University of Pennsylvania
ScholarlyCommons

PARC Working Papers | Population Aging Research Center

1-1-2007

Subjective Expectations in the Context of HIV/AIDS in Malawi

Adelin Delavande
RAND Corporation

Hans-Peter Kohler
University of Pennsylvania, Dept. of Soc, HPKOHLER@POP.UPENN.EDU

Delavande, Adelin and Hans-Peter Kohler. 2007. "Subjective Expectations in the Context of HIV/AIDS in Malawi." PARC Working Paper Series, WPS 07-06.

This paper is posted at ScholarlyCommons. http://repository.upenn.edu/parc_working_papers/4
For more information, please contact repository@pobox.upenn.edu.

Subjective Expectations in the Context of HIV/AIDS in Malawi

Adeline Delavande* Hans-Peter Kohler†

May 16, 2007

Abstract

In this paper we present a newly-developed interactive elicitation methodology to collect 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 respondent's answers about subjective expectations respect 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 less income and less land feel rightly at more risk of financial distress than people with higher SES, or people who are divorced or widow feel rightly at more risk of being infected with HIV than currently married individuals. While many expectations—including also the probability of being currently infected with HIV—are well-calibrated compared to actual probabilities, mortality expectations are substantially over-estimated compared to lifetable 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.

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; Cerwonka et al. 2000; UNAIDS 1999). The adaptation of behavioral change in AIDS-related behaviors, however, depends critically on individuals' subjective expectations about their own HIV-infection status and life expectancy, the prevalence of HIV in the local population, the availability of antiretroviral treatments for AIDS, etc. Several theoretical frameworks about the determinants of risk-taking behaviors in the context of HIV/AIDS—including for instance 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 of behavioral change. Despite this alleged central role of expectations, however, very

*Associate Economist, RAND Corporation, 1776 Main Street, Santa Monica, CA 90407-2138, USA and Assistant Professor of Economics, Universidade Nova de Lisboa, Lisbon, Portugal; *Email:* adeline@rand.org.

†Professor of Sociology, 3718 Locust Walk, University of Pennsylvania, Philadelphia, PA 19104-6299, USA; *Email:* hpkohler@pop.upenn.edu, *Homepage:* http://www.ssc.upenn.edu/∼hpkohler.

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 such as regarding 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 et al. 2003; Anglewicz and Kohler 2007; Prata et al. 2006).

To resolve the limitations of existing approaches, economists have recently developed approaches to elicit *probabilistic expectations*, that is, expectations that are measured on a well-defined numerical scale, are comparable across domains, and 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 probabilistic expectations in a meaningful way (for a recent review, see Manski 2004). In the context of developing countries with low literacy and numeracy, however, a direct question about the percent chance may be overly complicated or even meaningless to respondents. Prior to the study presented in this paper, therefore, there have been very few attempts to elicit probabilistic expectations in developing countries. Some of the exceptions include: Luseno et al. (2003) and Lybbert et al. (2007), who have elicited rainfall expectations by asking households head in Kenya and Ethiopia to allocate twelve stones into three piles, 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) andHill (2006) who have used a similar technique to elicit expectations about herd size and coffee prices respectively; McKenzie et al. (2006), who have used the percent chance wording to elicit expectations about future post-migration employment and income from Tongans who have intend to emigrate to New Zealand; and Delavande (2004) and Attanasio et al. (2005) who have used a visual scale labeled from 0 to 10 (or 100) to elicit probabilistic expectations about contraceptive failures and birth outcomes in Ghana or future income in Columbia. 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 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 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) covering 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 basic probabilistic theory, and vary in a 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 heavily 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 individual's face during their lives are characterized by uncertainty. This is particularly the case when 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 on the determinants of individual behaviors and their variations across persons and social groups. To illustrate this, consider a young man who engages in sexual activities without using a condom. His behavior can be consistent with many alternative specifications of his tastes and expectations. For example, he may believe that he is at great risk of contracting HIV from unprotected sex but dislike condom so much that he chooses not to use one. Alternatively, he might not dislike condom that much but believe that his partner and himself have the same serostatus, therefore he chooses not to use condom. A third hypothesis is that he believes condoms are ineffective at preventing the transmission of sexually transmitted diseases (STD). Other plausible competing explanations could be advanced. Choice data alone (e.g., lack of condom use) do not enable researchers to discriminate between these competing explanations and to understand individuals' decision process.[1]

In lieu of information about individuals' subjective expectations, social scientists often derive expectations from theoretical assumptions. For example, economists often assume that individuals form their expectations rationally, using all the information that is available to them. Individuals therefore hold probabilistic beliefs that are objectively correct. This rational expectation approach, however, is at odds with recent psychological and behavioral-economics research demonstrating that humans typically use heuristics or "rules of thumb" to make risk assessments in the context of uncertainty (for a review of this literature, see for instance Rabin 1998). In particular, individuals have been found to be excessively conservative and fail to adjust beliefs in light of new information (conservative heuristic), or on the contrary, to rely too heavily on recent information (representativeness heuristics), or conduct some averaging between prior and conditional information (for instance, see Bar-Hillel and Fischoff 1981; Edwards 1968; Grether 1980; Kahneman and Tversky 1982). So, even in the unlikely case that a social scientist could observe all the information at the disposition of a decision-maker, it would be very hard to accurately predict the decision-maker's subjective expectations without direct information about individuals subjective beliefs.

Eliciting direct information about individual's subjective expectations is therefore crucial for understanding the determinants of human behaviors in uncertain environments. Attitudional 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 to 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 et al. 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* that have the advantage of being measured on a numeric scales on which answers

can be consistently interpreted as probabilities across different domains (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) or 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 affecting 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 probabilities about survival in the HRS have been found to vary systematically with other variables such as smoking (Hurd and McGarry 1995), to evolve coherently in panel 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 (Delavande and Rohwedder 2006; Hurd and McGarry 2002).

Recent studies have also incorporated probabilistic expectations data into econometric models of choice behavior in various settings to avoid making unverifiable assumptions on expectations, and explain some of the observed heterogeneity in behavior. For example, (Nyarko and Schotter 2002) use subjects' stated beliefs about their opponent's strategies to analyze how experimental subjects play a constant sum game; Delavande (2005) estimates a random utility model of contraceptive behavior using expectations about birth control methods; Erdem et al. (2005) incorporate price expectations in a dynamic discrete choice model of information search and technology choice; Hurd et al. (2004) and Delavande (2005) study how subjective expectations of survival affect the timing of retirement and Social Security claiming; and finally, Lochner (2007) investigates criminal behavior using subjective expectations of arrest.

3 Data & 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, with ongoing data collection until 2007), 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* that is 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. 2007). 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 male and female respondents aged between 17 and 60 years old 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. 2007). The 2006 MDICP collected information, among other aspects, on (*a*) sexual relations, including the number of sexual partners, the frequency of sexual interactions, the characteristics of the last two sexual partners, and atti-

tudes 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 STIs, including the acceptability of various risk reduction strategies, perceived HIV/AIDS risks, frequency of attendance at community activities such as funerals and funerals and other community activities, and number of people known to have died of AIDS; and (*e*) 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 respondent's assessment of his/her own and partner's current HIV status and expected lifetime HIV risk, the 2006 wave of the MDCIP 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 3,200 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.

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 5 beans, it means that it is just as likely it happens as it does not happen (fifty-fifty). If you pick 6 bins, 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 not 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."*

The bean format outlined in this introductory text has the advantage of being visual, relatively intuitive and fairly engaging for respondents, it the question format can be designed to improve the consistency of answers. After the above introduction and any clarifying questions, respondents were first asked a training questions 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 larger 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 remembers the answer when answering about the two-week period in the next question. If the respondent

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

	Percentage of Respondents		
	Males	Females	Total
N	1,498	1,740	3,238
Age			
< 20	11.82	11.18	11.45
20–29	25.48	28.97	27.45
30–39	22.38	26.65	24.80
40–49	18.52	20.55	19.67
50+	21.79	12.65	16.62
Education			
low (no schooling)	12.91	26.37	20.14
medium (primary schooling)	67.02	63.96	65.38
high (secondary schooling or higher)	20.07	9.67	14.48
Marital status			
married	79.56	82.05	80.90
divorced/separated/widowed	2.40	11.74	7.42
never married	18.04	6.21	11.68
Land ownership			
≤ 2 acres	36.88	47.14	42.40
2–4 acres	32.10	32.26	32.18
> 4 acres	31.02	20.60	25.41
Lifetime number of sexual partners			
0	4.28	3.22	3.71
1	17.71	42.54	31.05
2	22.26	31.15	27.03
3	17.51	13.82	15.53
4+	38.24	9.27	22.67
Ever tested for HIV (prior to 2006 MDICP survey)			
no	38.17	37.90	38.02
yes, learned result	58.20	55.75	56.88
yes, did not learn result	3.63	6.35	5.09
2006 HIV status (determined after 2006 MDICP survey)			
negative	88.41	86.34	87.26
positive	3.59	6.14	5.01
no test	8.00	7.52	7.73
Region			
North (Rumphi)	31.87	31.68	31.77
Center (Mchinji)	33.47	34.22	33.88
South (Balaka)	34.65	34.10	34.35

violated the monotonicity property, the interviewer was instructed to explain the incoherency of the answers by stating that: "*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 0 or 10 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 *2 days*; (*b*) going to the market within the next *2 weeks*; (*c*) experiencing a food shortage within the next 12 months; (*d*) having to rely on family members for financial assistance in the next 12 months; (*e*) being infected with HIV now; (*f*) using condom at the next sexual encounter with spouse; (*g*) using condom at the next sexual encounter with someone other than spouse (not asked if respondent reports sex only with spouse); and (*h*) the respondent dying within (*i*) *1 year*; (*i*) *5 years*; and (*ii*) *10 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 reflects 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). While the correspondence between the number of beans and the implied probabilities was not explicitly stated in the preamble that was read to respondents prior to the expectation questions, a linear relationship covering the range from zero (very unlikely) to one (very likely) was strongly suggested by the statement. 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:

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

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. Figure 1 indicates how 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. The median and percentiles of the distribution of subjective probabilities are calculated assuming an uniform distribution of the underlying subjective probabilities P_i within each interval in Eq. (1). The mid-point

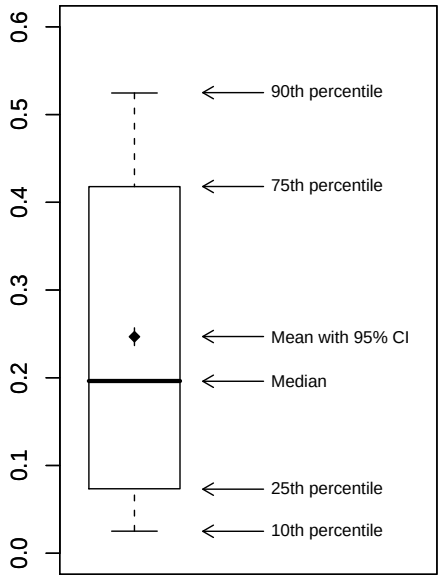


Figure 1: Standardized boxplot-like graph to display distribution of subjective probabilities

of each interval in Eq. (1) is used in calculations of the average (implied) subjective probability.[2]

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.[3] Table 2 presents the distribution of answers in terms of the number of beans allocated by respondents, and Figure 2 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 ability and experience. The interquartile range for both men and women in Figure 2 is .48–.51: 25% of men believe that they have a smaller

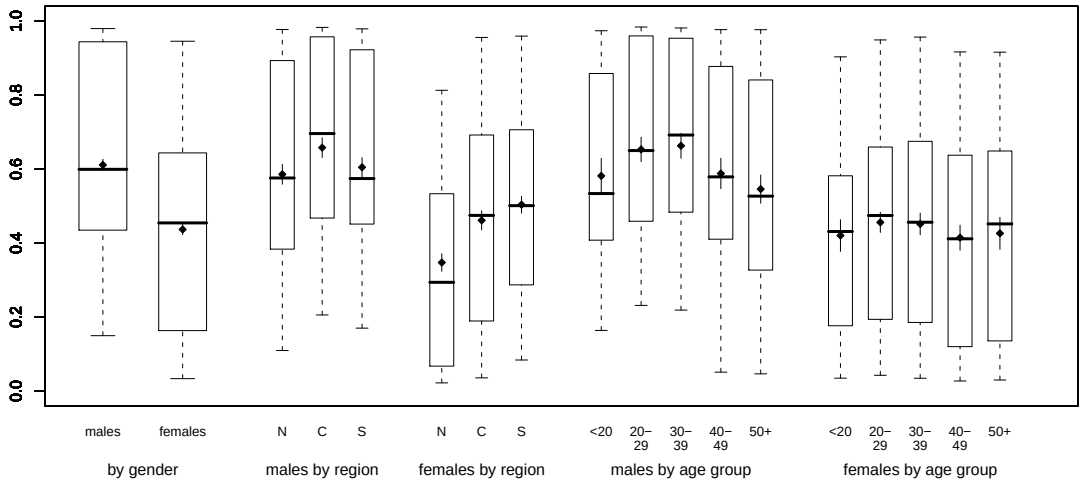


Figure 2: Distribution of respondents' subjective probability of winning if playing bawo, by gender, region, and age group

Notes: Region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka); see Table A.1 for data in tabulated form.

