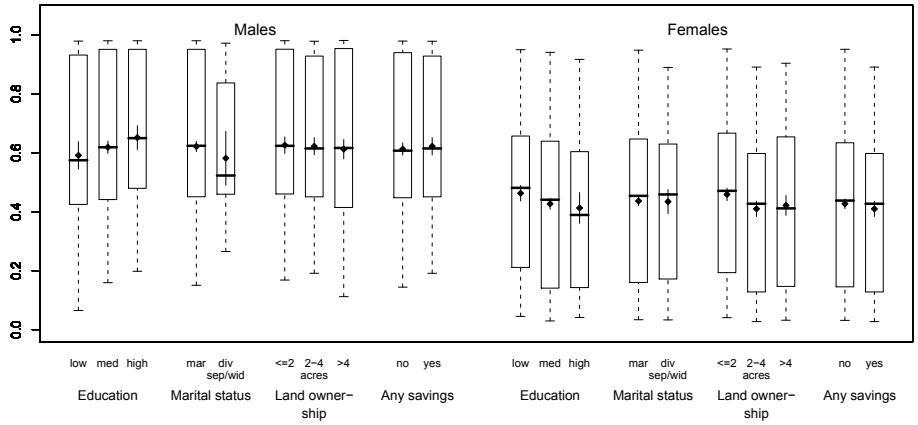
[14] The differences by education, marital status and land ownership are statistically significant in linear regressions controlling for age.

Figure 3: (Continued)

(b) Having to rely on family members for financial assistance in the next twelve months



(c) Winning a game of Bawo



Notes: Ever-married respondents only; region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka)

The availability of subjective expectations about food shortage and having to rely on family members also allows us to test whether respondents take into account that the outcomes of two events may have common underlying causes. For example, since assistance exchanged between family members is an important mechanism in rural Malawi for coping with crises such as food shortages, respondents' subjective expectations about these two events should be correlated: respondents who feel at greater risk of food shortage should also be more likely to expect to need financial help. To test this hypothesis, we estimate a linear regression of the responses to the question about the likelihood of having to rely on financial assistance (the number of beans), and on the likelihood of experiencing food shortage. Other demographic and economic variables are used as independent variables (Appendix Table B4). The regression results show that a higher likelihood of experiencing a food shortage is significantly and positively associated with reporting a higher likelihood of needing financial assistance: an additional bean on the likelihood of food shortage is associated with 0.22 additional beans on the likelihood of needing financial assistance. The magnitude of this association remains essentially unchanged if additional controls for education, marital status, land ownership, or having savings are introduced.

6.3 Infant mortality

Respondents were asked the likelihood that a baby born in their community this month will die within one year.[15] Infant mortality, unfortunately, continues to be a fairly common event in rural Malawi. The Malawi DHS, for instance, estimated an infant mortality rate, i.e., the probability of dying before the first birthday, of 98 per 1,000 for rural areas during 1994–2004 (Malawi DHS 2004). Respondents subjective expectations about infant mortality are in close correspondence to these DHS-estimated probabilities (Table 3): one bean—corresponding, on average, to an implied infant mortality of 100 per 1,000 births—is the most common answer, with the two next common answers being zero and two beans. Overall, 58% of the respondents placed two or fewer beans in the plate, thus estimating infant mortality as less than 250 per 1,000, which corresponds well with the DHS estimates, as infant mortality varies considerably across regions and can be as high as 145 per 1,000 in some districts. Respondents are aware of these regional differences: the central tendencies and percentiles of the distribution of implied probabilities by region match remarkably well the regional differences reported in the Malawi DHS (graphs not shown). Respondents are also clearly aware that the death of an infant is not a very likely event, as 77% of them placed four beans or fewer in the plate, and the median of subjective probabilities about infant mortality is 20%. Nevertheless, about 25%

[15] The question asked about "a baby born in your community," and the interpretation of "community" was left to the respondents.

of respondents—both male and female—made subjective estimates of the probability of infant mortality in excess of 43%. This is somewhat in contrast to actual mortality trends for Malawi overall, which show declines in infant mortality over the last decade, despite HIV/AIDS (Malawi DHS 2000, 2004).[16] A possible explanation for this overestimation of infant mortality in a subset of the population may be related to the problem of inferring mortality risks by observing trends in infant deaths. In particular, when the population is growing, infant mortality rates can decrease, while the total number of infant deaths increases (Montgomery 1998). Another possibility could be that people's estimates are based on the "availability" heuristic (Tversky and Kahneman 1974). For example, Lichtenstein et al. (2008) find that people overestimate the probability of lethal events due to sensational causes like tornado or homicides because those are widely reported in the media.

7. HIV/AIDS-related expectations

Individuals have been shown to mostly overestimate, but sometimes also underestimate, their risk of HIV infection (e.g., Aggleton et al. 1994; Pinkerton et al. 2000; Tharawan et al. 2003). In this section we evaluate the ability to elicit HIV/AIDS-related expectations using the interactive approach introduced in Section 4, and how respondents' subjective expectations about their own HIV status or the adoption of risk-prevention strategies (such as condom use) vary by socioeconomic characteristics. We will also assess whether perceptions of being HIV-positive are consistent with recent estimates of HIV prevalence, and whether respondents can accurately identify whether they belong to groups with elevated or reduced risk of HIV infection. We also compare whether the expectations of individuals about condom use in the future are consistent with their behavior in the past.

7.1 Expectations about own HIV infection

Figure 4a presents the distribution of answers about the likelihood of being currently infected with HIV/AIDS (see Table 3 for actual responses in terms of number of beans). These subjective probabilities of HIV infection can be compared to the actual HIV prevalence among MDICP respondents of 6.9% (7.9% for females and 5.6% for males) (Obare et al. 2009).[17] This prevalence among MDICP respondents is somewhat below the DHS estimate of 10.8% for rural Malawi (12.5% for females and 8.8% for males) (Malawi DHS 2004), but very close to the SSA average HIV prevalence of 6.1% (UNAIDS 2006).

[16] However, in many countries of sub-Saharan Africa, particularly those severely affected by AIDS, there is evidence of a reversal of the child mortality decline during the 1990s (Zaba, Whiteside, and Boerma 2004).

[17] Prevalence is tested based on the subset of respondents ($N = 3,037$) who participated in the HIV test after the 2006 survey. Participation rate in the HIV test was 92%.

