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Kazushi Takahashi*, Munenobu Ikegami ,
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Keywords: Index-Based Livestock Insurance, Quasi-Experiment, Uptake, Ethiopia
JEL classification: D12, G22, O12

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* Development Studies Center, IDE (kazushi_takahashi@ide.go.jp)

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INSTITUTE OF DEVELOPING ECONOMIES (IDE), JETRO
3-2-2, WAKABA, MIHAMA-KU, CHIBA-SHI
CHIBA 261-8545, JAPAN

Quasi-Experimental Evidence on the Drivers of Index-Based Livestock Insurance Demand in Southern Ethiopia

Kazushi Takahashi [a], Munenobu Ikegami [b], Megan Sheahan [c], Christopher B. Barrett [c]

[a] *Institute of Developing Economies-Japan External Trade Organization (IDE-JETRO)*
[b] *International Livestock Research Institute (ILRI)*
[c] *Charles H. Dyson School of Applied Economics and Management, Cornell University*

Abstract:
Microinsurance is widely considered an important tool for sustainable poverty reduction, especially in the face of increasing climate risk. Although index-based microinsurance, which should be free from the classical incentive problems, has attracted considerable attention, uptake rates have generally been weak in low-income rural communities. We explore the purchase patterns of index-based livestock insurance in southern Ethiopia, focusing in particular on the role of accurate product comprehension and price, including the prospective impact of temporary discount coupons on subsequent period demand due to price anchoring effects. We find that randomly distributed learning kits contribute to improving subjects' knowledge of the products; however, we do not find strong evidence that the improved knowledge *per se* induces greater uptake. We also find that reduced price due to randomly distributed discount coupons has an immediate, positive impact on uptake, without dampening subsequent period demand due to reference-dependence associated with price anchoring effects.

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1. Introduction

Climate risks, such as drought, flood, typhoon, and increased variability in weather conditions between seasons, threaten many rural households' livelihoods in developing countries and are widely expected to grow more frequent with climate change. Access to formal insurance services may help build resilience to such risk and protect households' longer-run welfare in the event of climate shocks by providing compensation for income and asset losses. Formal insurance, however, has remained underdeveloped in most poor, rural regions due to classic incentive problems associated with asymmetric information, such as moral hazard and adverse selection, as well as the high transaction costs involved in preventing opportunistic behavior by insurees. Available self-insurance options to smooth consumption, including *ex ante* risk mitigation toward more stable but lower return activities and *ex post* risk coping by selling productive assets in the face of downside shocks, are often costly, jeopardizing long-term household welfare (Morduch, 1995; Rosenzweig & Wolpin, 1993). Given limited and inadequate self-insurance options, vulnerable rural households have developed mutual assistance mechanisms within their communities, which can partly, albeit not fully, help recover from losses due to idiosyncratic shocks (Dercon & Krishnan, 2000; Townsend, 1994; Udry, 1994). It is, however, well known that such informal risk sharing mechanisms do not function effectively under covariate, catastrophic natural disasters, where all neighboring community members suffer substantial losses (Barrett, 2011). Protecting the rural poor from such covariate climate risks has been a major challenge to achieving sustainable rural poverty reduction.

As a result, microinsurance – small-scale insurance products aimed at low income people who are generally excluded from more traditional insurance markets –

has attracted widespread interest as a means to enhancing the resilience of the rural poor against covariate climate risks (Churchill, 2006; de Bock & Gelade, 2012; Mechler, Linnerooth-Bayer, & Peppiatt, 2006). In particular, recently introduced index-based weather insurance has elicited considerable attention, especially since it is free from information asymmetry problems (Barnett, Barrett, & Skees, 2008). Index insurance indemnity payouts are determined based not on actual losses experienced by policy holders, but on easily observable, objective weather or environmental parameters—such as rainfall, temperature, or remotely sensed estimates of vegetation levels—that are highly correlated with losses. This allows insurers to avoid both the moral hazard and adverse selection problems associated with indemnification of losses specific to the insured as well as the significant transaction costs associated with monitoring the behavior and verifying the losses of the insured. While basis risk (i.e., the discrepancy between realized loss and indemnity payouts predicted by the index) remains a potential threat to policy holders (Jensen, Mude, & Barrett, 2014a, 2014b), index products offer at least partial insurance against otherwise-uninsured climate risks. Index-based weather insurance has therefore excited considerable interest as a prospective remedy for hitherto-unmet demand for mitigating covariate weather risks in rural areas of developing countries.