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

# of beans	implied subjective probability	gender men	gender women	Total
0	0 to .05	6.3	14.9	10.9
1	.05 to .15	3.7	8.8	6.5
2	.15 to .25	4.8	9.5	7.3
3	.25 to .35	4.7	8.1	6.5
4	.35 to .45	6.4	7.9	7.2
5	.45 to .55	19.4	18.1	18.7
6	.55 to .65	9.5	8.2	8.8
7	.65 to .75	7.1	6.2	6.6
8	.75 to .85	8.3	5.8	7.0
9	.85 to .95	5.1	2.6	3.7
10	.95 to 1	24.7	9.9	16.7
Implied subjective probability				
Mean		0.61	0.44	0.52
10th percentile		0.15	0.03	0.05
25th percentile		0.43	0.16	0.25
Median		0.6	0.45	0.51
75th percentile		0.94	0.64	0.79
90th percentile		0.98	0.95	0.97
N		1,498	1,740	3,238

than 43% chance of winning, while 25% believe that they are highly likely—with a subjective probability of more than 94%—to win. Women are less optimistic about winning in Bawo, and the distribution is shifted downward as compared to men, but having a similarly high variance: 25% of women believe that they have a smaller than .16 chance of winning, while 25% believe that they win with a subjective probability of more than 64%. The average implied probability of winning is 61% for men and 44% for women, with the difference being statistically different (Figure 2).[4] This gender difference is consistent with the fact that men play Bawo more often than women, and are thus tend to be more experienced; the gender difference is also in agreement with the large 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 2 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 on their own abilities.

The reported probabilities of winning in a game of Bawo reveal some important characteristics of features of subjective expectations that continue to characterize many of the outcomes analyzed further below: (*a*) subjective probabilities often exhibit considerable variation with respondents differing substantially in their assessment about the likelihood of various events; (*b*) they vary importantly and meaningfully across subpopulations defined 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; an

exception are expectations about currently being infected with HIV, which is highly skewed.

5 Response patterns

This expectation module included in the 2006 wave of the MDICP was administered to 3,252 respondents in three regions of rural Malawi. 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 therefore 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 respondent's answers about about nested events. We then provide detailed description of respondents' subjective expectations about common events, HIV infection and prevention strategy and mortality, evaluate how these subjective probabilities vary with respondent's characteristics or reported behaviors.

5.1 Item non-response

Out of the 3,252 respondents to whom the expectation module was administered, 3,238 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 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% (Hurd et al. 2005). 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 of 4% in the SEE, and 25% in a Columbian survey (Attanasio et al. 2005).

5.2 Focal answers

Expectations questions have been found to exhibit heaping at focal answers of 0, 50 and 100% (for instance, see Hurd and McGarry 1995), and responses of "50%" have been shown to indicate epistemic uncertainty (Bruine de Bruin et al. 2000). In Malawi, the pattern of focal answers—0, 5, and 10 beans—is quite similar to those found in surveys conducted in developed countries. Table 4 shows the percentage of respondents who provided 0, 5 or 10 beans for a subset of questions. 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) or 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. If we restrict the HRS sample to respondents aged 64 and 65 in 1992, half of them provided either 0, 50 or 100% when asked about the probability of being alive at age 75.[5] We have little benchmark from data in developing countries. However, Attanasio et al. (2005) report that in Columbia 15% of their sample answered 50% when asked about the probability that their income would be above a threshold.

Table 3: Subjective probabilities of various common events

# beans	implied subjective probability	Going to the market within 2 days	Going to the market within 2 weeks	Experi-encing food shortage in the next 12 months	Rely on family for financial assistance in the next 12 months	Baby dying before 1st birthday	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	0 to .05	6.0	1.1	11.2	22.1	18.4	66.6	64.4	10.0	29.1	6.0	2.0
1	.05 to .15	9.6	1.3	7.7	11.7	22.2	9.5	7.6	1.5	24.1	8.5	1.9
2	.15 to .25	17.7	2.5	10.2	11.9	17.8	7.6	6.6	3.7	16.3	16.1	4.9
3	.25 to .35	14.9	6.2	8.8	8.6	10.8	4.7	4.4	3.9	9.0	16.7	7.9
4	.35 to .45	14.5	7.0	9.1	6.8	7.3	2.4	3.0	3.5	5.6	12.2	10.1
5	.45 to .55	14.7	12.3	17.4	13.1	17.4	5.6	6.1	11.4	13.1	20.4	24.9
6	.55 to .65	8.0	14.0	8.1	6.7	2.8	0.5	2.7	8.2	0.9	7.0	10.2
7	.65 to .75	4.9	15.3	7.4	5.0	1.3	0.5	0.9	5.5	0.4	5.8	11.3
8	.75 to .85	3.5	13.4	7.1	4.8	0.9	0.9	1.3	8.7	0.5	3.3	9.8
9	.85 to .95	1.8	6.8	3.0	2.4	0.4	0.7	0.5	7.2	0.3	0.9	4.8
10	.95 to 1	4.6	20.1	9.9	6.9	0.7	1.0	2.7	36.5	0.9	3.2	12.1
Implied subjective probability												
Mean		0.39	0.67	0.46	0.36	0.25	0.12	0.16	0.67	0.20	0.39	0.58
10th percentile		0.09	0.33	0.04	0.02	0.03	0.01	0.01	0.05	0.02	0.10	0.26
25th percentile		0.20	0.51	0.21	0.08	0.08	0.02	0.02	0.47	0.04	0.22	0.43
Median		0.36	0.69	0.47	0.30	0.20	0.04	0.04	0.78	0.14	0.37	0.54
75th percentile		0.53	0.88	0.68	0.56	0.43	0.14	0.20	0.97	0.31	0.53	0.77
90th percentile		0.75	0.98	0.95	0.83	0.53	0.41	0.52	0.99	0.50	0.71	0.96
N		3,236	3,223	3,209	3,229	3,237	3,228	2,643	598	3,191	3,191	3,189

Table 4: Distribution of focal answers

Question:	Percentage of responses with # of beans equal to 0	5	10	Total percentage of focal answers
Winning in Bawo	10.9	18.7	16.7	46.4
Going to market within 2 days	6.0	14.6	4.6	25.2
Going to market within 2 weeks	1.1	12.3	20.1	33.4
Experiencing food shortage	11.2	17.4	9.9	38.5
Financial assistance from family members	22.1	13.1	6.9	42.1
Baby dying before 1st birthday	18.4	17.4	0.7	36.5
Being infected with HIV now	66.6	5.6	1.0	73.2
Using condom with spouse	64.4	6.1	2.7	73.1
Using condom with someone other than spouse	10.0	11.4	36.5	57.9
Dying within 1 year	29.1	13.1	0.9	43.1
Dying within 5 years	6.0	20.4	3.2	29.6
Dying within 10 years	2.0	24.9	12.1	39.0

Overall, the pattern of focal answers in Table 4 is sensible. For example, as the length of time for the probability of going to the market increases, the proportion of respondents answering with 0 beans decreases sharply while the proportion of 10 beans increases substantially. There is a similar pattern for the mortality questions. Moreover, for events with low likelihood, like the one-year mortality of a baby or own HIV infection, the proportion of responses at 0 beans is far greater than the one at 10 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.[6] For 34% of the interviews, the interviewer reported that the respondent fully understood, for 35% that s/he mostly understood, for 30% that s/he understood after a while, and for about 1% 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 others 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 provided an answer for the event "going to the market within two days" smaller than or equal to for the event "going to the market within two weeks." Only 19 respondents out of 3,222 (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 2 and 3 beans was the most common action taken by respondents when

Table 5: 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	***69.28***	17.50	12.92	1.55	29.11
2nd quartile	29.90	***40.65***	13.38	2.33	24.06
3rd quartile	0.31	41.30	***51.08***	14.13	25.31
4th quartile	0.52	0.54	22.62	***81.99***	21.51
Total	100.00	100.00	100.00	100.00	100.00
Infant mortality					
1st quartile	***55.82***	41.63	29.89	27.75	40.75
2nd quartile	16.68	***20.11***	18.03	15.81	17.77
3rd quartile	11.53	20.43	***20.96***	21.71	18.08
4th quartile	15.96	17.83	31.12	***34.73***	23.39
Total	100.00	100.00	100.00	100.00	100.00
Win if play Bawo					
1st quartile	***33.61***	31.49	30.51	28.53	31.33
2nd quartile	24.02	***24.97***	30.82	24.65	25.81
3rd quartile	21.86	22.37	***21.11***	24.50	22.39
4th quartile	20.52	21.17	17.57	***22.33***	20.47
Total	100.00	100.00	100.00	100.00	100.00

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

the length of time increases from two days to two weeks (29% added 2, and 25% added 3 beans; see Table A.2 for a full tabulation). This consistency of the implied probabilities for going to the market within two days and two weeks provides strong support that respondents understood the concept of likelihood. The mortality expectations contain another set of nested events: respondents were elicited the probability of dying within one year, five years and ten years. The mortality questions deal with an event that respondents do not experience regularly like going to going to the market. Out of the 3,144 respondents who answered the questions for the three time horizons, only 1.45% violated the monotonicity property of the probabilities. This high level of consistency, however, is in part due to a question design that 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 have a propensity to always choose a high or low number of beans, independently of the outcome considered. Table 5 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 notice that among respondents who are optimistic about their own

mortality (those with answers in the 1st quartile), half also have their answer in their 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 (Table A.3). 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.

6 Expectations about common events

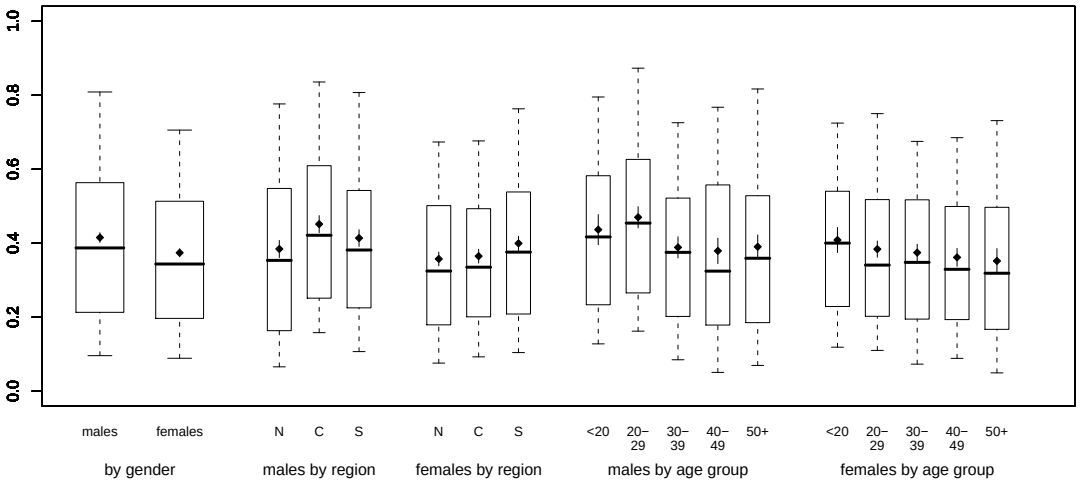
This section provides detailed description of the expectations questions about common events occurring in the respondents' lives or environments.

6.1 Going to the market

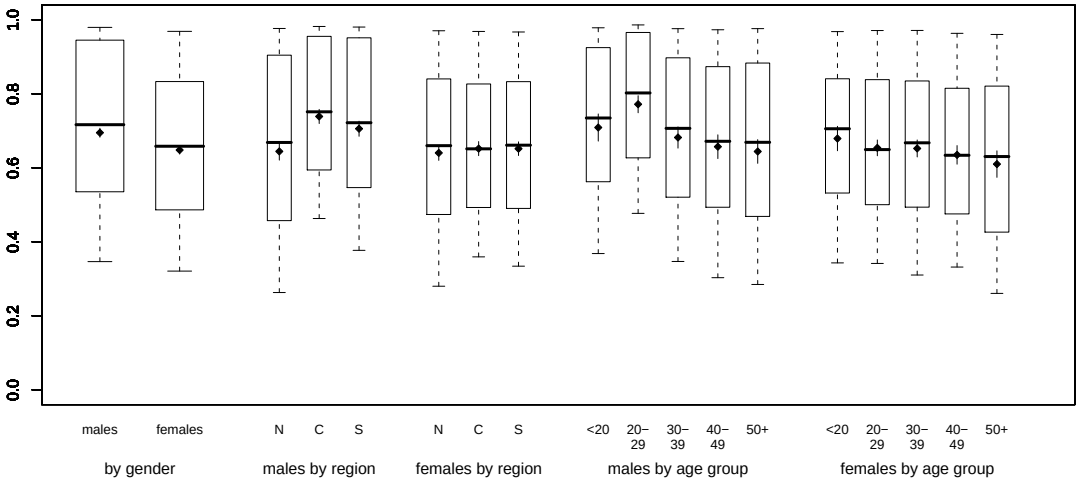
Figure 3 shows the distribution of respondents' subjective probabilities of going to the market within two days and two weeks of the interview, and Table 3 reports the actual allocation of the number of beans and summary statistics of the elicited subjective probabilities. The most common answers for the shorter time frame are 2, 3, 4 and 5 beans, while it is 10 and 7 beans for the longer one. The average answer is 3.9 beans for the two-day period and 6.9 beans for the two-week period, corresponding to an average implied probability of 42% for men and 37% for women for going to the market within two days, and of 69% for men and 65% for women for going to the market within two weeks.[7] In addition to the gender difference, there are age and regional differences: younger respondents provide on average a larger likelihood of going to the market for both time periods, while respondents in the North report lower probabilities than in the two other regions; the gender difference, on the other hand, is most pronounced in the Center.

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 7.73 trips per month compared to 5.4 for women.[8] In a remarkable agreement with the patterns in Figure 3, men and women in the age groups "less than 20" and "20–29" report the largest number of trips to the market (average for men: 9.43 and 8.10 respectively; average for women: 6.30 and 5.78 respectively).[9] The regional difference in reported number of trips differs, however, from the elicited beliefs: the most frequent visits to the market are reported in the North for both men and women, while the subjective probabilities are highest—albeit by a small margin—in the Center.