The difference between the DHS and MDICP prevalence is not due to age structure differences or differences in the HIV test participation rates (Obare 2006), but is likely due to the absence of peri-urban areas—such as rural trading centers—among the MDICP sample villages (Obare et al. 2009).

Contrary to claims that individuals in sub-Saharan Africa tend to overestimate their risk of being HIV-positive and are fatalistic about their infection status, the elicited subjective probabilities of current HIV infection are relatively low. Two-thirds of the respondents allocated zero beans in response to this question, while only 1% choose ten beans. The most common answers were, in order, zero beans (67% of respondents), one bean (9.6% of respondents), and two beans (7.5% of respondents). Women's mean subjective probability is equal to 14.5%, and that of men equals 9.5%. The sign and magnitude of this difference corresponds to the observed differences in HIV prevalence by gender, which show a 30% higher prevalence for women than for men. If we restrict the sample to individuals aged 15 to 49, the average implied probability is 12.7% (14.7% for females and 9.8% for males).

Figure 4: Respondent's subjective probability of being infected with HIV now

(a) By gender, region and age-group

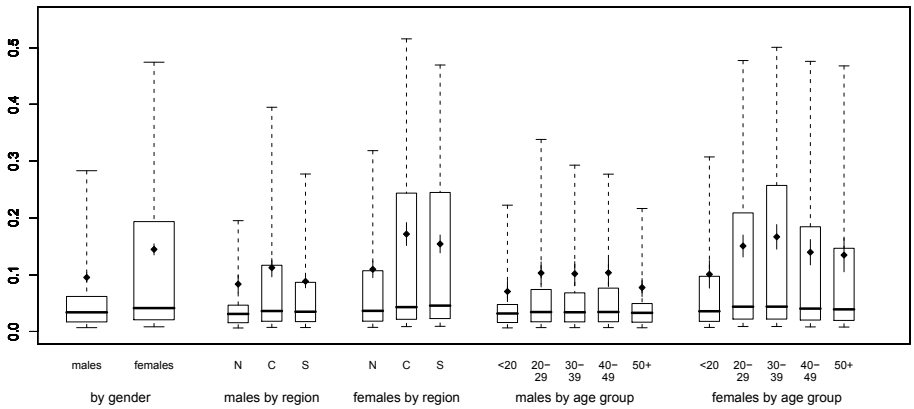
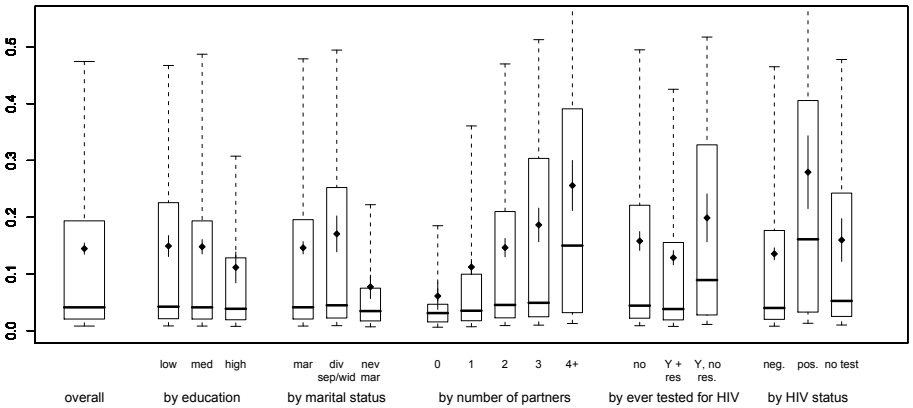
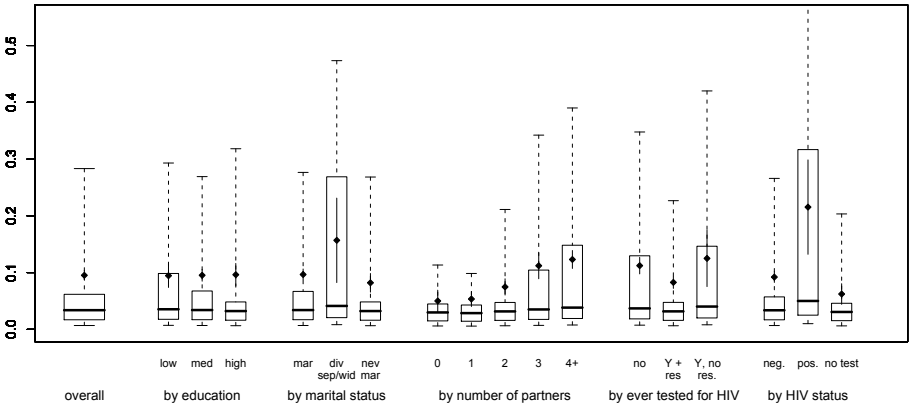


Figure 4: (Continued)

(b) Females: by education, marital status and number of partners and HIV status/knowledge



(c) Males: by education, marital status and number of partners and HIV status/knowledge



Notes: Ever-married respondents only; region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka)

In contrast to the expectations analyzed earlier in this paper, the distribution of subjective probabilities is relatively skewed. The median subjective infection probability is .041% for women and .034% for men, somewhat below the actual prevalence level, and without marked gender difference. It indicates that a substantial fraction of MDICP respondents assesses their risk of being HIV positive to be fairly low. The mean subjective infection probability is substantially above this level, and this higher mean subjective infection risk results from the fact that a subset of respondents perceive themselves to be quite likely to become HIV-positive: 25% of men believe that their risk of becoming infected with HIV is above 6.2%, and more strikingly, 25% of women believe that their risk of being HIV-positive is above 19%. This pattern of answers is consistent with a considerable variation of actual HIV infection risks across the population. In particular, actual infection risks depend in part on individuals' engagement in risky behaviors—e.g., engaging in extramarital relations, not using condoms with casual partners, etc.—as well as their own health status—e.g., presence of ulcers or other sexually transmitted infections. The skewed distribution of the subjective probabilities in Figure 4a is thus consistent with the finding that these risk factors of HIV infection are unevenly distributed, and that the actual risk of HIV infection may potentially be relatively low for a considerable fraction of the population. For example, only 8% of married MDICP respondents report having more than one partner in the last twelve months, and among those, 58% never used condoms with their last extramarital partner.