Despite sweeping claims that index-based microinsurance would be the next “revolution” in development practice (Morduch, 2006), the empirical evidence to date shows that unexpectedly low uptake, rarely above 30 percent of the intended population, causing many to rethink the attractiveness of the product or to suggest ways to improve it (de Bock & Gelade, 2012; Matul, Dalal, de Bock, & Gelade, 2013; Miranda & Farrin 2012). For example, Binswanger-Mkhize (2012) argued that higher income farmers are already self-insuring against risk by diversifying their income portfolio, while lower income farmers and landless laborers who are more likely to gain from index-based insurance cannot afford it. Breustedt, Bokusheva, & Heidelbac (2008) claimed that index-based insurance schemes did not provide statistically significant risk reduction for wheat farmers in Kazakhstan, which lowered product uptake. Leblois, Quirion, Alhassane, & Traoré (2014) modelled the *ex ante* expected utility benefits risk averse millet farmers in India might enjoy from purchasing index insurance and found minimal gains from insurance uptake, especially relative to the costs. Price and liquidity constraints are often identified as important factors suppressing demand (Cole et al., 2013; Gine, Townsend, & Vickery, 2008; Karlan, Osei, Osei-Akoto, & Udry, 2014). McIntosh, Sarris, & Papadopoulos (2013) found high uptake among households randomly allocated vouchers that reduced the cost of the product. Also, sufficient knowledge of the somewhat esoteric product, especially where no other insurance products are sold, may hold back potential policy holders (Skees 2008) and, conversely, better knowledge of the product increases observed uptake (Cai, de Janvry, & Sadoulet, 2013; Cai & Song, 2013; Gaurav, Cole, & Tobacman, 2011).

Most existing studies are rooted in the experience of crop insurance programs that insure against income loss from yield fluctuations and do not focus on the small number of index-based asset insurance, such as livestock insurance, programs that have emerged in the recent past (Chantarat, Mude, Barrett, & Carter, 2013; Janzen & Carter, 2013; McPeak. Chantarat, & Mude, 2010). To the extent that the livelihood systems, risk mitigation strategies, and the long term welfare outcomes associated with shocks differ between crop-based and pastoral-based production systems, we would expect the demand for and benefits of index-based insurance to similarly diverge. For example, where households derive their income primarily from crops, durable household assets will likely serve as the household's main store of wealth. While those assets may be drawn down in times of low income, the opportunity to recover crop income levels in subsequent periods is typically unaffected by a temporary shock like a drought. By contrast, households that derive their income primarily from livestock can suffer a permanent loss of expected income from a temporary shock (Chantarat et al., 2013; McPeak 2004). We might therefore expect demand for index-based livestock insurance (IBLI) to exceed that for index-based crop insurance.

Analysis of demand for IBLI is just now emerging from products piloted in northern Kenya (Jensen et al., 2014a, 2014b), Ethiopia (Bageant, 2014), and Mongolia (Mahul & Skees, 2007). This paper adds to this growing literature using the experience of a new IBLI product introduced in pastoral southern Ethiopia in 2012. We use two waves of panel data, a baseline and a follow-up round between which respondent households had two (semi-annual) opportunities to purchase an IBLI policy. The IBLI product under investigation insures pastoralists against livestock mortality that often follows from catastrophic drought. Because severe forage scarcity is common during drought, IBLI is paired with satellite data that tracks local forage conditions, which are strongly correlated with area-average livestock losses. When those conditions become sufficiently adverse, it triggers indemnity payments. Over the course of each IBLI sales period, we introduced two kinds of randomized encouragement designs aimed at improving pastoralists' understandings of IBLI (via "learning kits" featuring comics and audio tapes of skits made by local performers) and their ability to pay (via discount coupons). These experimental interventions were intended both to create incentives for IBLI uptake and to provide credible exogenous variation to identify demand patterns.