Further evidence that the elicited probabilities about going to the market correspond with actual behaviors is obtained from an individual-level regression of an 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 A.7). Individuals who have been more frequently to the market in the previous month report a higher probability of going in the next two weeks. Compared to those who made two or less trips to the market in the previous month, having been to the market 3 to 4 times is associated with 0.76 additional beans (an increase in subjective probability of 7.6 percentage points), having been to the market 5 to 9 times is associated with 1.1 additional beans (an increase in subjective probability of 11 percentage points) and having been to the market more than 10 times is associated with 2.4 additional beans (an increase in subjective probability of



(a) Going to the market within 2 days



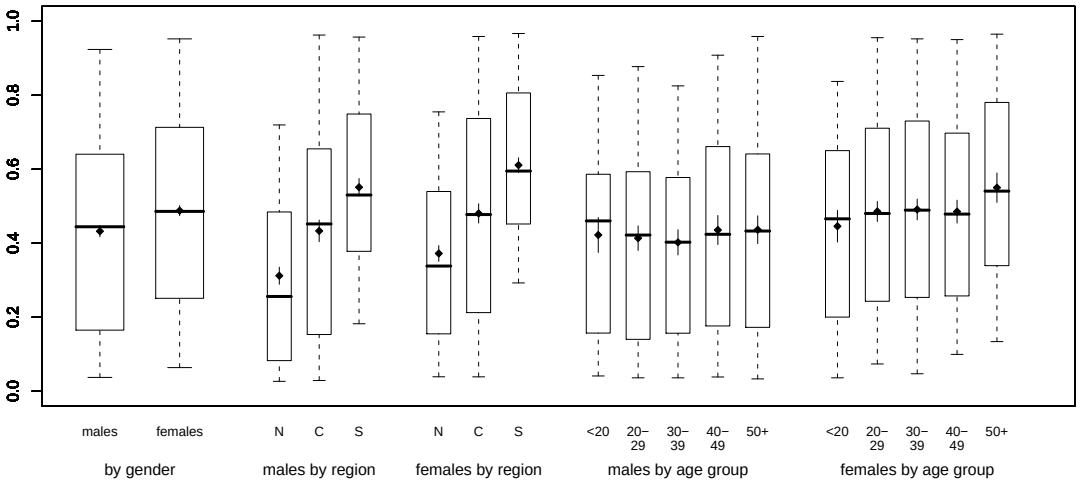
(b) Going to the market within 2 weeks

Figure 3: Distribution of respondents' subjective probability of going to the market within two days and within two weeks, by gender, region, and age group
Notes: Region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka).

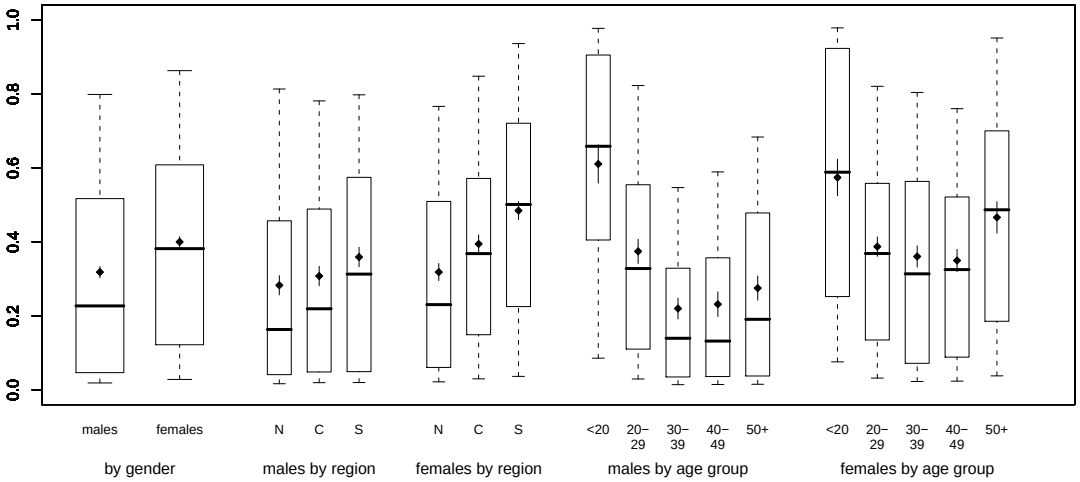
24 percentage points).

6.2 Food shortage and financial assistance

Food shortages have been a common recent problem for rural Malawians. In particular, in 2005, due to prolonged dry spell and problems with the distribution of fertilizer, Malawi experienced the lowest crop production of the past 7 years, with the estimated 2005 production of the most important staple crop, maize, being 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, illness, unexpected health-care expenditures, 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 for instance reveal that 83% of respondent's living parents, and 62% of respondent's non-resident adult children, received a non-financial transfer from the respondents in the last two years. Financial transfers were



(a) Experiencing a food shortage within the next 12 months



(b) Having to rely on family members for financial assistance in the next 12 months

Figure 4: Distribution of respondents' subjective probability of (*a*) experiencing a food shortage within the next 12 months, and (*b*) having to rely on family members for financial assistance in the next 12 months, by gender, region, and age group
Notes: Region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka).

less commonly reported: 45% of family members (excluding children below age 15) received a little or some, and 14% received a lot. Financial help is also weakly associated with self-reported health status: for instance, of individuals in relatively good health, 59% received any financial transfers from the respondent, as compared to 63% of individuals in relatively poor health.

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 12 months, and likelihood of having to rely on family members for financial assistance in the next 12 months. Figure 4 shows distribution of 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.

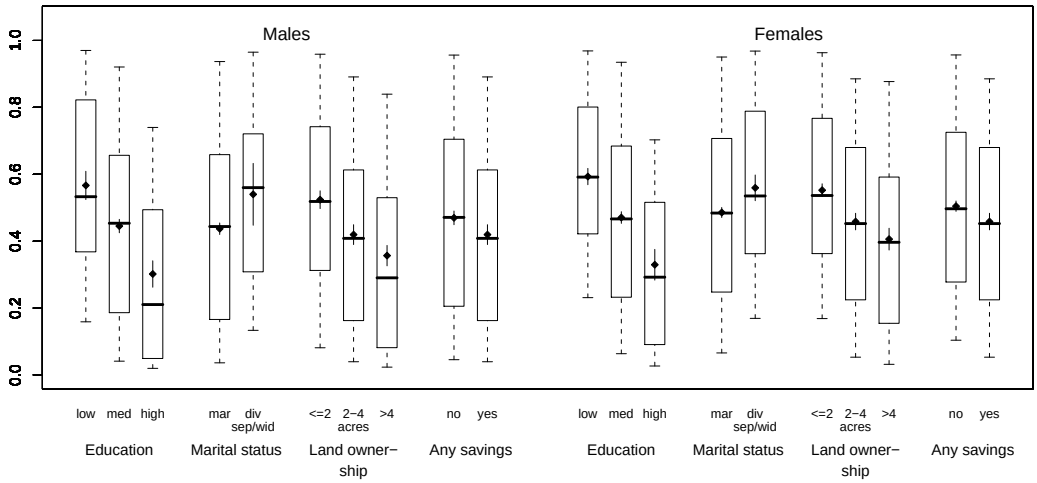
The respondent's subjective probability of experiencing a food shortage within the next 12 months is 46% (men: 32%; women 40%). The most common answers to the question were 5, 2 and 0 beans (Table 3), suggesting that most of the respondents do not believe another food

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 4a), and this difference remains even after controlling for age, schooling, marital status, subjective likelihood of food shortage, and other socioeconomic characteristics (Table A.10). 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—about which they have little control (Dominitz and Manski 2004, 2005, 2007), (*ii*) men want to appear as "good provider" during interviews (Miller et al. 2001), and the possibility that women are indeed at a greater risk of food shortage. 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: women report higher subjective expectations about having to rely on family members than do men (40% vs. 32%). While there is no marked age pattern in the expectations about a food shortages, younger and older respondents report—consistent with observed transfer patterns—a higher likelihood of having to rely on family members for financial assistance.[10]

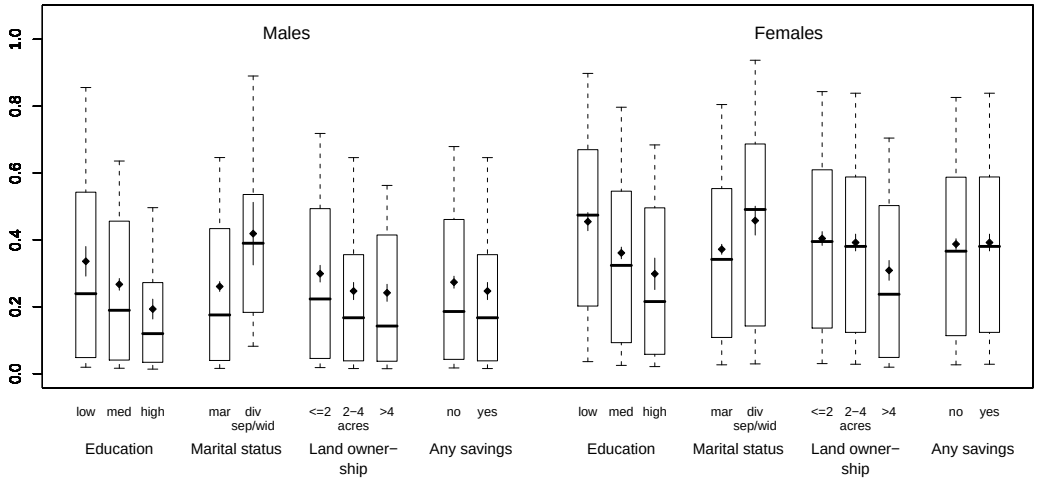
The subjective probabilities in Figure 4 also indicate that there is considerable heterogeneity among respondents in their assessment of facing a food crisis or having to rely on family members. The interquartile range for both men and women exceeds .45 in both cases. Hence, while 25% of men (women) expect to experience a food shortage with more than a 64% (71%) chance, there is also a subset of 25% of men (women) who expect this event with a less than 16% (25%) chance. Similarly, 25% of men (women) perceive a less then 5% (12%) change that they'll need financial assistance from family members, the upper quartile of male (female) respondents reports a higher than 52% (61%) chance. This substantial heterogeneity in beliefs may in part be related 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 systematically influence expectations.

Figure 4 also reveals marked regional differences, and respondents in the northern region report the smallest probabilities of experiencing food shortage or 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).[11] The subjective expectations about food shortage and financial assistance reported follow exactly the regional variation in the drought.

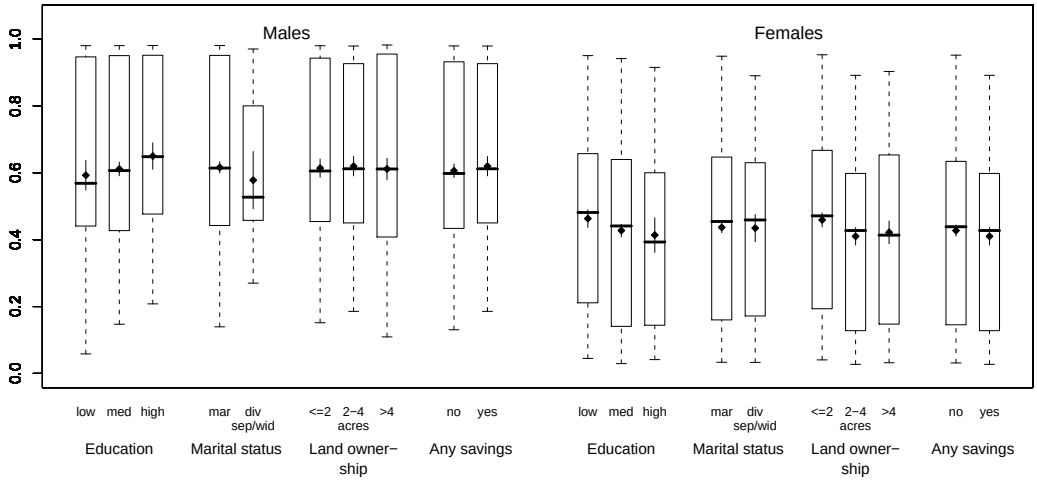
Figure 5a–b reveals that respondents' subjective probabilities about food shortages and the need to rely on family members vary meaningfully with respondents' socioeconomic status (SES). For example, respondents who have more education, are married, own relatively large land and have any savings all report lower subjective probabilities of experiencing a food shortage than their counterparts who have low education, are divorced/separated/widowed, own little land or do not have savings. A very similar—albeit less pronounced—pattern exists with respect to the expectation about having to rely on family members for financial assistance within the next 12 months. In summary, therefore, Figure 5a–b provides a clear indication that individuals with higher socioeconomic status are less concerned about experiencing a food shortage or having to rely on family members for assistance in the near future, consistent with the tendency that higher SES individuals are less vulnerable to food and financial crises. The differences by education, marital status and land ownership are statistically significant in linear regressions controlling for



(a) Experiencing a food shortage within the next 12 months



(b) Having to rely on family members for financial assistance in the next 12 months



(c) Winning a game of Bawo

Figure 5: Distribution of ever-married respondents' subjective probability of (*a*) experiencing a food shortage within the next 12 months, and (*b*) having to rely on family members for financial assistance in the next 12 months, and (*c*) winning a game of Bawo played against the interviewer, by gender and socioeconomic status

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

age (Table A.8). These marked socioeconomic differences in subjective expectations regarding food shortages or 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 5c). 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 systematically with marital status, land ownership or similar factors.