Figure 4a also shows that the subjective probabilities of HIV infection vary considerably by region and age. The regional pattern is not primarily caused by a regional variation in the median subjective risks of being HIV-positive, but results from increases in subjective risks in the right tail of the distribution: an estimated probability in the 75^{th} percentile is almost 2.3 times higher for women in the South and Center than for women in the North, and more than 20% of women in the Center and South cite a probability of 30 % or higher, compared with only 11% of women in the South. The regional pattern of subjective infection probabilities does not, however, fully correspond with regional variations in HIV prevalence. In both the Malawi DHS and the MDICP, the central region exhibits the lowest HIV prevalence, and the southern region the highest (MDICP prevalence estimates: Center: 3.96%; North: 4.07%; South: 5.92%. Malawi DHS estimates for both urban and rural areas: Center: 6.5%; North: 8.1%; South: 17.6%).[18] While respondents, especially women, in the northern region correctly perceive a higher HIV infection risk than men in the southern region, their high subjective risk perceptions in the center are not consistent with the lowest level of HIV prevalence in that region.

Figure 4a also reveals a systematic age pattern of subjective probabilities about current

[18] Note however that there was only a 39% HIV testing in Lilongwe, which might yield an underestimation of prevalence in the central region.

HIV infection. This pattern is particularly marked for women, and matches the observed pattern of HIV prevalence by age peaks between ages 30 and 39 (Table 6; see also Malawi DHS 2004; Obare et al. 2009). The subjective probabilities reported by women strongly suggest that women are aware of this age pattern of HIV prevalence. In contrast to the male age pattern of HIV prevalence, which peaks at ages 40-49 (Figure 4a), there is basically no age gradient among men between 20 and 49 in the perceived probabilities of being HIV-positive.[19]

The subjective probabilities of being currently infected with HIV also vary systematically with other correlates of HIV prevalence (Figure 4b-c, Table 6). Particularly striking is the variation by marital status and by number of sexual partners: consistent with the pattern of observed HIV prevalence, divorced/separated/widowed women and men report the highest perceived probability of being HIV-positive, and, similarly, respondents with more sexual partners report a higher probability of being infected.[20] There is also a clear education gradient—particularly pronounced for women—in the subjective expectation of being infected with HIV, following closely the corresponding gradient in the actual HIV prevalence (Table 6). Overall, all the previous patterns suggest that people who are at greater risk are more likely to believe they are infected.

Figure 4b-c also reports the subjective probabilities of being infected with HIV by the respondent's knowledge about his/her infection status and his/her actual infection status. For most respondents, the HIV tests conducted as part of the 2004 MDICP—that is, two years prior to the current expectation module—are the primary source of knowledge about their HIV status (Section 3). Only a small number have utilized the VCT services that have become available in recent years as part of the government VCT program, and the uptake of these services in the sample population was very low as of 2006 (UNAIDS 2006).

For both men and women in Figure 4b-c, there is a clear pattern depending on whether a respondent knows his/her HIV status. This pattern does not match actual HIV prevalence across these groups (Table 6). The perceived probability is highest for those who have never been tested and those who have been tested but were not told the result, and they are lowest—and very close to the actual prevalence rate—for respondents who have been tested for and informed about their HIV status. Moreover, the variance of the reported subjective probabilities of current HIV infection varies depending on whether a respondent has knowledge about his/her HIV status: those who have knowledge about their HIV status—in most cases, as of two years prior to implementation of the current expectation module—exhibit by far the smallest variance, while the expectation of those

[19] For the actual HIV infection, we can reject the hypothesis of equal means for each age category at 5% for both men and women; while we can reject it at 5% for the implied probability for women only.

[20] For both actual and perceived HIV infection, we can reject the hypothesis of equal means by marital status or number of partners at 5%.

who have never been tested for HIV, or have been tested for HIV but did not receive the test results, exhibit substantially higher variance.

Table 6: Subjective HIV infection probability and observed HIV infection rates

	Average subjective HIV infection probability	Actual HIV infection rate	2006 MDICP prevalence	2006 MDHS prevalence (15–49 years old)
Age				
< 20	0.087	0.012	0.011	0.021
20–29	0.131	0.034	0.037	0.110
30–39	0.141	0.085	0.087	0.186
40–49	0.125	0.058	0.058	0.150
50+	0.102	0.037	0.037	0.102
Marital status				
married	0.124	0.050	0.050	0.132
divorced/separated/ widowed	0.169	0.179	0.185	0.266
never married	0.081	0.000	0.000	0.003
Education				
low education	0.134	0.069	0.072	0.123
medium education	0.123	0.051	0.051	0.111
high education	0.102	0.048	0.048	0.137
Number of partners				
0	0.055	0.000	0.000	
1	0.097	0.028	0.028	
2	0.120	0.049	0.050	
3	0.148	0.078	0.080	
4+	0.152	0.087	0.088	
Ever tested for HIV?				
no	0.137	0.061	0.062	0.126
yes, learned result	0.107	0.051	0.051	0.144
yes, did not learn result	0.175	0.043	0.042	0.144

Finally, Figure 4b-c also reveals the variation in subjective assessments of the probability of being being HIV-positive by the actual 2006 HIV status. The 2006 HIV status was determined after the expectation module was completed, so respondents could not draw on this information when answering the expectation module, and many respondents also had no prior knowledge of their infection status (39% of HIV-negatives, 42% of HIV-positives, and 58% of those with no 2006 test). For both men and women, the subjective probability varies greatly based on the actual 2006 infection status: HIV-positives report the highest perceived probability of being infected with HIV, and it is particularly the upper tail of the distribution that reports high subjective expectations about being HIV positive. Nevertheless, it is somewhat puzzling that the subjective expectation of being infected with HIV remains fairly low among those who are tested as HIV positive in 2006, with 75% reporting a probability below 40% (women) or 32% (men).

7.2 Expectations about HIV prevention strategies: Condom use with spouse and other partners

Expectations about HIV prevention strategies provide an opportunity to evaluate an individual's intentions in trying to reduce the transmission of the disease. Thus, during the expectation module of the 2006 MDICP survey, respondents were asked about the likelihood that they would use condoms with various partners. In our analyses of these questions, we focus on married respondents—who represent the largest proportion of the sample—and their use of condoms with their spouse and extramarital partners.