Our data reveal that uptake rate of IBLI approaches 30 percent in the initial year of product offer, exceeding that of most other index-based insurance products in their pilot periods. Estimation results indicate that the reduced price of the insurance through the provision of discount coupons significantly increases the uptake of IBLI. While there is a potential threat that a one-time price reduction serves as a price reference, which decreases demand in subsequent periods (Dupas, 2014; Fischer, McConnell, Karlan, & Raffler, 2014), we find no evidence of such anchor effects. On the other hand, while the learning kits do boost accurate knowledge of the product, better knowledge does not appear to increase uptake of IBLI.

The remainder of this paper is structured as follows. Section 2 explains the study site, sampling framework, and detailed designs of the IBLI product and quasi-experiments. Section 3 discusses descriptive statistics. Section 4 explains our estimation strategy, followed by discussion of estimation results in Section 5. Section 6 concludes.

2. Data

2.1. Study area

Our study area is located on the Borana plateau in Oromia regional state[1] of southern Ethiopia (Figure 1). Most of the population is pastoralist, whose livelihoods depend primarily on livestock. The region is comprised of arid and semi-arid ecological zones with four seasons: a long rainy season (March to May); a long dry season (June to September); a short rainy season (October to November); and a short dry season

[1] The largest Ethiopian administrative unit is the regional state, which is subdivided into zones, then into woredas, and further into kebeles, and finally into reeras.

(December to February). Herd migration in search of forage and water during the two dry seasons is common among pastoralists in this area.

==Figure 1. here ==

The sustainability of pastoralism as a livelihood in Borena has been, however, significantly undermined due to recurrent drought, violent conflicts, and other political and economic instability (Desta, Berhanu, Gebru, & Amosha, 2008; Tache, 2008). Among these, drought is by far the greatest cause of livestock mortality in our study area (Barrett & Santos, 2014; Lybbert, Barrett, Desta, & Coppock, 2004). Major droughts occurred almost every six or seven years between the mid-1970s and 2012 (i.e., 1973/74, 1983/84, 1991/92, 1999/00, 2005/06, and 2011/12), each causing massive numbers of livestock deaths (Desta et al., 2008; Megeresa, Markemann, Angassa, & Zárate, 2013). There exists a range of customary insurance arrangements, like *debare* and *busa gonofa*, that provide informal inter-household transfers in the form of cash or livestock. Yet many times the livelihoods of the entire community are threatened during drought, rendering traditional risk sharing arrangements weak and insufficient. Moreover these informal arrangements tend to cover only a small portion of household losses, usually exclude the persistently poor who need it the most, and are generally perceived to be in decline (Huysentruyt, Barrett, & McPeak, 2009; Lybbert et al., 2004; Santos & Barrett, 2011). In this setting, the demand for insurance that protects the pastoral population against drought-induced livestock losses should, therefore, be relatively substantial.

2.2. Design of IBLI

To help pastoralists manage the considerable drought-related mortality risk, IBLI was introduced by the International Livestock Research Institute (ILRI) and Cornell University in collaboration with the Oromia Insurance Company (OIC) in August 2012. The basic product design is similar to a previously designed IBLI product in northern Kenya that was rolled out in January 2010. As in northern Kenya, the standardized Normalized Differenced Vegetation Index (NDVI), a numerical indicator of the degree of greenness based on remotely sensed data collected by satellites, accumulated over one rainy season and the following dry season was used to construct an index (Chantarat et al., 2012; Mude et al., 2012). This index was calibrated for high correlation with average livestock mortality from drought at the woreda level. Indemnity payouts are triggered when the index falls below the 15th percentile of the historical index distribution from 1981-2012.