The availability of subjective expectations about food shortage and having to rely on family members also allows to test whether respondents take into account that the outcomes of two events may have common underlying causes. For example, since help among 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) on likelihood of experiencing food shortage and other demographic and economic variables are used as independent variables (Table A.9). The regression results show that a higher likelihood of experiencing 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 0.24–0.27 additional beans on the likelihood of needing financial assistance; or, stated in terms of subjective probabilities, a 10 percentage point higher subjective probability of experiencing a food shortage is associated with a 2.4–2.7 percentage point higher subjective probability of having to rely on family members for financial help. 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.[12] Infant mortality, unfortunately, continues to be a fairly common event in rural Malawi. The Malawi DHS, for instance, estimated an infant mortality, 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): 1 bean—corresponding, on average, to an implied infant mortality of 100 per 1,000 births (10% mortality risk)—is the most common answer, with the two next commons answers being 0 and 2 beans. Overall, 58% of the respondents placed two or fewer beans in the plate, thus estimating a infant mortality of 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 have placed 4 beans or less in the plate, and the median of subjective probabilities about infant mortality is 20%. Nevertheless, about 25% of respondents—both male and female—have subjective probabilities about infant mortality in excess of 43%. The HIV/AIDS epidemic might explain some of the high answers. During the pilot phase, a respondent explained that he allocated 9 beans because nowadays babies were dying more often than in the past due to HIV/AIDS.

This is somewhat in contrast to actual mortality trends for Malawi overall, which show declines in infant mortality in the last decade despite HIV/AIDS, but strong increases in adult mortality as a result of HIV/AIDS (Malawi DHS 2000, 2004).[13] A possible explanation for this overestimation of infant mortality in a subset of the population may be the 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). Thus, some respondents might have noticed an increase of child funerals, without taking into account that more children were born.

7 HIV/AIDS-related expectations

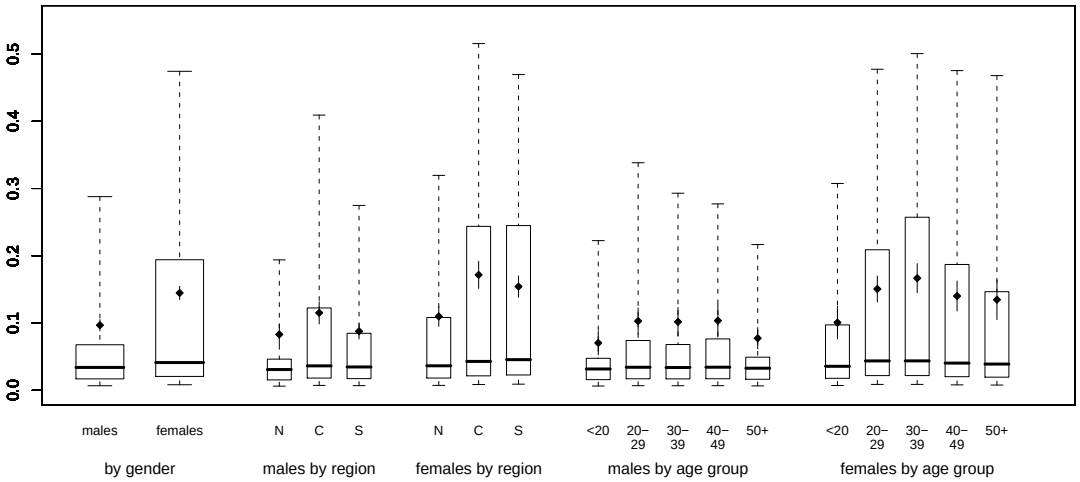
Individuals have been shown to mostly overestimate, but sometimes also underestimate, their risk of HIV infection (e.g., Aggleton et al. 1994; Pinkerton et al. 2000; Tharawan et al. 2003). In this section we evaluate the ability to elicit HIV/AIDS related expectations using the interactive approach introduced 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 individual expectation about condom use in the future are consistent with their behavior in the past.

7.1 Expectations about own HIV infection

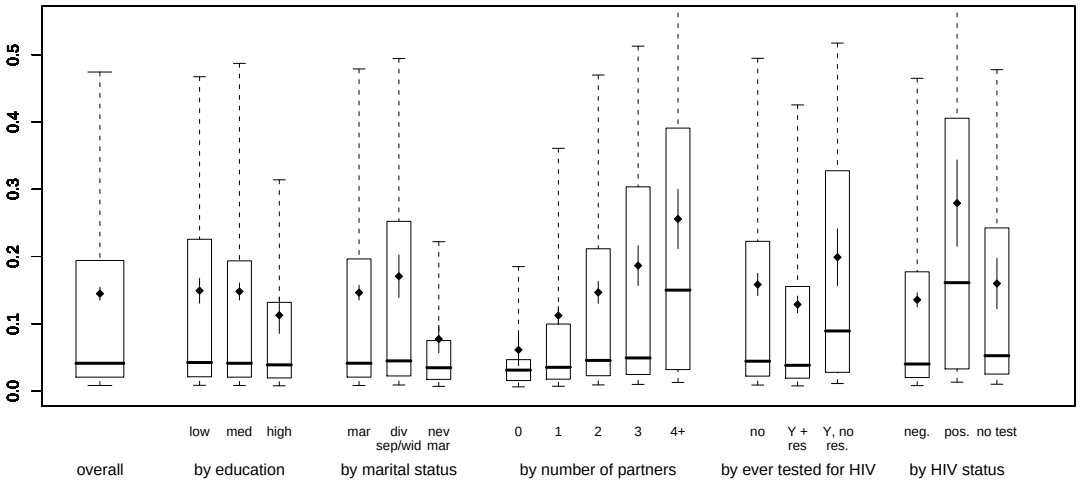
Figure 6a presents the distribution of answers about the likelihood of being currently infected with HIV/AIDS (see Table 3 for actual responses in terms of number of beans). These subjective probability of HIV infection can be compared to the actual HIV prevalence among MDICP respondents of 6.9% (7.9% for females and 5.6% for males) (Obare et al. 2007).[14] This prevalence among MDICP respondents is somewhat below the DHS estimate for rural Malawi of 10.8% (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). The differences between the DHS and MDICP prevalence is not due to age-structure differences or differences in the HIV-test participation rates (Obare 2006), but likely due to the absence of peri-urban areas—such as rural trading centers—among the MDICP sample villages (Obare et al. 2007).

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-third of the respondents allocated zero beans in response to this question, while only 1% reported ten beans. The most common answers were, in that order, 0 beans (67% of respondents), 1 bean (9.5% of respondents) and 2 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 that show a 30% higher prevalence for women as compared to men. If we restrict the sample to individuals age 15 to 49, the average implied probability is 12.67% (14.67% for females and 9.78% for males).

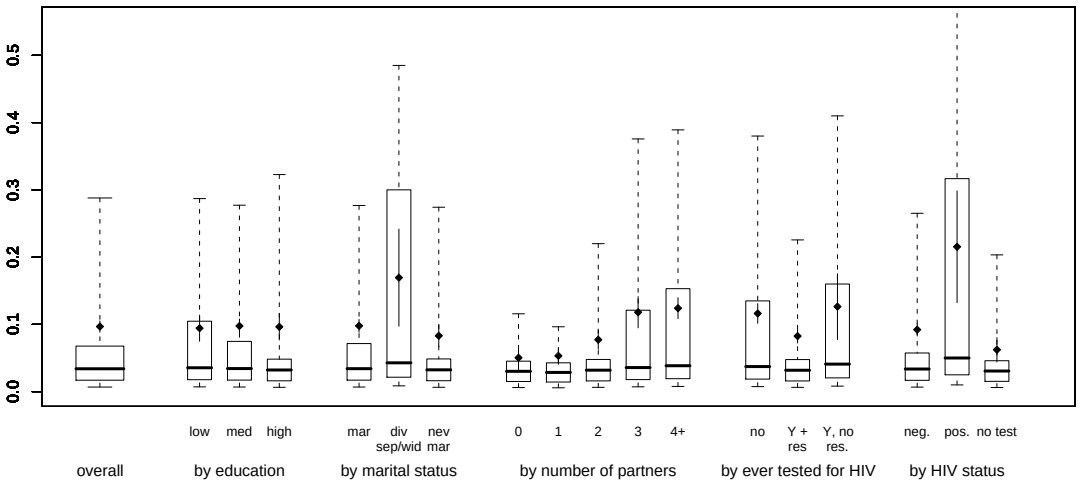
In contrast to the expectations analyzed earlier in this paper, the distribution of subjective probabilities is relatively skewed. The median subjective infection probability is .041% for women and .034% for men, somewhat below the actual prevalence level and without marked gender difference. It indicates that a substantial fraction of MDICP respondents assesses their risk of



(a) By gender, region and age-group



(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

Figure 6: Respondent's subjective probability of being infected with HIV now
Notes: Region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka); see Tables A.4–A.6 for data in tabulated form.

being HIV positive to be fairly low. The mean subjective infection probability is substantially above this level, and this higher mean subjective infection risks results from the fact that a subset of respondents perceive themselves to be quite likely to be HIV-positive: 25% of men believe that their risk of being infected with HIV is above 6.8%, 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 extra-marital 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 6a is thus consistent with the fact 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 12 months, and among those, 58% never used condom with their last extra-marital partner.

Figure 6a 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 it results from increases in subjective risks in the right tail of the distribution: the 75th percentile for women in the South and Center is almost 2.3 times as high as that of women in the north, and more than 20% of women in the Center and South perceive a probability of 30 percent or higher of being HIV-positive, but only 11% of women in the South do so. The regional pattern of subjective infection probabilities, however, does not fully agree with the regional variation of 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%.[15] 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 6a also reveals a systematic age pattern of subjective probabilities about current HIV infection, and this pattern is particularly marked for women and matches the observed pattern of HIV prevalence by age peaks during ages 30–39 (Table 6; see also Malawi DHS 2004; Obare et al. 2007). The reported subjective probabilities 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 that peaks at ages 40–49 (Table 6), there is basically no age gradient among men between 20 and 49 in the perceived probabilities of being HIV-positive.[16]

The subjective probabilities of being currently infected with HIV also vary systematically with other correlates of HIV-prevalence (Figure 6b–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.[17] There is also a clear 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 hold higher beliefs of infection.

Figure 6b–c also reports the subjective probabilities of being infected with HIV by the respondents' knowledge about his/her infection status and his/her actual infection status. For most

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	0.007	0.021
20–29	0.131	0.034	0.031	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	
Marital status				
married	0.124	0.050	0.050	0.132
divorced/separated/ widowed	0.170	0.179	0.185	0.266
never married	0.081	0.000	0.000	0.003
Education				
low education	0.133	0.069	0.072	0.123
medium education	0.124	0.050	0.051	0.111
high education	0.102	0.047	0.047	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	0.151	0.078	0.079	
4+	0.153	0.087	0.088	
Ever tested for HIV?				
no	0.139	0.061	0.062	0.126
yes, learned result	0.107	0.051	0.051	0.144
yes, did not learn result	0.175	0.042	0.042	

respondents, the HIV tests conducted as part of the 2004 MDICP—that is, 2 years prior to the current expectation module—are the primary source of knowledge about their HIV status (Section 3). Only a small number has 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 6b–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 perceive 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 2-year prior to implementation of the current expectation module—exhibit by far the smallest variance, while the expectation of those who have never been tested for HIV, or have been tested for HIV but didn't receive the test results, exhibit substantially higher variance.

Finally, Figure 6b–c also reveals the variation of subjective probabilities about 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 about 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 strongly with 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

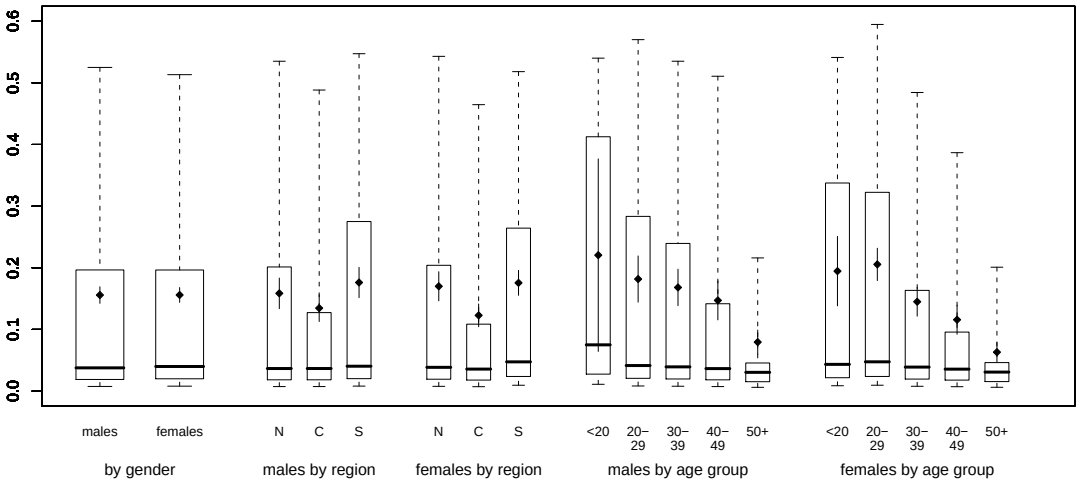
Expectations about HIV prevention strategies provide a possibility to evaluate individual's intentions in trying to reduce the transmission of the disease, and during the expectation module of the 2006 MDICP survey, respondents were therefore asked their likelihood of using condom with various partners.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

7.2.1 Condom use with spouse

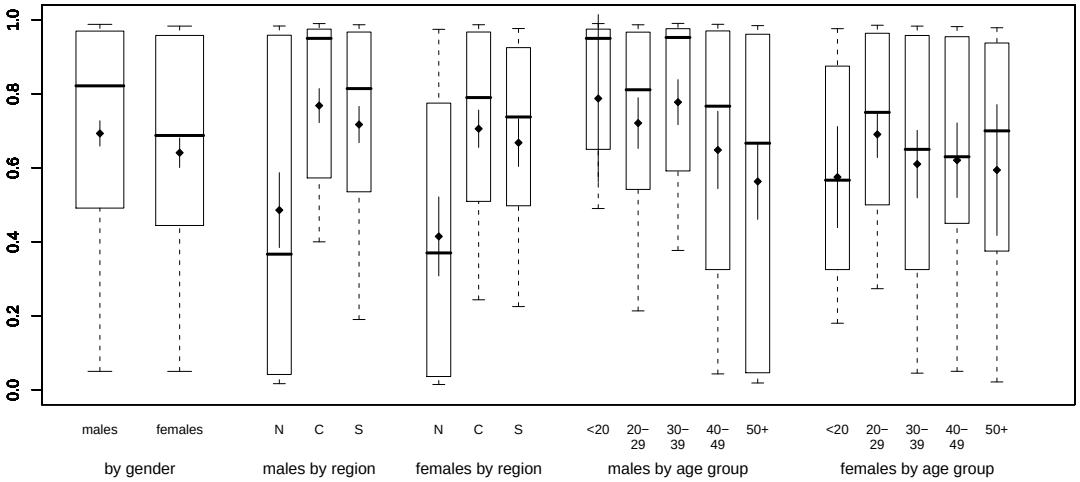
Figure 7a presents the distribution of respondents' subjective probability of using a condom at next sexual encounter with (*a*) the spouse and (*b*) someone other than spouse (see Table 3 for actual responses in terms of number of beans). In answering the question about condom use with the spouse, almost two-thirds of respondents placed no beans on the plate, 90% of the respondent provided an answer of 5 beans or less, and less than 3% of the respondents answered with 10 beans. The median subjective probability in Figure 7a for both men and women is therefore quite low (3.8% for men; 4% for women), consistent with the fact that 65% of the 2006 MDICP married respondents reported that it is not acceptable to use condom with a spouse to protect against HIV/AIDS. Other studies have also documenting that condom use is still very uncommon within marriage in Malawi (Bracher et al. 2004; Chimbiri 2007). There is, however, a gradient by age: younger respondents are more likely to provide a positive likelihood of using condom, potentially reflecting changing attitudes towards condom use among young adults.