7.2.1 Condom use with spouse

Table 3 presents the distribution of respondents' subjective probability of using a condom at the next sexual encounter with (*a*) the spouse and (*b*) someone other than the spouse. In answering the question about condom use with the spouse, almost two-thirds of respondents placed no beans on the plate, 90% of the respondents provided an answer of five beans or fewer, and less than 3% of the respondents answered with ten beans. The average is 1.4 beans out of ten, which is consistent with the fact that about 17% of the respondents report using condoms with their spouse sometimes, while less than 1% report using condoms almost every time or all the time. Other studies have documented that condom use is still very uncommon within marriage in Malawi (Bracher, Santow, and Watkins 2004; Chimbiri 2007). A full 65% of the 2006 MDICP married respondents said they believe it is not acceptable to use condoms with a spouse to protect against HIV/AIDS. There is, however, a gradient by age in condom use expectations: younger respondents are more likely to report a positive likelihood of using condoms, potentially reflecting changing attitudes toward condom use among young adults (Table not shown).

Most notable in Table 3 is the skewed distribution. While the "median person" is still fairly hesitant to use condoms within marriage, there may be a small *innovator group* who are forerunners in the adoption of condom use within marriage (e.g., for a review of the diffusion of innovation theory, see Rogers 2003). The existence of this spread between mean and median—reflecting the extent to which condom use is reported more likely by the innovators in the top half of the distribution, compared to more traditional individuals in the bottom half of the distribution—is particularly pronounced among young adults. This is consistent with an interpretation that condom use within marriage has become relatively accepted among a sizable subset of the young adult population.

The elicited subjective probabilities of condom use also provide an indication that respondents who feel at greater risk of being infected with HIV are more likely to use a condom with their spouse (Table 7). Respondents who have extramarital relationships report higher expectations of condom use with the spouse than those who do not have extramarital partners.[21] Expectations abut condom use are also higher among individuals who have bought condoms in the past two months, or who have reported a subjective probability of being currently infected with HIV of greater than 0.05 by allocating at least one bean in response to this question. In addition, more educated respondents are more likely to use a condom with their spouses than less educated respondents.[22] Table 7 also shows that the gradient with respect to the above characteristics in respondents' expectations about condom use is much more prominent at the 75th percentile than at lower percentiles or at the mean. This pattern indicates again that these changing expectations about condom use are likely to be driven by *innovators* who are forerunners in the adoption of condoms within marriage. These innovators seem to be more common among the more educated respondents, or among respondents who believe that they are more likely to be HIV-positive.

[21] A respondents was classified as having other partner(s) if s/he answered the questions about condom use with partners other than spouse.

[22] In Table 7, we can reject at 5% the hypothesis of equal means within category for each of the categories we consider.

Table 7: Subjective probability of using condom at next sexual encounter with spouse, by characteristics (married respondents only, males and females combined

		# of beans		implied subjective probability				
						Percentiles		
	N	mean	SE	mean	SE	25th	50th	75th
Subjective probability of own HIV infection								
$<$ .05 (zero beans)	1,687	1.09	0.06	0.13	0.005	0.02	0.03	0.09
$\geq$ .05 (one or more beans)	856	1.99	0.09	0.21	0.009	0.03	0.07	0.33
Extra-marital partners								
no	1,985	1.29	0.05	0.15	0.005	0.02	0.04	0.15
yes	562	1.75	0.10	0.19	0.010	0.02	0.05	0.29
Condom use with spouse in the past								
never	1,911	0.63	0.04	0.08	0.003	0.02	0.03	0.05
ever	610	3.75	0.13	0.38	0.012	0.08	0.36	0.56
Bought condom in last 2 months								
no	2,402	1.17	0.05	0.13	0.004	0.02	0.04	0.15
yes	143	5.07	0.26	0.51	0.025	0.30	0.52	0.69
Education								
low education	551	1.10	0.09	0.13	0.008	0.02	0.04	0.14
medium education	1,700	1.42	0.06	0.16	0.006	0.02	0.04	0.20
high education	293	1.77	0.17	0.19	0.016	0.02	0.04	0.31

7.2.2 Condom use with a partner other than the spouse

Married respondents were also asked the likelihood of using condoms the next time they have sex with someone other than their spouse. A total of 582 respondents answered the question, 57% of whom were men. The remaining 2,046 respondents skipped the questions because they reported that they do not have sex with anyone other than their spouse. In contrast to the responses about condom use with the spouse, only 10% reported zero beans, about 80% reported five beans or more, and more than a third of the respondents reported ten beans. As a result, Table 3 reports a fairly high subjective probability of 67% of using a condom at the next sexual encounter with someone other than the spouse.

This fairly high probability is in contrast to respondents' answers when asked during the MDICP about their sexual practices with their two most recent sexual partners other than their spouses. Since many of the respondents answering the questions about the likelihood of using condoms with an extramarital partner did not report having more than one partner in the last twelve months, observations about *actual* condom use with extramarital partners are only available for 279 respondents, 70% of whom are men. Among these respondents, 62% have never used condoms with their most recent extramarital partner, 19% have used condoms at the beginning or sometimes, and 19% have used condoms almost every time or every time. This low prevalence of past condom use contrasts with the relatively high elicited expectations of condom use at the next extramarital sexual encounter (Table 3). This discrepancy is consistent with several explanations. For example, respondents may wish to provide answers that are more socially acceptable in front of the interviewers, or respondents may actually intend to use condoms with extramarital partners, but fail to do so in practice due to the unavailability of a condom or lack of self-control. Nevertheless, despite this disparity in the level of past and expected condom use, there is an association between past behavior and future expectations: the mean subjective probability of using a condom at the next sexual encounter with an extramarital partner is 68% for those who have never used a condom in the past with an extramarital partner, and it increases to 74% and 85% for those who report that they used condoms sometimes/at the beginning or (almost every time).