==Figure 2. here ==

IBLI is marketed and sold during two periods per year, directly preceding each rainy season (August-September and January-February), with coverage lasting one year and the potential for two indemnity payouts, one after each dry season (Figure 2). During each sales period, a household decides whether to buy IBLI and, if so, how many animals to insure. A premium payment is equal to the calculated total insured herd value (TIHV)[2] multiplied by a woreda specific insurance premium rate given spatial differences in expected mortality risk.[3] More precisely,

$$TIHV = (\text{\# of camel insured}) * 15{,}000 + (\text{\# of cows insured}) * 5{,}000 +$$

[2] These nominal values are constant across sales periods.

[3] More specifically, woreda specific premium rates, which are close to actuarially fair premium rates, are as follows: 9.75 percent for Dilo, 8.71 percent for Teltele, 7.54 percent for Yabello, 9.49 percent for Dire, 8.58 percent for Arero, 9.36 percent for Dhas, and 11.05 percent for Miyo and Moyale.

$(\text{\# of goats and sheep insured}) * 700$

and

$$Premium\ payment = \text{Woreda specific insurance premium rates} * TIHV.$$

If a household buys IBLI in the August-September sales period, it is insured from October 1 to September 30 of the following year and may receive indemnity payouts in March and/or October of the year following purchase. Note that if a pastoral household buys IBLI not only in the August-September sales period but also the following January-February sales period, then insurance coverage periods for the two contracts overlap from March to September, and the household may receive indemnity payouts for both contracts in October. This seasonally-overlapping design allows households to insure the same number of livestock but pay less on more frequent intervals and is, therefore, expected to reduce the cash constraints faced by pastoralists.

The feature of two potential payouts in a year and the 15th percentile trigger level make an expected probability of payout occurring once every three and a half years. The indemnity payouts, if triggered, will be equal to the premium payment at a minimum and to half of TIHV at a maximum, depending on the realized NDVI. Within the period of data we study in this paper, two sales periods occurred, the first in August-September 2012 and the second in January-February 2013, and no indemnity payouts were made to insured households.

2.3. Sampling framework

While IBLI was marketed and sold to any household on the Borana plateau, we study a random sample of households in the region to explore the pattern of IBLI uptake among pastoralists. The baseline survey data were collected in March-April 2012 before the first IBLI sales period (August-September 2012) was announced, with a follow-up survey implemented in April 2013 directly after the second IBLI sales period (January-February 2013). Sampling for the household survey is clustered at the reera level, the smallest administrative unit after kebele. Sample reeras (hereafter, called study sites) were selected so as to maximize agro-ecological and livelihood variation across the Boran pastoral area. Reeras inaccessible by vehicle were, however, excluded for logistical and cost reasons. As shown in Figure 1, 17 study sites were selected and, within these, development agents (DAs) who worked in the survey areas as local development officers completed a population and livestock holding census. Households in the census were then split into wealth terciles based on the number of livestock held. Then, 15 percent of households per study site were selected for the sample, one third from each of the livestock holding terciles, totaling 528 households across the 17 study sites. Due to logistical challenges in the March-May rainy season, however, baseline data were collected from only 515 of the selected sample in March 2012. This study draws on information from the 474 households that constitute a balanced panel (resurveyed in April 2013) and contain complete data sets in both captured sales periods.[4]

2.4. Encouragement design

To stimulate uptake of IBLI and construct a quasi-experimental research design,

[4] The basic characteristics of those remain in and drop out from our sample are quite similar. Also, we have re-estimated models, such as those reported in Table 6, and found that the inverse mills ratio constructed from the first-stage selection model, whose dependent variable takes one if the household remains in the sample, is statistically insignificant, indicating that the sample attrition may not be problematic. For ease of discussion, we do not include the selection-correction term in our main regressions.

three different encouragement tactics were offered to randomly selected subpopulations during each of the two sales periods. The first component of the encouragement design intended to increase overall awareness of IBLI and to improve knowledge of how the product worked and its benefits. This was done through the use of two tools referred to as a "learning kit" – a comic and an audio tape of a skit – which were distributed randomly to households within randomly selected study sites through separate processes in each sales period. Study sites were stratified into three categories, i.e., those located closer to major livestock markets, those with sparse rainfall, and those located far from functioning livestock markets and within which households generally hold larger herds. Within each of these three strata, sites were randomly assigned comic and skit tape treatments, keeping at least one site as a control (no learning kit). Half of the households in each treatment site received the relevant learning kit and half did not.