Most important in Figure 7a is the large difference between the mean and the median as a result of a very skewed distribution. While the "median person" is still fairly hesitant to use condom within marriage, there may exist 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 as 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 extra-marital relationships report higher expectations of condom use with the spouse than those who do not have extra-marital partners.[18] Expecta-



(a) Condom use with spouse



(b) Condom use with someone other than spouse

Figure 7: Distribution of respondents' subjective probability of using a condom at next sexual encounter with (*a*) spouse and (*b*) someone other than spouse, by gender, region, and age group

Notes: Married respondents only; condom use with someone other than spouse was not asked if respondent reported sex only with spouse; region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka).

tions abut condom use are also higher among individuals who have bought condoms in the past two months, or have reported a subjective probability of being currently infected with HIV of larger 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.[19] 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.

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)	1,726	1.08	0.05	0.13	0.005	0.02	0.03	0.08
$\geq$ .05 (one or more beans)	877	1.98	0.09	0.21	0.009	0.03	0.07	0.33
Extra-marital partners								
no	2,029	1.28	0.05	0.14	0.005	0.02	0.04	0.15
yes	578	1.74	0.10	0.19	0.010	0.02	0.05	0.28
Condom use with spouse in the past								
never	1,961	0.63	0.04	0.08	0.003	0.02	0.03	0.05
ever	620	3.75	0.13	0.38	0.012	0.08	0.36	0.57
Bought condom in last 2 months								
no	2,461	1.17	0.04	0.13	0.004	0.02	0.04	0.14
yes	144	5.10	0.26	0.51	0.025	0.30	0.52	0.69
Education								
low education	567	1.09	0.09	0.13	0.008	0.02	0.04	0.14
medium education	1,740	1.41	0.06	0.16	0.006	0.02	0.04	0.20
high education	297	1.80	0.17	0.19	0.016	0.02	0.04	0.32

7.2.2 Condom use with partner other than spouse

Married respondents were also asked the likelihood of using condom the next time they have sex with someone other than their spouse. 598 respondents answered the question, 57% whom were men. 2,046 respondents skipped the questions because they reported that they do not have sex with someone else than spouse when asked about this particular subjective probability.

Figure 7b depicts the distribution of respondents' subjective probability of using a condom at the next sexual encounter with someone other than the spouse (see Table 3 for actual responses in terms of number of beans). In contrast to the responses about condom use with the spouse, only 10% reported 0 beans, about 80% reported 5 beans or more, and more than a third of the respondents reported 10 beans. As a result, Figure 7b reveals a fairly high subjective probability of using a condom with someone other than the spouse. Men provide a slightly higher mean and median response than women, and there is a slight age pattern for men with 40+ year old men reporting a lower probability of condom use with extra-marital partners than their younger counterparts. There is also a pronounced regional pattern, with the reported likelihood of condom use with extra-marital partners being much lower in the North as compared to the central and southern region. Paradoxically, respondents in the northern region report the highest *actual* use of condom with extra-marital partners: about 25% of those who answered the question about expected condom use with a partner other than the spouse report that they have used condom at almost every time or every time with their last extra-marital partner, compared to about 18% in the two other sites.[20] Respondents in the North seem therefore more realistic about their future condom use by giving a lower—and thus more accurate—subjective probability of doing so.

Respondents were also asked during the MDICP about their sexual practice with their two most recent sexual partners, in addition to their spouse. Since many of the respondents answer-

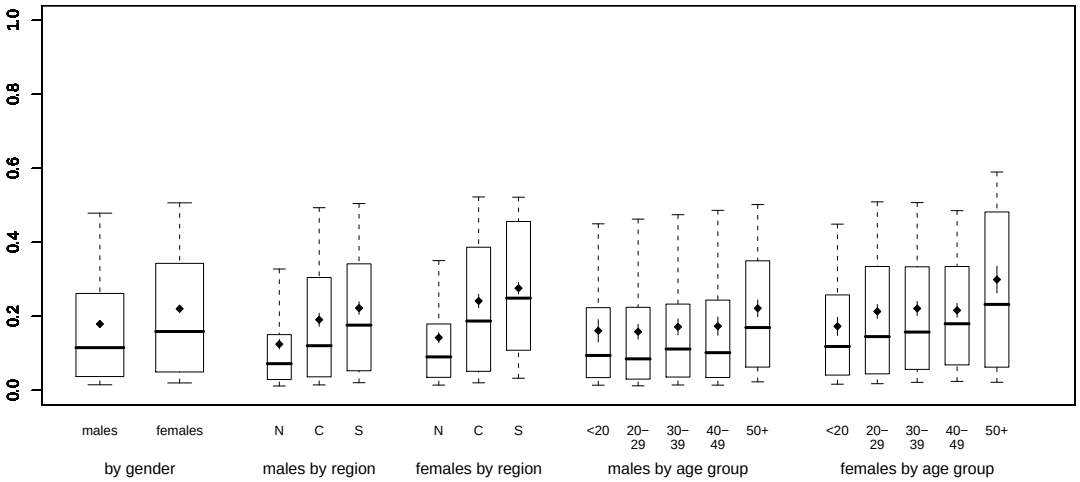
ing the questions about the likelihood of using condom with an extra-marital partner did not report more than one partner in the last 12 months, observations about *actual* condom use with extra-marital partners are only available for 279 respondents, 70% of whom are men. Among these respondents, 62% have never used condom with their most recent extra-marital partner; 19% have used condom at the beginning or sometimes, and 19% have used condom almost every time or every time. This low prevalence of past condom use contrasts with the relatively high elicited expectations of condom use at next extra-marital sexual encounter (Figure 7b). This discrepancy is consistent with several explanations. Respondents, for example, may want to provide answers that are socially more acceptable in front of the interviewers; or, respondents may actually intend to use condom with extra-marital 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 future condom use, there is an association between past behavior and future expectations: the mean subjective probability to use a condom at the next sexual encounter with an extra-marital partner is 68% for those who have never used a condom in the past with an extra-marital partner, and it increases to 75% and 85% for those who report that they used condoms sometimes/at the beginning or (almost every time) (see Table A.11 for additional details).

8 Mortality

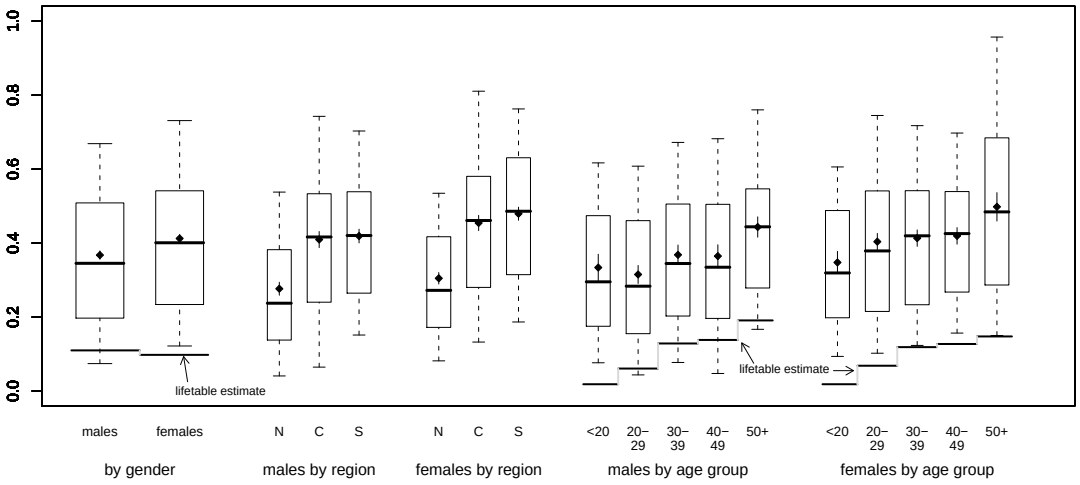
Oster (2007) has recently argued that there is is no reason per se to expect a behavioral response to increased in HIV infection rates in sub-Saharan Africa; in particular, as becoming infected with HIV means premature death, the "utility lost" depends on how many years people expect to live without 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 then 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 foregone pleasures (e.g., reduced joy from sex as a result of condom use, lower levels of satisfaction as a result of giving up extra-marital partners, etc.), 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) or Auld (2003).

Very little, however, is 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 lifetable 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 about mortality risks in a sub-Saharan African context with high HIV prevalence, Figure 8 depicts the distribution of MDICP respondents' subjective expectations about their own mortality. In particular, respondents were asked about their subjective probability of dying within one year (Figure 8a), five years (Figure 8b), and ten years (Figure 8c; 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 lifetable estimates by gender and age group (see also Table A.15).[21]

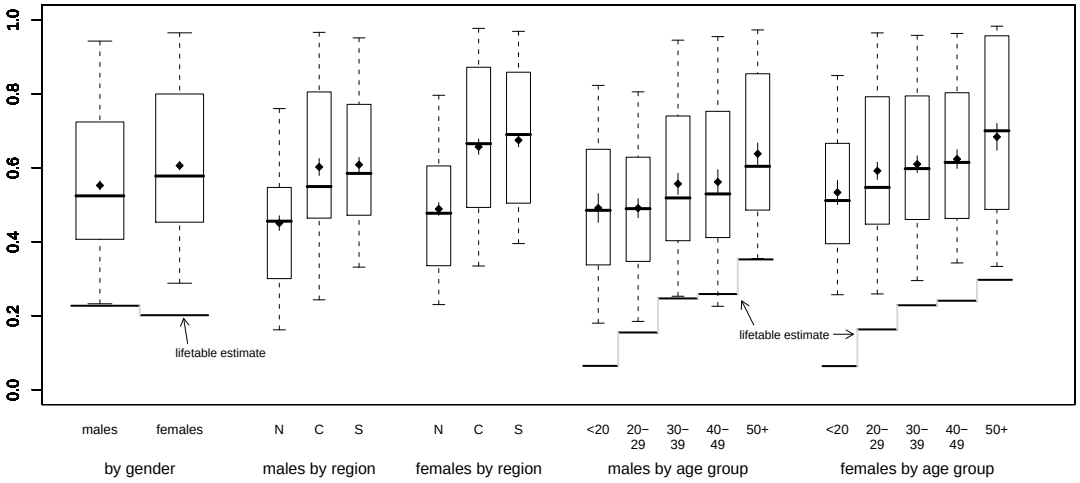
An important characteristic of the reported subjective expectations about mortality is that respondents' expectations agree in broad terms with the actual variation in mortality: the probability of dying increases the longer the time horizon, and the older the respondent. For example, the mean implied probability of dying is 17.9% (men) and 22.0% (women) over a 1-year horizon, and



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



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



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

Figure 8: Respondent's subjective probability of dying within a 1-year, 5-year and 10-year time period, by gender, region and age group

Notes: Region is coded as: N = North (Rumphi), C = Center (Mchinji), S = South (Balaka); lifetable estimates are obtained from United Nations (2007); see Tables A.12– A.15 for data in tabulated form.

it increases to 36.7% (men) and 41.2% (women) for the five year, 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, and for men the increase is 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 have actually greater life expectancies.

The subjective probabilities of dying within one, five and ten years, however, deviate from the observed mortality pattern in an important dimension: both men and women in rural Malawi substantially *overestimate* their mortality risk, and they are much more pessimistic regarding their own survival as is warranted given current estimates of actual mortality rates. Across all ages in the sample, the median perceived 5-year mortality risk exceeds the corresponding lifetable estimate by a factor of 3.2 for males and 4.1 for females, and the median perceived 10-year mortality risk exceeds the lifetable 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, where the median five-year mortality probability reported by 15–19 year old which is 16–17 times greater than the lifetable estimate; for the ten year period, young respondents overestimate the probability of dying by a factor of 7.6–8 (for additional details, see Table A.15). A similar phenomenon has been reported among teens in the US: 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 4 to 5 years was 50 times greater than the statistical estimate.[22] The discrepancy between life table estimates and subjective mortality expectations, however, decreases with age: above age 30, the median subjective probability of dying for men exceeds the corresponding lifetable estimate by a factor of 2.5–2.7 (5 year period) and 1.7–2.1 (10 year period); for women, the overestimation of mortality risk above age 30 is by a factor of 3.2–3.5 (5 year period) and 2.4–2.6 (10 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 a lot of 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 are more optimistic than the life tables (Hurd et al. 2005).