8. Mortality

Oster (2007) has recently argued that there is no reason per se to expect a behavioral response to increases in HIV infection rates in sub-Saharan Africa; in particular, as becoming infected with HIV means premature death, the "utility lost" depends on how many years people expect to live without HIV (see also Philipson and Posner 1993). Current life expectancy estimates for Malawi are indeed striking: males can expect to live 44.4 years, and females 45.7 years (based on period life table for 2000-05, United Nations 2007). Given these low levels of life expectancy and high levels of poverty, Oster argues that individuals have little motivation to adopt risk-prevention strategies, as these strategies are "costly" in terms of financial expenses (e.g., purchasing condoms) or forgone pleasures (e.g., reduced joy from sex as a result of condom use, or lower levels of satisfaction as a result of giving up extramarital partners), but, as a result of the generally high levels of mortality, provide only limited gains in terms of longer life expectancy. Similarly "fatalistic" explanations for the HIV/AIDS epidemic in Africa have also been provided by Kremer (1996) and Auld (2003).

Very little is, however, known about the individuals' expectations about mortality in

sub-Saharan Africa, how these expectations vary by age or socioeconomic characteristics, and how they compare to life table estimates of mortality risks. For instance, are rural Malawians indeed pessimistic about their own survival, and do they overestimate their risk of dying? Do men and women differ in their mortality expectations? To provide a first indication about perceptions of mortality risks in a sub-Saharan African context with high HIV prevalence, Figure 5 depicts the distribution of MDICP respondents' subjective expectations about their own mortality. In particular, respondents were asked to assess the probability that they will die within one year (Figure 5a), five years (Figure 5b), and ten years (Figure 5c; see Table 3 for actual responses to these questions in terms of number of beans). For the five- and ten-year periods, the figures also include the corresponding life table estimates by gender and age group (see also Appendix Table B5). The calculations are based on United Nations (2007) life table estimates for Malawi for 2000-05. The probability of dying for a person aged x to $x+5$ within a five-year time period is calculated as $1 - {}_5L_{x+5}/{}_5L_x$; the probability of dying within a 10-year time period is calculated as $1-{}_5L_{x+10}/{}_5L_x$. Calculations are performed for five-year age groups, and then combined across all age groups ("overall"), or across ten-year age groups using the age structure of the survey respondents.

Figure 5: Respondent's subjective probability of dying within a 1-year, 5-year and 10-year time period, by gender, region and age group

(a) Probability of dying within a 1-year period

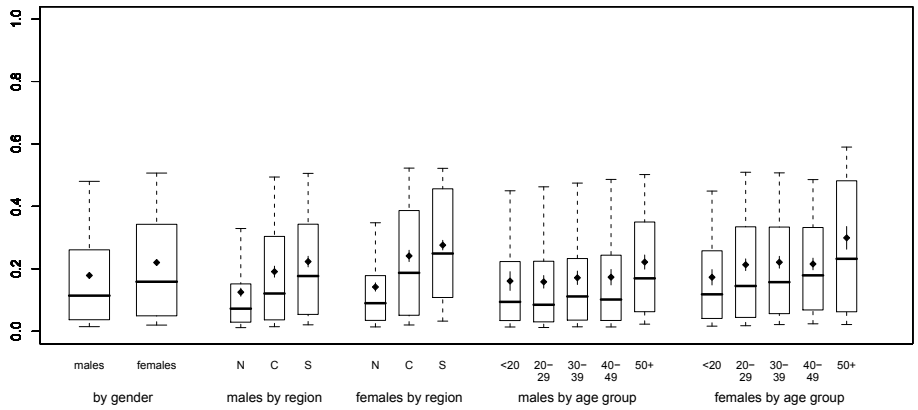
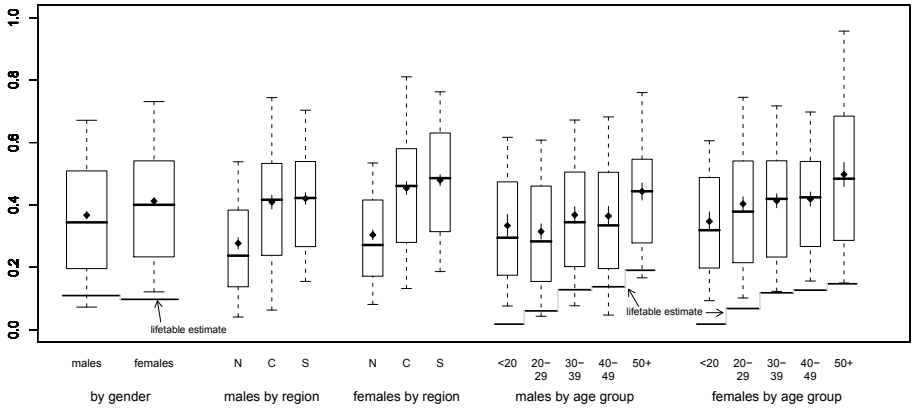
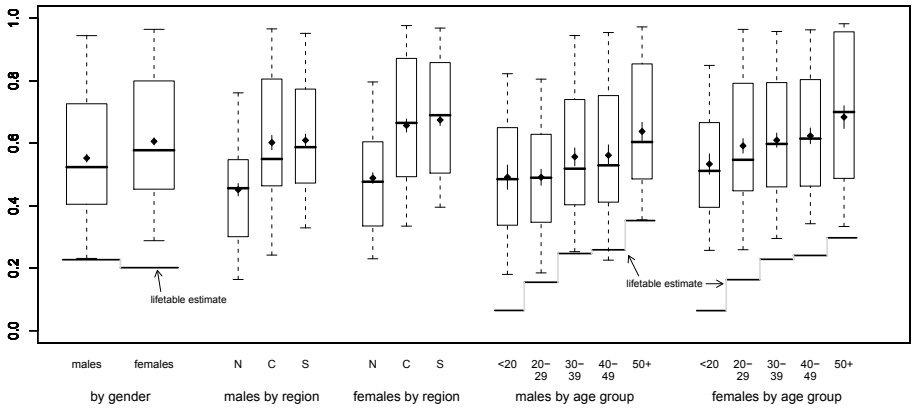


Figure 5: (Continued)

(b) Probability of dying within a 5-year period



(c) Probability of dying within a 10-year period



Notes: Region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka); life table estimates are obtained from United Nations (2007).