The second component of the encouragement design was the distribution of discount coupons which lowered the cost of purchasing IBLI. With a coupon, the recipient could purchase IBLI at a discounted rate for the first 15 Tropical Livestock Units (TLUs)[5] insured. In each study site and each sales period, households offered discount coupons were randomly chosen to receive coupons ranging from 10-80 percent in order to manufacture exogenous variation in the effective price faced by prospective IBLI purchasers. Twenty percent of the sample households did not receive a coupon during each sales period and in total 4.6 percent of the sample households did not receive a coupon during the both periods.[6]

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[5] 1 TLU is equivalent to 1 cow, 0.7 camel, 10 goat, or 10 sheep.

[6] Discount coupons were printed in 10 percent intervals between 10 percent and 80 percent with roughly one tenth of the sampled households falling into each interval. In parallel with the household survey for this study, a separate but overlapping herd

To implement these experiments, DAs were trained to explain and distribute the coupons to the study households either in collective meetings or, less often, in separate personal visits. For the comic, DAs read and gave a paper version of the comic to treatment recipients, again either in community meetings or individually. Similarly, the DAs convened group meetings or met households at their home to play the audio tape of the skit describing IBLI. Unfortunately, ILRI staff found that some DAs did not implement these random assignments rigorously in the first sales period, especially for the cartoon and skit tape. Consultants were hired to implement these activities in the second sales period together with DAs to improve the quality of implementation. As a result, we use an intent-to-treat estimation strategy that will necessarily suffer some attenuation bias due to imperfect compliance.

3. Summary statistics

Table 1 presents selected descriptive statistics derived from the baseline data collected in early 2012 for the full sample then separately for those households that did and did not purchase IBLI. We refer to the overall sample below to describe the general characteristics of households in our study, except for those several variables that are statistically significantly different between these two sets of households.

==Table 1. here ==

The average household size is 6.3, with a male-female ratio close to one. The average age of household heads, which are predominantly male, is approximately 50 years. Ninety percent of household heads have never attended formal school, and

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migration survey was conducted which included 20 households from our larger sample. 10 of those households received 100 percent discount rates.

therefore the average amount of completed education is only half a year which is quite low even relative to an average of 4.7 years across all Ethiopian households (McIntosh et al., 2013).

The average monthly household consumption per capita is 321 birr,[7] and 46 percent of the household, using the $1.25 (purchasing power parity) per day poverty line, fall into poverty. Those households that subsequently purchased IBLI tend to be wealthier than those that did not. As noted previously, the predominant source of income is livestock, including milk and meat production, which accounts for approximately 59 percent of total household income. Other income sources, such as crop production and other off-farm activities, play a relatively minor role; only 15 percent of households derive income from crop production with the unconditional average share of crop income within the total household income to be only 6 percent and average cultivated land size of 1.4 acres. Livestock comprises the overwhelming majority of households' non-human assets. The average TLU of animal owned by sample households are 14.7, dominated by large cattle herds supplemented with goats, sheep, and camels.

==Table 2. here ==

Table 2 shows the percent of sampled households that purchased IBLI in each sales period as well as the average animals insured, in terms of TLU and TIHV, separately for those who purchased IBLI in both periods, only the first period, only the second period, and never purchased. About 30 percent of sampled households purchased IBLI during the first period, but that rate declined to 18 percent in the second period.

[7] 1 USD is equivalent to 17.42 Ethiopian birr as of February 2012.