The overestimation of mortality might be an overreaction to the substantial increases in adult mortality that has occurred as a result of the HIV/AIDS epidemic in the last decade in sub-Saharan Africa in general (e.g., Blacker 2004; Urassa et al. 2001; Zaba et al. 2004) and in Malawi in particular (Blacker 2004; Doctor 2001). Zaba et al. (2004), for example, report that in the worst affected countries of Africa, the probability of dying between 15-year old and 60 has risen from a range of 10 to 30% in the mid-1980s, to a range of 30–60% at end of the 1990s. For Malawi, Blacker (2004) report 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 (Grether 1980; Kahneman and Tversky 1982).

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 expectation 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 provides the first large-scale data on of 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 basic properties of probability theory. Moreover, for basically 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. Beliefs about HIV infection 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 higher belief 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 less income and less land feel rightly at more risk of financial distress than people with higher SES, or people who are divorced or widow feel rightly at more risk of being infected with HIV than currently married individuals. The knowledge of differentials in risk is necessary, even though not sufficient, to induce risk-prevention strategies about 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 is important in the decision to adopt risk-reduction strategy. We however find that some of the expectations are not well-calibrated compared to actual probabilities. In particular, mortality expectations are substantially over-estimated compared to life table mortality rates. This overestimation might have important implications for HIV-prevention strategy, since one important cost associated with being infected with HIV is a reduction of life expectancy. This cost may be perceived as smaller than it actually is for individuals whose beliefs about life expectancy are heavily biased downward. Finally, risk-reduction strategies have to be perceived as efficient and acceptable in the population in order to be implemented. The skewed distribution of expectations about condom use with spouse is consistent with the median person being hesitant to use condom within marriage while a small group of innovators are the forerunners in the adoption of this strategy.

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. Our next step will be to investigate how the elicited subjective expectations relate to actual risk behavior.

Acknowledgments: We gratefully acknowledge the support for this research through the National Institute of Child Health and Development (grant numbers RO1 HD044228 and RO1 HD/MH41713), National Institute on Aging (grant number P30 AG12836), the Boettner Center for Pensions and Retirement Security at the University of Pennsylvania, and the National Institute of Child Health and Development Population Research Infrastructure Program (grant number R24 HD-044964), all at the University of Pennsylvania, and the Norwegian Center for Advanced Studies.

Notes

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

[2]This midpoint of the interval in Eq. (1) is equal to the number of beans, X, divided by 10, except for 0 beans, where the midpoint is .025, and 10 beans, where the midpoint is .0975.

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

[4]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).

[5]Source: author's computation ($N = 227$). We use HRS 1992 because respondents were asked to provide a number between 0 and 10, as in the present survey. In later waves, respondents were asked to provide a number between 0 and 100.

[6]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".

[7]The gender difference is statistically significant for the two week period: the mean answer for men and women regarding the two-week period is 7.0 and 6.5 respectively ($t = 5.62$, p-value < 0.001.)

[8]The difference is statistically significant at 5%.

[9]For both the actual number of trips to the market and the number of beans reported for going to the market within 2 days and 2 weeks, we can reject the null-hypothesis that the means for each age category are equal at 5%.

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

[11]The southern region was the hardest hit by the drought, with over 70 percent 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 gaps as early as at the beginning of 2005 (USAID 2005a), and had the highest price of maize at local market of the country in July 2005 (USAID 2005b).

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

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

[14]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%.

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

[16]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.

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

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

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

[20]Note also that about half as many respondents report having extra-marital partners in Rumphi compared to the two other sites.

[21]The calculations are based on United Nations (2007) lifetable estimates for Malawi for 2000–05. The probability of dying for a person aged x to $x + 5$ within a 5-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 5-year age groups, and then combined across all age groups ("overall") or across 10-year age groups using the age structure of the survey respondents.

[22]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.

References

Agbinya, J. (2004). Computer board games of Africa: Algorithms, strategies & rules. Working Paper, University of the Western Cape, South Africa.

Aggleton, P., K. O'Reilly, G. Slutkin, and P. Davies (1994). Risking everything? Risk behavior, behavior change, and AIDS. *Science 265*(5170), 341–345.

Ajzen, I. and M. Fishbein (1980). *Understanding attitudes and predicting social behaviour*. Englewood Cliffs, NJ: Prentice-Hall.

Akwara, P., N. J. Madise, and A. Hinde (2003). Perception of risk of HIV/AIDS and sexual behavior in Kenya. *Journal of Biosocial Science 35*, 385–411.

Anglewicz, P., J. Adams, F. Obare, S. Watkins, and H.-P. Kohler (2007). The Malawi Diffusion and Ideational Change Project 2004–06: Data collection, data quality and analyses of attrition. Unpublished working paper, Population Studies Center, University of Pennsylvania, Philadelphia, PA Available online at http://www.malawi.pop.upenn.edu.

Anglewicz, P. and H.-P. Kohler (2007). Overestimating HIV infection: The construction and accuracy of subjective probabilities of HIV infection in rural Malawi. Paper presented at the 2005 International Union for the Scientific Study of Population Conference in Tours, France.

Attanasio, O., C. Meghir, and M. Vera-Hernánde (2005). Elicitation, validation, and use of probability distributions of future income in developing countries. Unpublished working paper, University College London.

Auld, M. C. (2003). Choices, beliefs, and infectious disease dynamics. *Journal of Health Economics 22*, 361–377.

Bar-Hillel, M. and B. Fischoff (1981). When do base rates affect predictions? *Journal of Personality and Social Psychology 4*, 671–680.

Bicego, G. (1997). Estimating adult mortality rates in the context of the AIDS epidemic in sub-Saharan Africa: Analysis of DHS sibling histories. *Health Transition Review 7*(S2), 7–22.

Blacker, J. (2004). The impact of AIDS on adult mortality: evidence from national and regional statistics. *AIDS 18*(Supplement 2), 19–26.

Bracher, M., G. Santow, and S. C. Watkins (2004). Assessing the potential for condoms to prevent the spread of HIV: A case study from rural Malawi. *Studies in Family Planning 35*(1), 48–64.

Bruine de Bruin, W., B. Fischhoff, S. Millstein, and L. Halpern-Felsher (2000). Verbal and numerical expressions of probability: 'it's a fifty-fifty chance'. *Organizational Behavior and Human Decision Processes 81*, 115–131.

Cerwonka, E. R., T. R. Isbell, and C. E. Hansen (2000). Psychosocial factors as predictors of unsafe sexual practices among young adults. *AIDS Education and Prevention 12*(2), 141–153.

Chimbiri, A. (2007). The condom is an intruder in marriage: evidence from rural Malawi. *Social Science and Medicine 64*(5), 1102–1115.

Delavande, A. (2004). Probabilistic expectations aboutbirth control: Results from a pilot study in Ghana. Unpublished manuscript, Universidade Nova de Lisboa.

Delavande, A. (2005). Pill, patch or shot? Subjective expectations and birth control choice. CEPR Discussion Paper No. 4856 URL: http://ssrn.com/abstract=721595.

Delavande, A. and S. Rohwedder (2006). Differential mortality in Europe and the US: Estimates based on subjective probabilities of survivals and validation. Mimeo, RAND Corporation.

Doctor, H. V. (2001). Decomposing the changes in life expectancy at birth in Malawi between 1966 and 1998. Unpublished working paper, Population Studies Center, University of Pennsylvania, Philadelphia, PA Available online at http://www.malawi.pop.upenn.edu.

Doctor, H. V. and A. A. Weinreb (2003). Estimation of AIDS adult mortality by verbal autopsy in rural Malawi. *AIDS 17*(17), 2509–2513.

Dominitz, J. and C. F. Manski (1996). Eliciting student expectations of the returns to schooling. *Journal of Human Resources 31*(1), 1–26.

Dominitz, J. and C. F. Manski (1997). Using expectations data to study subjective income distribution. *Journal of the American Statistical Association 87*, 855–867.

Dominitz, J. and C. F. Manski (2004). How should we measure consumer confidence? *Journal of Economic Perspectives 18*(2), 51–66.

Dominitz, J. and C. F. Manski (2005). Measuring and interpreting expectations of equity returns. NBER Working Paper No. 11313 Online available at http://www.nber.org.

Dominitz, J. and C. F. Manski (2007). Expected equity returns and portfolio choice: Evidence from the Health and Retirement Study. *Journal of the European Economic Association*, forthcoming.

Edwards, W. (1968). Conservatism in human information processing. In B. Kleinmuntz (Ed.), *Formal Representation of Human Judgment*. New York: Wiley & Sons.

Erdem, T., M. Keane, and J. Strebel (2005). Learning about computers: An analysis of information search and technology choice. *Quantitative Marketing and Economics 3*, 207–247.

Erkut, S. (1983). Exploring sex differences in expectancy, attribution, and academic achievement. *Sex Roles 9*, 217–231.

European Commission (2005). Emergency assistance to the vulnerable groups suffering from food shortages in Malawi. Available online at http://ec.europa.eu/echo/pdf_files/decisions/2005/dec_malawi_01000.pdf, accessed on March 13 2007.

FAO (2007). Mixed prospects for the 2007 cereal crops in southern Africa. FAO/GIEWS Global Watch, online available at http://www.fao.org/giews/english/shortnews/Southern_Africa.pdf, accessed on March 12, 2007.

Fischhoff, B., A. Parker, W. Bruine de Bruin, J. Downs, C. Palmgren, R. Dawes, and C. F. Manski (2000). Teen expectations of significant life events. *Public Opinion Quarterly 64*, 189–205.

Fisher, J. D. and W. A. Fisher (1992). Changing AIDS risk behaviors. *Psychological Bulleton 111*(3), 455–474.

Gouws, E., P. J. White, J. Stover, and T. Brown (2005). Short term estimates of adult HIV incidence by mode of transmission: Kenya and Thailand as examples. *Sexually Transmitted Infections 82*(Supplement 3), 51–55.

Grether, D. M. (1980). Bayes rule as a descriptive model: The representativeness heuristic. *Quarterly Journal of Economics 95*(3), 537–557.

Hill, R. (2006). The role of risk in shaping production decisions: An application to coffee farmers in Uganda. Working Paper, Oxford University.

Hurd, M. and K. McGarry (2002). The predictive validity of subjective probabilities of survival. *Journal of Human Resources 30*, 268–292.

Hurd, M. D. and K. McGarry (1995). Evaluation of the subjective probabilities of survival in the Health and Retirement Study. *Journal of Human Resources 30*, S268–S292.

Hurd, M. D., S. Rohwedder, and J. Winter (2005). IndividualsŠ expectations about longevity: an international comparison. Presentation prepared for the First SHARE-ELSA-HRS User Conference.

Hurd, M. D., J. Smith, and J. Zissimopoulos (2004). The effects of subjective survival on retirement and social security claiming. *Journal of Applied Econometrics 19*, 761–775.

Kahneman, D. and A. Tversky (1982). Subjective probability: A judgement of representativeness. In D. Kahneman, P. Slovic, and A. Tversky (Eds.), *Judgment under Uncertainty: Heuristics and*

Biases. Cambridge: Cambridge University Press.

King, G., C. J. L. Murray, J. A. Salomon, and A. Tandon (2004). Enhancing the validity and cross-cultural comparability of measurement in survey research. *American Political Science Review 98*, 191–207.

Kremer, M. (1996). Interacting behavioral choice and epidemiological models of AIDS. *Quarterly Journal of Economics 111*(2), 549–573.

Lillard, L. and R. Willis (2001). Cognition and wealth: The importance of probabilistic thinking. Michigan Retirement Research Center Working Paper UM00-04.

Lochner, L. (2007). Individual perceptions of the criminal justice system. *American Economic Review 97*, 444–460.

Luseno, W., J. McPeak, C. Barrett, G. Gebru, and P. Little (2003). The value of climate forecast information for pastoralists: Evidence from southern Ethiopia and northern Kenya. *World Development 31*(9), 1477–1494.

Lybbert, T., C. Barrett, J. McPeak, and W. Luseno (2007). Bayesian herders: Asymmetric updating of rainfall beliefs in response to external forecasts. *World Development 35*(3), 480–497.

Malawi DHS (2000). *Malawi Demographic and Health Survey 2000*. Malawi National Statistical Office and ORC Macro, Laverton, Maryland, 2005. Available online at http://www.measuredhs.com.

Malawi DHS (2004). *Malawi Demographic and Health Survey 2004*. Malawi National Statistical Office and ORC Macro, Laverton, Maryland, 2005. Available online at http://www.measuredhs.com.

Manski, C. F. (2004). Measuring expectations. *Econometrica 72*(5), 1329–1376.

McKenzie, D., J. Gibson, and S. Stillman (2006). A land of milk and honey with streets paved with gold: Do emigrants have over-optimistic expectations about incomes abroad? Unpublished working paper, The World Bank.

Miller, K., E. Zulu, and S. C. Watkins (2001). Husband-wife survey responses in Malawi. *Studies in Family Planning 32*(2), 161–174.

Montgomery, M. R. (1998). Learning and lags in mortality perceptions. In M. R. Montgomery and B. Cohen (Eds.), *From Death to Birth: Mortality Decline and Reproductive Change*. Washington, DC: National Academy Press.

Mura, R. (1987). Sex-related differences in expectations of success in undergraduate mathematics. *Journal for Research in Mathematics Education 18*, 15–24.