An important characteristic of the reported subjective expectations about mortality is that respondents' expectations correspond in broad terms with the actual variation in mortality: the probability of dying increases the longer the time horizon, and the older the respondent. For example, the mean implied probability of dying is 17.9% (men) and 22.0% (women) over a one-year horizon, and it increases to 36.7% (men) and 41.2% (women) for the five-year horizon, and to 55.2% (men) and 60.6% (women) for the ten-year horizon. The mean reported probability of dying during, for example, the next five years increases for women from 40.4% at ages 20-29, to 49.8% at ages 50 and older; while for men the probability increases from 31.5% (ages 20-29) to 44.3% (ages 50+). The reported subjective mortality risks are also substantially lower in the northern region (Rumphi), consistent with the actual variation in mortality across these regions (Bicego 1997). There is also a gender difference, with women being somewhat more pessimistic about their own survival than men. A similar gender difference in mortality expectations has also been found in developed countries among older adults: in HRS and SHARE, women provide higher expectations of dying than men, while they actually have greater life expectancies.

However, the subjective probabilities of dying within one, five, and ten years, deviate from the observed mortality pattern in one important respect: both men and women in rural Malawi substantially *overestimate* their mortality risk, and they are much more pessimistic regarding their own survival than is warranted given current estimates of actual mortality rates. Across all ages in the sample, the median perceived five-year mortality risk exceeds the corresponding life table estimate by a factor of 3.2 for males and 4.1 for females, and the median perceived ten-year mortality risk exceeds the life table estimate by a factor of 2.3 (males) to 2.9 (females). This overestimation of mortality risks varies considerably by age. The "bias" is the most severe for younger respondents: the median five-year mortality probability reported by 15-19 year olds is 16-17 times greater than the life table estimate; for the ten-year period, young respondents overestimate the probability of dying by a factor of 7.6-8 (for additional details, see Appendix Table B5). A similar phenomenon has been reported among teenagers in the U.S.: teens of the NLSY97 have relatively well-calibrated expectations about various life events, but greatly overestimated their chance of death (Fischhoff et al. 2000). The average answer in the NLSY97 for a time period of four to five years was 50 times greater than the statistical estimate.[23] The discrepancy between life table estimates and subjective mortality expectations decreases, however, with age: above age 30, the median subjective probability of dying exceeds the corresponding life table estimate by a factor of 2.5-2.7 (five-year period) and 1.7-2.1 (ten-year period) for men, while for women the overestimation of mortality risk above age 30

[23] The NLSY97 asked about the probability of dying from any cause between now and when the respondents turn 20 to a set of respondents aged 15 and 16.

is by a factor of 3.2-3.5 (five-year period) and 2.4-2.6 (ten-year period). This subjective overestimation of mortality risks at older ages contrasts with findings in developed countries for persons aged 50 and over: for example, while the survival expectations in the HRS exhibit considerable heterogeneity, they aggregate remarkably well to population probabilities (Hurd and McGarry 1995). Yet some small age variation in discrepancies between expectations and life table has been reported in the HRS and SHARE. However, in those surveys younger respondents tend to provide expectations that are lower than the life table mortality rates, while older respondents are more optimistic than the life tables (Delavande and Rohwedder 2008).

The overestimation of mortality might be an overreaction to the substantial increases in adult mortality that have occurred as a result of the HIV/AIDS epidemic in the last decade in sub-Saharan Africa in general (e.g., Zaba, Whiteside, and Boerma 2004; Blacker 2004; Urassa et al. 2001), and in Malawi in particular (Doctor 2001; Blacker 2004). Zaba, Whiteside, and Boerma (2004), for example, report that in the worst-affected countries of Africa, the probability of dying between the ages of 15 and 60 has risen from a range of 10%-30% in the mid-1980s, to a range of 30%-60% at end of the 1990s. For Malawi, Blacker (2004) reports a change of this probability from 24.8% for men in the 1977-1987 period to 48.7% in the 1987-1998 period. A similar increase is reported for women (from 29.0% to 42.9%). While longitudinal data on subjective mortality risks do not exist, it is possible that individuals in rural Malawi have "overreacted" in their subjective expectations to the rapid mortality increase resulting from the AIDS epidemic (Kahneman and Tversky 1982; Grether 1980).

9. Conclusions

The elicitation of subjective expectations about HIV/AIDS-related behaviors and events are an important, but rarely implemented, tool for understanding the determinants and consequences of HIV-infection risks in sub-Saharan Africa. This lack of data on HIV/AIDS-related expectations is in part due to the fact that existing methods for eliciting subjective probabilities are based on questions about the "percent chance" of various events, and these methods are not applicable to contexts with low literacy and numeracy. In this paper, we therefore present and evaluate a new interactive elicitation technique to collect probabilistic beliefs from respondents in a developing country context. This method has been implemented as part of the 2006 Malawi Diffusion and Ideational Change Project involving more than 3,000 individuals in rural Malawi, and the expectation data collected as part of this survey provide the first large-scale data on probabilistic expectations about important life events and health and economic outcomes in a developing country.

Remarkably, almost all respondents are found to provide beliefs consistent with a

basic property of probability theory, by respecting the monotonicity of nested events. Moreover, for essentially all the domains we have considered, we find that the central tendencies and percentiles of the distributions of elicited subjective probabilities vary with observable characteristics—such as gender, age, education or risk behavior—in the same way that actual outcomes vary with these variables. For example, expectations about infant and adult mortality and economic outcomes exhibit regional differences that are similar to actual outcomes. Estimates of the likelihood of becoming infected with HIV increase with the number of sexual partners a respondent has had, and decrease with education level, as do actual levels of prevalence. Moreover, we find that beliefs about future events vary across individuals in the same way past experience does: people who have been to the market more frequently in the previous month report a greater belief in the probability of going to the market in the coming days. These systematic relationships between elicited expectations and characteristics provide strong evidence that individuals in a developing country are able to provide meaningful answers when asked about their beliefs in a probabilistic manner.

From a substantive point of view, these systematic relationships between elicited expectations and characteristics indicate that, overall, people in rural Malawi are aware of differential risks. For example, people with lower incomes and less land rightly feel at greater risk of financial distress than people with higher SES, and people who are divorced or widowed rightly feel at greater risk of being infected with HIV than currently married individuals. The knowledge of differentials in risk is necessary, though insufficient, to inducing risk-prevention strategies for HIV/AIDS, such as condom use; or economic-related outcomes, such as investment in education.