Only 24 out of 474 households bought IBLI in both sales periods to generate overlapping coverage for the March-September 2013 period. The number of insured TLU is also small. The unconditional mean is only 0.79 at the first period and 0.50 in the second period, which represents less than 5 percent of all animals owned. The average TIHV is 4.1 thousand birr in the first sales period and 2.6 thousand birr at the second sales period, respectively, which are close to or only slightly greater than the monthly household income. Those who purchased IBLI during both sales periods tend to insure more animals than those who purchased it in either the first or second period only. But the overall pattern of purchase suggests that households were experimenting with the new product by purchasing a limited amount of coverage for their herds, although this represented a substantial outlay relative to household income.

==Table 3. here ==

Table 3 displays the main reason the 2013 survey respondents gave for not purchasing IBLI. The top two reasons are the lack of cash followed by the lack of knowledge about IBLI, mimicking the major constraints commonly raised across other index-based insurance pilots in the developing world (Cai et al., 2013; Cole et al., 2013; Gaurav et al. 2011; Gine et al., 2008; Karlan et al., 2014; Platteau & Ontiveros, 2013) despite the fact that the previously described random encouragement design employed in this study aimed to mitigate such constraints.

==Table 4. here ==

Table 4 shows the sources of information for those respondents who had heard about IBLI, also collected in the 2013 survey round. DAs and ILRI staff played major roles as information channels, with 86 percent and 67 percent of respondents citing them as IBLI information sources respectively. Meanwhile, a non-negligible number of households claimed to obtain information about IBLI through the encouragement designs, although some treated respondents did not recognize these as an IBLI information source.

To obtain deeper insights into the effect of the learning kits, in the 2013 survey we implemented an eight question quiz about IBLI, ranging from questions about the insurer, the conditions, frequency, and amount of indemnity payout, to simple computations of premiums and payouts under hypothetical scenarios. The number of correct answers is statistically significantly larger among respondents who received the learning kit treatments, either a comic or a skit, during the second sales period, when the experimental implementation was more closely supervised and done correctly (Table 5).

==Table 5. here ==

Figure 3 displays the relationship between TIHV and a household-specific premium rate, where a household-specific premium rate is defined as[8]:

$$Household\ specific\ premium\ rate$$
$$= (1 - discount\ rate) * Woreda\ specific\ premium\ rate.$$

As expected, the IBLI uptake decreases with the household-specific premium rates, suggesting that IBLI demand is price responsive and that discount coupons may induce uptake. Descriptively, the encouragement design seems to have contributed to spreading information about the existence of IBLI as well as to inducing uptake in the study sites.

==Figure 3. here ==

4. Estimation Strategy

[8] For households that did not receive a discount coupon, their premium rate is equivalent to the woreda specific premium rate. Premium rates at the woreda level did not vary with sales period, while the discount rates at the household level varied with the sales period.

In order to more rigorously study the effectiveness of these encouragement designs and a broader set of constraints to IBLI uptake, we turn to multivariate regression analysis. We are interested in not only whether or not households choose to buy IBLI in a given sales period, but also how many animals they choose to insure, measured by TIHV, conditional on purchasing an IBLI policy. Since more than half of all households do not buy IBLI at all, parameters estimated via Ordinary Least Squares (OLS) would be biased and inconsistent. One standard approach to consistently estimating a model with a continuous dependent variable with censored observations is the standard Tobit model. The standard Tobit (i.e., Type I Tobit), however, imposes a rather restrictive assumption that the decision to buy IBLI and decisions about how many TLU to insure are determined by a single process, which need not be true.

To overcome the restrictive assumptions inherent in the standard Tobit model, we employ the "double-hurdle" (DH) model originally proposed by Cragg (1971). The DH model is more flexible than the standard Tobit in that it assumes the observed demand for IBLI can be decided in a step-wise manner, i.e., first the decision whether or not to buy IBLI, followed by the second decision on the quantity of animals to insure.[9] The underlying decision-making process of the DH model can be expressed as:

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[9] Another approach is the generalized Tobit model, including the Heckman selection model. As with the DH model, the Heckman selection model takes into account the two-step decision making process. The major difference between the Heckman selection model and DH model is that the former is designed for incidental truncation where zeros are unobserved due to self-selection. In other words, the Heckman model assumes that there will be no zero observations in the second stage, once the first-stage selection is passed, while the DH model allows for the option of deliberate zero observations. Although both models seem relevant in our context, we prefer the DH model because it nests the Heckman model. The estimated results via the Heckman model are qualitatively similar to the DH model.