Nyarko, Y. and A. Schotter (2002). An experimental study of belief learning using elicited beliefs. *Econometrica 70*, 971–1005.

Obare, F. (2006). The effect of non-response on population-based HIV prevalence estimates: The case of rural Malawi. Paper presented at the annual meeting of the Population Association of America, Los Angeles, CA, March 30–April 2, 2006 Available online at http://paa2006.princeton.edu.

Obare, F., P. Fleming, P. Anglewicz, F. Martinson, A. Kapatuka, S. Watkins, and H.-P. Kohler (2007). Hiv incidence and learning one's HIV status: Evidence from repeat population-based voluntary counseling and testing in rural Malawi. Unpublished working paper, Population Studies Center, University of Pennsylvania, Philadelphia, PA.

Oster, E. (2007). HIV and sexual behavior change: Why not Africa. Unpublished working paper, University of Chicago Available online at http://home.uchicago.edu/%7Eeoster.

Philipson, T. J. and R. A. Posner (1993). *Private Choices and Public Health: The AIDS Epidemic in an Economic Perspective*. Cambridge: Harvard University Press.

Pinkerton, S. D., L. I. Wagner-Raphael, C. A. Craun, and P. R. Abramson (2000). A quantitative study of the accuracy of college students' HIV risk estimates. *Journal of Applied Biobehavioral*

Research 5(1), 1–25.

Prata, N., L. Morris, E. Mazive, F. Vahidnia, and M. Stehr (2006). Relationship between HIV risk perception and condom use: Evidence from a population-based survey in Mozambique. *International Family Planning Perspectives 32*(4), 192–200.

Rabin, M. (1998). Psychology and economics. *Journal of Economic Literature 36*(1), 11–46.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press.

Salomon, J. A., A. Tandon, and C. J. L. Murray (2004). Comparability of self rated health: cross sectional multi-country survey using anchoring vignettes. *British Medical Journal 328*, 258–.

Santos, P. and C. Barrett (2006). Heterogeneous wealth dynamics: On the roles of risk and ability. Working Paper, Cornell University.

Tharawan, K., C. Manopaiboon, C. E. Ellertson, K. Limpakarnjanarat, P. H. Kilmarxa, C. Coggins, S. Chaikummao, T. D. Mastro, and C. J. Eliasa (2003). Knowledge and perceptions of HIV among peripartum women and among men whose wives are of reproductive age, northern Thailand. *Contraception 68*(1), 47–53.

UNAIDS (1999). *Sexual Behavioral Change for HIV: Where Have Theories Taken us?* Geneva: United Nations. Available online at http://www.unaids.org.

UNAIDS (2006). *Report on the global HIV/AIDS epidemic*. New York: World Health Organization and UNAIDS. (available online at http://www.unaids.org).

United Nations (2007). *World Population Prospects: The 2006 Revision. Data Sets from the Extended CD-ROM*. New York: United Nations, Population Division, Population Estimates and Projections Section.

Urassa, M., J. T. Boerma, R. Isingo, J. Ngalula, J. Ng'weshemi, G. Mwaluko, and B. Zaba (2001). The impact of HIV/AIDS on mortality and household mobility in rural Tanzania. *AIDS 15*(15), 2017–2023.

USAID (2005a). Malawi food security update—February 2005. Available online at http://www.fews.net/centers/files/Malawi_200501en.pdf, accessed on March 13 2007.

USAID (2005b). Malawi food security update—July 2005. Available online at http://www.fews.net/centers/files/Malawi_200506en.pdf, accessed on March 13 2007.

van de Ruit, C. and M. Vandemoortele (2005). Socio-economic consequences of AIDS: A qualitative study in rural Malawi. Unpublished working paper, University of Pennsylvania, Philadelphia, PA.

Watkins, S., J. R. Behrman, H.-P. Kohler, and E. M. Zulu (2003). Introduction to "Research on demographic aspects of HIV/AIDS in rural Africa". *Demographic Research Special Collection 1*(1), 1–30. Available online at http://www.demographic-research.org.

Weinreb, A. A. (2006). Substitution and substitutability: The effects of kin availability on intergenerational transfers in Malawi. In A. H. Gauthier, C. Chu, and S. Tuljapurkar (Eds.), *Riding The Age Waves: The Distribution of Resources Across Generations*, pp. forthcoming. Berlin: Springer Verlag.

Zaba, B., A. Whiteside, and J. T. Boerma (2004). Demographic and socioeconomic impact of AIDS: taking stock of the empirical evidence. *AIDS 18*(Supplement 2), S1–S7.

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 bins, 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 not 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

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

		# of beans		implied subjective probability						
						Percentiles				
	N	mean	SE	mean	SE	10th	25th	50th	75th	90th
Males	1,498	6.16	0.08	0.61	0.008	0.15	0.43	0.60	0.94	0.98
Females	1,740	4.35	0.07	0.44	0.007	0.03	0.16	0.45	0.64	0.95
Males, by region										
North	499	5.90	0.14	0.59	0.014	0.11	0.38	0.58	0.89	0.98
Center	459	6.64	0.14	0.66	0.014	0.21	0.47	0.70	0.96	0.98
South	482	6.09	0.14	0.60	0.013	0.17	0.45	0.57	0.92	0.98
Females, by region										
North	590	3.43	0.12	0.35	0.012	0.02	0.07	0.29	0.53	0.81
Center	548	4.61	0.14	0.46	0.013	0.04	0.19	0.47	0.69	0.96
South	592	5.05	0.12	0.5	0.012	0.08	0.29	0.5	0.71	0.96
Males, by age group										
< 20	141	5.85	0.25	0.58	0.024	0.16	0.41	0.53	0.86	0.97
20–29	304	6.60	0.17	0.65	0.017	0.23	0.46	0.65	0.96	0.98
30–39	267	6.69	0.18	0.66	0.017	0.22	0.48	0.69	0.95	0.98
40–49	221	5.91	0.22	0.59	0.021	0.05	0.41	0.58	0.88	0.98
50+	260	5.48	0.20	0.55	0.020	0.05	0.33	0.53	0.84	0.98
Females, by age group										
< 20	174	4.19	0.23	0.42	0.022	0.03	0.18	0.43	0.58	0.90
20–29	451	4.55	0.14	0.46	0.014	0.04	0.19	0.47	0.66	0.95
30–39	415	4.51	0.16	0.45	0.015	0.03	0.19	0.46	0.67	0.96
40–49	320	4.12	0.18	0.41	0.017	0.03	0.12	0.41	0.64	0.92
50+	197	4.24	0.23	0.43	0.022	0.03	0.14	0.45	0.65	0.92

Table A.2: 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	.15	.16
-3	3	.09	.25
-2	4	.12	.37
-1	7	.22	.59
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	66	2.1	100
Total	3,222	100	

Table A.3: 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	0.18	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	0.13	0.14	0.14	0.13	1.00					
(7)	Being infected with HIV	0.02	0.03	0.05	0.11	0.02	0.13	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	0.26	0.03	0.06	0.09	0.02	0.28	1.00		
(10)	1-year mortality	0.03	0.04	0.02	0.22	0.13	0.25	0.25	0.07	0.01	1.00	
(11)	5-year mortality	0.03	0.05	0.04	0.24	0.12	0.24	0.28	0.08	- 0.01	0.79	1.00
(12)	10-year mortality	0.02	0.03	0.03	0.23	0.09	0.21	0.28	0.08	- 0.02	0.65	0.86

Table A.4: Respondent's subjective probability of being infected with HIV now, by gender, region, and age group

		# of beans		implied subjective probability						
						Percentiles				
	N	mean	SE	mean	SE	10th	25th	50th	75th	90th
Males	1,499	0.79	0.04	0.10	0.004	0.01	0.02	0.03	0.07	0.29
Females	1,729	1.30	0.05	0.14	0.005	0.01	0.02	0.04	0.19	0.47
Males, by region										
North	499	0.63	0.08	0.08	0.008	0.01	0.02	0.03	0.05	0.19
Center	459	0.98	0.09	0.12	0.008	0.01	0.02	0.04	0.12	0.41
South	483	0.70	0.06	0.09	0.006	0.01	0.02	0.03	0.08	0.27
Females, by region										
North	587	0.93	0.08	0.11	0.008	0.01	0.02	0.04	0.11	0.32
Center	546	1.58	0.11	0.17	0.010	0.01	0.02	0.04	0.24	0.52
South	587	1.41	0.08	0.15	0.008	0.01	0.02	0.05	0.25	0.47
Males, by age group										
< 20	142	0.51	0.10	0.07	0.009	0.01	0.02	0.03	0.05	0.22
20–29	304	0.85	0.11	0.10	0.010	0.01	0.02	0.03	0.07	0.34
30–39	267	0.84	0.11	0.10	0.011	0.01	0.02	0.03	0.07	0.29
40–49	221	0.86	0.13	0.10	0.012	0.01	0.02	0.03	0.08	0.28
50+	260	0.58	0.09	0.08	0.008	0.01	0.02	0.03	0.05	0.22
Females, by age group										
< 20	174	0.83	0.13	0.10	0.012	0.01	0.02	0.04	0.10	0.31
20–29	449	1.37	0.10	0.15	0.010	0.01	0.02	0.04	0.21	0.48
30–39	413	1.53	0.12	0.17	0.011	0.01	0.02	0.04	0.26	0.50
40–49	317	1.25	0.12	0.14	0.011	0.01	0.02	0.04	0.19	0.48
50+	195	1.19	0.16	0.13	0.015	0.01	0.02	0.04	0.15	0.47

Table A.5: Distribution of women's subjective probability being infected with HIV now, by education, marital status and number of partners and HIV status/knowledge

		# of beans		implied subjective probability						
						Percentiles				
	N	mean	SE	mean	SE	10th	25th	50th	75th	90th
Overall	1,729	1.30	0.05	0.14	0.005	0.01	0.02	0.04	0.19	0.47
By education										
low education	456	1.35	0.10	0.15	0.009	0.01	0.02	0.04	0.23	0.47
medium education	1,103	1.33	0.07	0.15	0.006	0.01	0.02	0.04	0.19	0.49
high education	168	0.97	0.15	0.11	0.014	0.01	0.02	0.04	0.13	0.31
By marital status										
married	1,420	1.31	0.06	0.15	0.006	0.01	0.02	0.04	0.20	0.48
div./separ./widow'd	199	1.57	0.17	0.17	0.016	0.01	0.02	0.04	0.25	0.49
never married	108	0.59	0.11	0.08	0.011	0.01	0.02	0.03	0.08	0.22
By number of partners										
0	56	0.41	0.13	0.06	0.012	0.01	0.02	0.03	0.05	0.19
1	737	0.95	0.07	0.11	0.007	0.01	0.02	0.04	0.10	0.36
2	537	1.33	0.09	0.15	0.008	0.01	0.02	0.05	0.21	0.47
3	238	1.74	0.16	0.19	0.015	0.01	0.02	0.05	0.30	0.51
4+	158	2.47	0.23	0.26	0.023	0.01	0.03	0.15	0.39	0.75
By ever tested for HIV										
no	652	1.44	0.09	0.16	0.008	0.01	0.02	0.04	0.22	0.49
yes, learned result	959	1.13	0.07	0.13	0.006	0.01	0.02	0.04	0.16	0.43
yes, did not learn result	109	1.88	0.23	0.20	0.022	0.01	0.03	0.09	0.33	0.52
By HIV status										
negative	1,315	1.20	0.06	0.14	0.005	0.01	0.02	0.04	0.18	0.46
positive	92	2.73	0.34	0.28	0.033	0.01	0.03	0.16	0.41	0.96
no test	115	1.48	0.20	0.16	0.019	0.01	0.03	0.05	0.24	0.48

Table A.6: Distribution of men's subjective probability being infected with HIV now, by education, marital status and number of partners and HIV status/knowledge

		# of beans		implied subjective probability						
						Percentiles				
	N	mean	SE	mean	SE	10th	25th	50th	75th	90th
Overall	1,499	0.79	0.04	0.10	0.004	0.01	0.02	0.03	0.07	0.29
By education										
low education	193	0.77	0.11	0.09	0.010	0.01	0.02	0.04	0.10	0.29
medium education	1,003	0.80	0.06	0.10	0.005	0.01	0.02	0.03	0.07	0.28
high education	300	0.77	0.11	0.10	0.010	0.01	0.02	0.03	0.05	0.32
By marital status										
married	1,191	0.80	0.05	0.10	0.005	0.01	0.02	0.03	0.07	0.28
div./separ./widow'd	36	1.56	0.39	0.17	0.037	0.01	0.02	0.04	0.30	0.49
never married	271	0.64	0.09	0.08	0.008	0.01	0.02	0.03	0.05	0.27
By number of partners										
0	64	0.30	0.10	0.05	0.009	0.01	0.02	0.03	0.05	0.12
1	265	0.31	0.07	0.05	0.006	0.01	0.01	0.03	0.04	0.10
2	333	0.58	0.08	0.08	0.007	0.01	0.02	0.03	0.05	0.22
3	262	1.01	0.12	0.12	0.012	0.01	0.02	0.04	0.12	0.38
4+	573	1.08	0.08	0.12	0.008	0.01	0.02	0.04	0.15	0.39
By ever tested for HIV										
no	568	0.99	0.08	0.12	0.007	0.01	0.02	0.04	0.13	0.38
yes, learned result	867	0.63	0.06	0.08	0.005	0.01	0.02	0.03	0.05	0.23
yes, did not learn result	54	1.11	0.26	0.13	0.025	0.01	0.02	0.04	0.16	0.41
By HIV status										
negative	1,084	0.74	0.05	0.09	0.005	0.01	0.02	0.03	0.06	0.27
positive	44	2.05	0.44	0.22	0.042	0.01	0.03	0.05	0.32	0.61
no test	98	0.42	0.10	0.06	0.009	0.01	0.02	0.03	0.05	0.20