In addition to the differentials, the perceived level of various risks may be important in the decision to adopt risk-reduction strategies. We find that the elicited expectations are well-calibrated compared to actual probabilities for some events, but not for all. For example, the average likelihood of salient events—like receiving financial transfers or using a condom with a spouse—corresponds relatively well to actual population realizations. In contrast, the likelihood of using a condom with an extramarital partner is overestimated compared to past use, which may reflect that respondents intend to use condoms, but end up not doing so due to lack of availability or self-control. The average likelihood of being infected with HIV is slightly overestimated, but respondents do not appear fatalistic about their serostatus. The overestimation of HIV status is consistent with individuals overestimating the probabilities of low probability events that have been documented in developed countries. Finally and importantly, mortality expectations are substantially overestimated compared to life table mortality rates. The overestimation of mortality expectations might have important implications for HIV prevention strategy. Several authors (e.g., Oster 2007; Philipson and Posner 1993) have argued that there is no reason to expect a behavioral response to high HIV prevalence in sub-Saharan Africa given the

high mortality risk, since one important cost associated with being infected with HIV is a reduction in life expectancy. This cost may be perceived as smaller than it actually is for individuals whose beliefs about life expectancy are heavily biased downward.

Despite the systematic variation of beliefs according to demographic variables, we still find that there is substantial heterogeneity in beliefs, even among respondents sharing similar characteristics. This heterogeneity underscores the relevance of collecting subjective expectations data to make better inferences about behavior. Recent studies have shown how to incorporate probabilistic expectations data into structural econometric models of choice behavior in various settings to avoid making unverifiable assumptions about expectations, and to explain some of the observed heterogeneity in behavior (e.g., Erdem, Keane, and Strebel 2005; Delavande 2008; Lochner 2007). The literature on health, human capital development, and HIV/AIDS point to the central relevance of subjective expectations in understanding the health-related behaviors individuals, as well as their investments in human capital and sexual and marriage behaviors. Despite this relevance, very little is known about health-related subjective expectations in developing countries, and no large-scale health-related probabilistic expectation data have been collected for regions in sub-Saharan Africa that are most affected by HIV/AIDS, and that face a rapidly changing health and disease environment. This lack of knowledge about health-related subjective expectations not only limits our understanding of relevant behaviors, it also hampers the development of appropriate health-interventions, because the determinants of behavioral changes in response to the HIV/AIDS epidemic remain poorly understood.

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Appendix A: Expectation module included in the 2006 MDICP questionnaire

INTERVIEWER: Put the plate and the cup side by side. Recount the number of beans and check that you have 10 beans in the cup [__]. As you provide the explanation below, add the beans into the plate to illustrate what you say.

"I will ask you several questions about the chance or likelihood that certain events are going to happen. There are 10 beans in the cup. I would like you to choose some beans out of these 10 beans and put them in the plate to express what you think the likelihood or chance is of a specific event happening. One bean represents one chance out of 10. If you do not put any beans in the plate, it means you are sure that the event will NOT happen. As you add beans, it means that you think the likelihood that the event happens increases. For example, if you put one or two beans, it means you think the event is not likely to happen but it is still possible. If you pick 5 beans, it means that it is just as likely it happens as it does not happen (fifty-fifty). If you pick 6 beans, it means the event is slightly more likely to happen than not to happen. If you put 10 beans in the plate, it means you are sure the event will happen. There is no right or wrong answer, I just want to know what you think.

Let me give you an example. Imagine that we are playing Bawo. Say, when asked about the chance that you will win, you put 7 beans in the plate. This means that you believe you would win 7 out of 10 games on average if we play for a long time.

INTERVIEWER: Report for each question the NUMBER OF BEANS put in the PLATE. After each question, replace the beans in the cup (unless otherwise noted).

For questions X1a to X1f: If respondent puts 10 (or 0) beans, prompt "Are you sure that this event will almost surely (not) happen?" CIRCLE 1 in column P if you prompted the respondent, and report the final answer only.

X1	Pick the number of beans that reflects how likely you think it is that…	# of beans in plate	Prompt for 0 or 10?
a)	*you will win if we play a game of Bawo after this interview*	[_____]	1
b)	*a baby born in your community this month will die within one year*	[_____]	1
c)	*you will go to the market at least once within the next 2 days* (LEAVE BEANS IN PLATE)	[_____]	1
d)	*you will go to the market at least once within the next 2 weeks?*	[_____]	1
INTERVIEWER: Did Respondent add any beans between X1c and X1d?		**If yes → X1f**	
e)	*Remember, as time goes by, you may find more time to go to the market. Therefore, you should have added beans to the plate. Let me ask you again. Now, add beans in the plate so that the number of beans in the plate reflects how likely you think it is that you will go the market at least once within 2 weeks?*	[_____]	1
f)	*you will experience shortage of food in the next 12 months?*	[_____]	1

For the subsequent questions, no longer prompt for "0" and "10" answers

X2	Pick the number of beans that reflects how likely you think it is that…	# of beans in plate
	a) *you will have to rely on family members for financial assistance in the next 12 months*	[____]
	b) *you are infected with HIV/AIDS now*	[____]
FOR MARRIED RESPONDENTS (INTERVIEWER: If respondent is not married → X2f)		
	c) *your spouse is infected with HIV/AIDS now*	[____]
	d) *you will use condom the next time you have sex with your spouse*	[____]
	e) *you will use condom the next time you have sex with someone else other than your spouse* **(INTERVIEWER: If sex only with spouse, write 99)**	[____] → X3
FOR UNMARRIED RESPONDENTS		
	f) *your romantic partner is infected with HIV/AIDS now* **(INTERVIEWER: If no romantic partner, write 99 and → X2h)**	[____]
	g) *you will use condom the next time you have sex with your romantic partner* **(INTERVIEWER: if no romantic partner, write 99)**	[____]
	h) *you will use condom the next time you have sex with someone you just met* **(INTERVIEWER: If no sex with someone just met, write 99)**	[____]
	i) *you will be married one year from now*	[____]

Finally, I would like to ask you to consider the likelihood that you may not be alive as time goes by. We hope that nothing bad will happen to you, but nevertheless, something unfortunate may occur over the next years despite all precautions that you may take. If you don't want to, you do not need to answer this question.