$$d_{it} = \begin{cases} 1\ if\ \ d_{it}^{*} = m_{it}\alpha_t + \xi_{it} > 0 \\ 0\ otherwise \end{cases} \quad (1)$$

$$y_{it} = \begin{cases} y_{it}^{*}\ if\ \ y_{it}^{*} = X_{it}\beta_t + \varepsilon_{it} > 0 \text{ and } d_{it}^{*} > 0 \\ 0\ otherwise \end{cases} \quad (2)$$

where d_{it} is a binary indicator variable to describe whether household *i* bought IBLI during sales period *t*, y represents TIHV, d^{*} and y^{*} are the unobserved latent variables, m and X are vectors of explanatory variables, and α and β are estimated parameters. Because we observe two separate sales periods, this model can be run separately for each period.

Following Cragg (1971), we assume that the first-hurdle error term ξ_{it} and second-hurdle error tem ε_{it} (e.g., error terms in equations (1) and (2)) are independently and normally distributed with zero mean at each sales period. While covariance between those errors can be non-zero, Garcia & Labeaga (1996) and Jones (1992), among others, show that estimated results are quite similar regardless of whether the assumption of zero covariance is relaxed. To reduce computational burdens, we maintain the assumption of zero covariance between the first- and second-hurdle error terms. Given independent error terms, the log likelihood function for the DH model can be equivalent to the sum of the log-likelihoods of a *probit* model and truncated regression model (Burke, 2009; Cragg, 1971). Thus, separate regressions for the first hurdle with the *probit*, followed by the second hurdle with the truncated regression, yield consistent estimates with the DH model described above (Ricker-Gilbert, Jayne, & Chirwa, 2011).

Major explanatory variables of interest in the first- and second sales period DH models include the effective price of IBLI faced by each household and the knowledge of IBLI. The former is captured by the inclusion of household and sales period specific premium rates as well as a dummy variable to represent which households received a discount coupon. As shown in Appendix 1, we found a significant difference between the administrative records on discount coupon disbursement and households' self-reported receipt of coupons. Since the administrative records precisely capture the results of random assignment, we prefer to include them over self-reports. If there is any noncompliance in distributing those coupons, as implied in the first sales period given reports to ILRI, our estimates will reflect "intention to treat" effects.

Knowledge of IBLI is proxied using the number of correct answers to a quiz about IBLI administered during data collection. The data are derived only from the second wave of the survey because we did not ask the knowledge of IBLI at the time of baseline survey, as the product had not yet been designed or marketed. An obvious concern is that households with greater interest in IBLI know more about the product and are more likely to buy, or that knowledge of IBLI increases after a household bought IBLI, causing an endogeneity problem. To address this, we apply a two-step estimation strategy, where we first estimate the number of correct answers to the quiz, using the learning kits experimental treatments as instruments, and then estimate the DH models including the predicted number of correct answers from the first stage as one of the regressors. The intent to treat dummies of skit tapes and comics,[10] which are purely exogenous by experimental design, are used as instruments to identify the exogenous component of knowledge of IBLI but are excluded from the demand model under the assumption that the learning kits should only influence uptake through an increase in

[10] We again use the administrative record, instead of respondents' self-reporting, for these variables.

knowledge.

Other controls are constructed from the baseline survey to minimize potential endogeneity concerns and to provide an *ex ante* picture of the household before IBLI was introduced (see Appendix 2 for a full list of explanatory variables). These include: (1) monthly per capita household income and the proportion of household income from livestock, (2) household livestock holdings, measured in TLU, and a squared term to allow for nonlinear effects; (3) the value of non-livestock assets, represented by a wealth index computed using principal component analysis; (4) the amount of cultivated land, (5) characteristics of the household and household head, such as household size and age, years of completed education, and gender of household head; (6) the household's subjective expected livestock mortality within the year following the baseline survey; (7) dummy variables that capture whether households expect livestock prices to increase or to remain the same within a year from the baseline survey; (8) risk tolerance dummies elicited through field experiments following Binswanger (1980)[11]; and (9) woreda dummy variables, which function as controls for the woreda-level unobservables. Standard errors are clustered at the study site level for all regressions.