Table A.7: 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	0.040	0.099
	(0.147)	(0.148)
30–39	-0.166	-0.134
	(0.151)	(0.152)
40–49	-0.326*	-0.240
	(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**	6.355**
	(0.162)	(0.176)
N	2,720	2,720
R^2	0.149	0.144

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

Table A.8: Linear regression of subjective likelihood (measured in terms of number of beans) of food shortage and having to rely on family members on indicators of socioeconomic status; ever-married respondents only

	Likelihood of experiencing food shortage within next 12 months (response in terms of number of beans)					Likelihood of having to rely on family members for financial assistance within next 12 months (response in terms of number of beans)				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
constant	6.145**	4.438**	5.115**	4.764**	4.284**	6.111**	5.783**	5.989**	5.690**	6.131**
	(0.326)	(0.286)	(0.298)	(0.297)	(0.355)	(0.367)	(0.323)	(0.332)	(0.326)	(0.375)
Age (reference category: < 20 years old)										
20–29	-0.290	-0.206	-0.194	-0.258	-0.558^{+}	0.820*	0.844**	0.802*	0.853**	0.784*
	(0.290)	(0.292)	(0.300)	(0.298)	(0.319)	(0.324)	(0.323)	(0.325)	(0.323)	(0.326)
30–39	-0.628*	-0.357	-0.173	-0.417	-1.014**	0.705*	0.754*	0.753*	0.755*	0.713*
	(0.288)	(0.289)	(0.298)	(0.296)	(0.321)	(0.325)	(0.323)	(0.326)	(0.323)	(0.328)
40–49	-0.751*	-0.262	-0.006	-0.320	-1.188**	0.131	0.211	0.215	0.224	0.160
	(0.294)	(0.294)	(0.304)	(0.301)	(0.328)	(0.334)	(0.331)	(0.334)	(0.331)	(0.338)
50+	-0.461	0.047	0.339	0.004	-0.445	-0.105	0.000	0.017	0.015	-0.054
	(0.304)	(0.304)	(0.313)	(0.310)	(0.340)	(0.345)	(0.340)	(0.344)	(0.341)	(0.349)
Female	0.309*	0.650**	0.559**	0.639**	0.933**	-1.995**	-1.924**	-1.957**	-1.895**	-1.956**
	(0.132)	(0.131)	(0.129)	(0.132)	(0.126)	(0.142)	(0.136)	(0.136)	(0.135)	(0.144)
Education (reference category: low education)										
medium	-1.259**				-0.876**	-0.302^{+}				-0.236
	(0.149)				(0.159)	(0.159)				(0.165)
high	-2.631**				-1.593**	-0.316				-0.259
	(0.221)				(0.220)	(0.243)				(0.252)
Marital status (reference category: currently married)										
divorced/separated		0.873**			0.913**		-0.036			-0.104
widowed		(0.201)			(0.222)		(0.213)			(0.214)
Land ownership (reference category: $\leq$ 2 acres)										
2–4 acres			-0.989**		-0.042			-0.383*		-0.350*
			(0.140)		(0.142)			(0.151)		(0.154)
> 4 acres			-1.579**		-0.359*			-0.246		-0.217
			(0.159)		(0.153)			(0.166)		(0.174)
Resp. has savings				-0.799**	-0.077				0.269^{+}	0.306*
account				(0.149)	(0.134)				(0.149)	(0.151)

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

Table A.9: Linear regression of the likelihood of having to rely on financial assistance on likelihood of experiencing food shortage; ever-married respondents only

	Likelihood of having to rely on family members for financial assistance within next 12 months (response in terms of number of beans)				
	Model 1	Model 2	Model 3	Model 4	Model 5
Likelihood of food shortage within 12 months (response in terms of number of beans)	0.272**	0.250**	0.244**	0.244**	0.245**
	(0.020)	(0.020)	(0.020)	(0.021)	(0.021)
Age (reference category: < 20 years old)					
20–29	-0.553^{+}	-0.590^{+}	-0.562^{+}	-0.507^{+}	-0.505^{+}
	(0.311)	(0.308)	(0.306)	(0.305)	(0.305)
30–39	-0.889**	-1.008**	-0.978**	-0.904**	-0.900**
	(0.311)	(0.308)	(0.306)	(0.307)	(0.307)
40–49	-0.956**	-1.165**	-1.150**	-1.085**	-1.073**
	(0.314)	(0.313)	(0.311)	(0.313)	(0.313)
50+	-0.243	-0.459	-0.459	-0.390	-0.383
	(0.324)	(0.324)	(0.322)	(0.325)	(0.325)
Female	1.144**	0.983**	0.908**	0.897**	0.907**
	(0.117)	(0.122)	(0.122)	(0.122)	(0.123)
Education (reference category: low education)					
medium		-0.626**	-0.617**	-0.610**	-0.613**
		(0.150)	(0.150)	(0.156)	(0.156)
high		-1.036**	-1.051**	-1.061**	-1.070**
		(0.212)	(0.211)	(0.217)	(0.217)
Marital status (reference category: currently married)					
divorced/separated			0.740**	0.741**	0.738**
widowed			(0.219)	(0.221)	(0.221)
Land ownership (reference category: $\leq$ 2 acres)					
2–4 acres				0.140	0.135
				(0.139)	(0.139)
> 4 acres				-0.087	-0.098
				(0.146)	(0.147)
Resp. has savings					0.079
					(0.127)
constant	1.961**	2.821**	2.802**	2.716**	2.691**
	(0.314)	(0.359)	(0.359)	(0.358)	(0.361)

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

Table A.10: 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 12 months (response in terms of number of beans)	0.220	0.020	0.000
Age (reference category: < 20 years old)			
20–29	-0.999	0.236	0.000
30–39	-1.353	0.257	0.000
40–49	-1.515	0.263	0.000
50+	-0.815	0.278	0.003
Female	0.913	0.119	0.000
Education (reference category: low education)			
medium	-0.674	0.154	0.000
high	-1.004	0.213	0.000
Marital status (reference category: currently married)			
divorced/separated/ widowed	0.754	0.220	0.001
never married	2.628	0.239	0.000
Land ownership (reference category: $\leq$ 2 acres)			
2–4 acres	0.246	0.133	0.066
> 4 acres	-0.094	0.143	0.508
Resp. has savings	0.042	0.123	0.734
constant	3.248	0.321	0.000
N	2,699		
R^2	0.203		

Table A.11: Subjective probability of using condom at next sexual encounter with someone other than spouse by characteristics

		# of beans		implied subjective probability				
						Percentiles		
	N	mean	SE	mean	SE	25th	50th	75th
Condom use with most recent extra-marital sexual encounter								
never	174	6.88	0.25	0.68	0.024	0.49	0.79	0.97
sometimes/at beginning	53	7.57	0.38	0.75	0.036	0.54	0.83	0.97
almost every time/ every time	52	8.62	0.29	0.85	0.028	0.73	0.96	0.98

Table A.12: Respondent's subjective probability of dying within a 1-year time period, by gender, region and age group

		# of beans		implied subjective probability						
						Percentiles				
	N	mean	SE	mean	SE	10th	25th	50th	75th	90th
Males	1,479	1.71	0.05	0.18	0.005	0.01	0.04	0.12	0.26	0.48
Females	1,712	2.14	0.05	0.22	0.005	0.02	0.05	0.16	0.34	0.51
Males, by region										
North	491	1.14	0.07	0.12	0.007	0.01	0.03	0.07	0.15	0.33
Center	451	1.82	0.09	0.19	0.009	0.01	0.04	0.12	0.30	0.49
South	479	2.16	0.09	0.22	0.009	0.02	0.05	0.18	0.34	0.50
Females, by region										
North	579	1.34	0.07	0.14	0.007	0.01	0.04	0.09	0.18	0.35
Center	537	2.36	0.10	0.24	0.009	0.02	0.05	0.19	0.39	0.52
South	586	2.72	0.08	0.28	0.008	0.03	0.11	0.25	0.46	0.52
Males, by age group										
< 20	140	1.52	0.16	0.16	0.015	0.01	0.03	0.09	0.22	0.45
20–29	297	1.48	0.11	0.16	0.010	0.01	0.03	0.08	0.22	0.46
30–39	266	1.63	0.12	0.17	0.011	0.01	0.04	0.11	0.23	0.47
40–49	219	1.64	0.13	0.17	0.013	0.01	0.03	0.10	0.24	0.49
50+	256	2.16	0.12	0.22	0.012	0.02	0.06	0.17	0.35	0.50
Females, by age group										
< 20	171	1.65	0.13	0.17	0.013	0.02	0.04	0.12	0.26	0.45
20–29	444	2.06	0.10	0.21	0.010	0.02	0.04	0.15	0.33	0.51
30–39	407	2.15	0.10	0.22	0.010	0.02	0.06	0.16	0.33	0.51
40–49	317	2.11	0.10	0.22	0.010	0.02	0.07	0.18	0.33	0.49
50+	190	2.94	0.19	0.30	0.019	0.02	0.06	0.23	0.48	0.59

Table A.13: Respondent's subjective probability of dying within a 5-year time period, by gender, region and age group

		# of beans		implied subjective probability						
						Percentiles				
	N	mean	SE	mean	SE	10th	25th	50th	75th	90th
Males	1,480	3.66	0.06	0.37	0.006	0.07	0.20	0.35	0.51	0.67
Females	1,711	4.12	0.06	0.41	0.006	0.12	0.23	0.40	0.54	0.73
Males, by region										
North	489	2.74	0.09	0.28	0.009	0.04	0.14	0.24	0.38	0.54
Center	455	4.08	0.11	0.41	0.011	0.06	0.24	0.42	0.53	0.74
South	478	4.19	0.10	0.42	0.009	0.15	0.26	0.42	0.54	0.70
Females, by region										
North	579	3.04	0.08	0.31	0.008	0.08	0.17	0.27	0.42	0.54
Center	537	4.55	0.11	0.45	0.011	0.13	0.28	0.46	0.58	0.81
South	585	4.79	0.09	0.48	0.009	0.19	0.32	0.49	0.63	0.76
Males, by age group										
< 20	140	3.33	0.19	0.33	0.018	0.08	0.18	0.30	0.47	0.62
20–29	296	3.12	0.13	0.32	0.012	0.04	0.16	0.28	0.46	0.61
30–39	267	3.67	0.14	0.37	0.014	0.08	0.20	0.34	0.51	0.67
40–49	218	3.63	0.16	0.36	0.016	0.05	0.20	0.33	0.50	0.68
50+	257	4.44	0.14	0.44	0.014	0.17	0.28	0.44	0.55	0.76
Females, by age group										
< 20	171	3.46	0.16	0.35	0.015	0.09	0.20	0.32	0.49	0.61
20–29	445	4.04	0.12	0.40	0.011	0.10	0.22	0.38	0.54	0.74
30–39	405	4.13	0.12	0.41	0.011	0.12	0.23	0.42	0.54	0.72
40–49	317	4.19	0.12	0.42	0.011	0.16	0.27	0.43	0.54	0.70
50+	190	5.00	0.20	0.50	0.020	0.15	0.29	0.48	0.68	0.96

Table A.14: Respondent's subjective probability of dying within a 10-year time period, by gender, region and age group

		# of beans		implied subjective probability						
						Percentiles				
	N	mean	SE	mean	SE	10th	25th	50th	75th	90th
Males	1,479	5.54	0.06	0.55	0.006	0.23	0.41	0.52	0.72	0.94
Females	1,710	6.09	0.06	0.61	0.006	0.29	0.45	0.58	0.80	0.96
Males, by region										
North	489	4.51	0.10	0.45	0.010	0.16	0.30	0.46	0.55	0.76
Center	454	6.06	0.12	0.60	0.012	0.24	0.46	0.55	0.81	0.97
South	478	6.10	0.10	0.61	0.010	0.33	0.47	0.58	0.77	0.95
Females, by region										
North	579	4.90	0.09	0.49	0.009	0.23	0.34	0.48	0.61	0.80
Center	536	6.62	0.11	0.66	0.011	0.34	0.49	0.67	0.87	0.98
South	585	6.78	0.09	0.67	0.009	0.40	0.50	0.69	0.86	0.97
Males, by age group										
< 20	140	4.91	0.20	0.49	0.020	0.18	0.34	0.49	0.65	0.82
20–29	296	4.91	0.13	0.49	0.013	0.18	0.35	0.49	0.63	0.81
30–39	266	5.59	0.15	0.56	0.015	0.25	0.40	0.52	0.74	0.95
40–49	218	5.64	0.17	0.56	0.017	0.23	0.41	0.53	0.75	0.95
50+	257	6.42	0.15	0.64	0.015	0.35	0.49	0.60	0.85	0.97
Females, by age group										
< 20	171	5.35	0.17	0.53	0.017	0.26	0.39	0.51	0.67	0.85
20–29	445	5.95	0.12	0.59	0.012	0.26	0.45	0.55	0.79	0.96
30–39	404	6.13	0.12	0.61	0.012	0.29	0.46	0.60	0.79	0.96
40–49	317	6.26	0.13	0.62	0.013	0.34	0.46	0.61	0.80	0.96
50+	190	6.91	0.19	0.68	0.019	0.33	0.49	0.70	0.96	0.98

Table A.15: Lifetable estimates of probability of dying within 5 and 10 years

	Lifetable estimates for probabiltiy of dying				Ratio of median subjective probability to lifetable estimate			
	Males		Females		Males		Females	
Time period:	5 yrs	10 yrs	5 yrs	10 yrs	5 yrs	10 yrs	5 yrs	10 yrs
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: Lifetable estimates are based on the United Nations (2007) lifetable for Malawi for 2000–05. The probability of dying for a person aged x to $x+5$ within a 5-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 5-year age groups, and then combined across all age groups ("overall") or across 10-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 Tables A.13–A.14.