INTERVIEWER: If respondent refuses to answer, skip to **X8.**

		# OF BEANS in plate
X6	*Pick the number of beans that reflects how likely you think it is that you will die within a one-year period beginning today.* **(LEAVE BEANS ON PLATE)**	[____] if 10 →X8
X7	**Put additional beans so that the number of beans in the plate reflects how likely you think it is that you…**	
	a) *will die within a five-year period beginning today* **(LEAVE BEANS ON PLATE; IT IS POSSIBLE TO ADD ZERO ADDITIONAL BEANS)**	[____] if 10 → X8
	b) *will die within a ten-year period beginning today* **(IT IS POSSIBLE TO ADD ZERO ADDITIONAL BEANS. PUT BEANS BACK IN CUP AFTER RECORDING THE ANSWER)**	[____]

Appendix B: Additional Tables and Figures

Table B1: Consistency of elicited subjective probabilities: Number of beans for going to the market within 2 weeks minus number of beans of going within 2 days

Difference	Freq.	Percent	Cum.
-10 to -4	5	.2	.2
-3	3	.1	.3
-2	4	.1	.4
-1	7	.2	.6
0	186	5.8	6.4
1	334	10.4	16.7
2	928	28.8	45.5
3	815	25.3	70.8
4	516	16.0	86.8
5	241	7.5	94.3
6	81	2.5	96.8
7	36	1.1	98.0
8 to 10	65	2.0	100
Total	3,222	100	

Table B2: Pairwise correlations of responses (in terms of number of beans) across different subjective probability questions

		Correlation Matrix										
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	Winning in Bawo	1.00										
(2)	Going to market, 2 days	0.19	1.00									
(3)	Going to market, 2 weeks	0.20	0.76	1.00								
(4)	Food shortage	0.02	0.03	0.03	1.00							
(5)	Financial assistance	0.03	0.06	0.04	0.23	1.00						
(6)	Baby dying	0.08	0.12	0.14	0.14	0.13	1.00					
(7)	Being infected with HIV	0.02	0.03	0.05	0.11	0.02	0.12	1.00				
(8)	Condom use, spouse	0.05	0.06	0.08	0.04	0.04	0.05	0.16	1.00			
(9)	Condom use, other partner	0.11	0.19	0.27	0.03	0.06	0.10	0.02	0.28	1.00		
(10)	1-year mortality	0.03	0.04	0.02	0.22	0.13	0.26	0.25	0.07	0.01	1.00	
(11)	5-year mortality	0.03	0.05	0.04	0.24	0.13	0.25	0.28	0.08	-0.01	0.79	1.00
(12)	10-year mortality	0.02	0.02	0.03	0.23	0.09	0.21	0.27	0.08	-0.02	0.65	0.86

Table B3: Linear regression using likelihood of going to the market (# beans) within two weeks as dependent variable

	Model 1	**Model 2**
# of trips to the market last month	$0.133***$	
	(0.009)	
# of trips to the market last month		
(reference category: 2 trips or less)		
3 to 4		$0.768***$
		(0.131)
5 to 9		$1.172***$
		(0.128)
10 or more		$2.365***$
		(0.127)
Female	$-0.265***$	$-0.229**$
	(0.090)	(0.090)
Age (reference category: < 20 years old)		
20–29	0.04	0.099
	(0.147)	(0.148)
30–39	-0.166	-0.134
	(0.151)	(0.152)
40–49	$-0.327**$	-0.24
	(0.156)	(0.157)
50+	$-0.511***$	$-0.412**$
	(0.169)	(0.170)
Region (reference category: Mchinji)		
Balaka	-0.169	$-0.253**$
	(0.110)	(0.110)
Rumphi	$-0.751***$	$-0.870***$
	(0.113)	(0.112)
Constant	$6.535***$	$6.354***$
	(0.162)	(0.176)
N	2719	2719
R^2	(0.150)	(0.140)

Notes: Robust standard errors in parentheses. *p-values:* $^{+}$ $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$.

Table B4: Linear regression using likelihood of having to ask financial assistance (# beans) as dependent variable; all respondents

	Coef.	Std. Err.	*p*-value
Likelihood of food shortage within twelve months (response in terms of number of beans)	0.220	0.019	< 0.001
Female	0.910	0.120	0.000
Age (reference category: < 20 years old)			
20–29	-0.999	0.215	0.000
30–39	-1.353	0.242	0.000
40–49	-1.521	0.251	0.000
50+	-0.816	0.261	0.002
Education (reference category: low education)			
medium	-0.675	0.147	0.000
high	-1.015	0.211	0.000
Marital status (reference category: currently married)			
divorced/separated/widowed	0.756	0.202	0.000
never married	2.630	0.219	0.000
Land ownership (reference category: $\leq$ 2 acres)			
2-4 acres	0.246	0.131	0.059
> 4 acres	-0.097	0.145	0.502
Resp. has savings	0.044	0.130	0.737
constant	3.251	0.306	0.000
N	2,698		
R^2	0.203		

Table B5: Life table estimates of probability of dying within 5 and 10 years

	Life table estimates for probabiltiy of dying				Ratio of median subjective probability to life table estimate			
	Males		Females		Males		Females	
Time period:	5 years	10 years	5 years	10 years	5 years	10 years	5 years	10 years
Overall	0.110	0.227	0.098	0.201	3.2	2.3	4.1	2.9
Age group:								
< 20	0.018	0.065	0.018	0.064	16.4	7.6	17.4	8.0
20–29	0.061	0.155	0.068	0.163	4.6	3.2	5.6	3.4
30–39	0.128	0.247	0.119	0.228	2.6	2.1	3.5	2.6
40–49	0.138	0.259	0.127	0.241	2.4	2.0	3.4	2.5
50+	0.173	0.352	0.148	0.297	2.5	1.7	3.3	2.4

Notes: Life table estimates are based on the United Nations (2007) life table for Malawi for 2000-05. The probability of dying for a person aged x to $x + 5$ within a five-year time period is calculated as $1 - {}_5L_{x+5}/{}_5L_x$; the probability of dying within a ten-year time period is calculated as $1 - {}_5L_{x+10}/{}_5L_x$. Calculations are performed for five-year age groups, and then combined across all age groups ("overall") or across ten-year age groups using the age structure of the survey respondents. The median subjective probabilities of dying within a five and ten year period are obtained from Figures 5b-c.

Figure B1: Standardized boxplot-like graph to display distribution of subjective probabilities