5. Estimation Results

5.1. Static Estimation

==Table 6. here ==

[11] We do not use an estimated cardinal value of risk preference, such as the midpoints of the imputed constant relative risk aversion (CRRA) intervals, because such a CRRA coefficient estimate imposes strong assumptions on the shape of preferences and may not precisely reflect Arrow-Pratt risk preferences if there exist any threshold effects in underlying wealth dynamics (Lybbert & Barrett, 2011).

Table 6 presents the estimated results of the first step regression for factors associated with the knowledge of IBLI. The first sales-period coupon recipients tend to have better knowledge about IBLI. The second sales period random “learning kit” assignments are positively correlated with the number of correct answers, while the first sales period assignments are not, which might be because some DAs did not implement these random assignments correctly during the first sales period, as explained earlier. Other important determinants of IBLI knowledge include education of the household head, which has the positive impacts.

==Table 7. here ==

The main estimation results on the DH model, incorporating instrumented values of the number of correct answers to quiz from the first step regression above, are presented in Table 7, where the dependent variable of probit regressions (i.e., columns (1), and (3)) takes one if the household bought IBLI during that sales period, while the dependent variable of the truncated regressions (i.e., columns (2) and (4)) represents TIHV measured in thousand birr. The predicted number of correct answers to the quiz is negatively correlated with the probability of purchase IBLI in the first sales period, but positively related to the insured value of livestock in the second period, and statistically insignificantly related to TIHV in the first sales period and the probability of uptake in the second. The results are thus mixed, implying that while the learning kits improve knowledge of IBLI, the improved knowledge via these encouragement devices may not induce greater uptake. Note that naïve estimation with the number of correct answers to quiz based on the actual (not predicted) value, a clearly endogenous variable, generates consistently positive, and mostly strongly statistically significant, coefficient estimates (Panel A of Appendix 3). It is apparent that those wishing to buy IBLI make an effort to learn more about it.

Household demand for IBLI is clearly sensitive to the price the household faces. In each sales period, the household-and-round-specific premium rates consistently and negatively affect the decision to purchase as well as the value of animals insured. The estimated marginal impacts[12] of the premium rates are -1.65 and -1.22 at the first and second sales periods, respectively, implying that that a decrease in the premium rate by one percentage point is associated with increases in the value of animal insured by 1.65 and 1.22 thousand birr at the first and second sales periods, respectively. Controlling for price, IBLI demand is not significantly and consistently affected by whether households receive a coupon or not, except for the decision to buy IBLI in the first sales period, during which coupon recipients were more likely to purchase IBLI.[13]

Note that the discounted premium rates may have income effects aside from the pure price effect. Although we expect such income effects are small in our context, as the reduction in the premium rate is minor relative to the total household income, we

[12] These marginal impacts reflect unconditional average partial effects of the discount premium rate on IBLI demand. The marginal impacts on the value of insured animal conditional on purchase of IBLI are -3.12 and -2.75 at the first and second period, respectively. These estimates are obtained using the *craggit* user-written command in Stata (Burke, 2009).

[13] We re-estimated the model with the coupon dummy and the discounted premium rates based on self-reports, rather than administrative records for both the prediction of the number of correct answers to quiz and the demand for IBLI. The results, presented in Panel B of Appendix 3, show the mixed effects of the coupon dummy. While coupon recipients are more likely to purchase IBLI, they tend to insure less value of animals. On the one hand, coupon recipients may be more encouraged by DAs and ILRI staff to buy IBLI when they receive the coupon. On the other hand, however, self-motivated people, who are willing to buy IBLI even without the discount coupon, tend to buy more IBLI than those motivated by the experiments. These effects may cause an opposing effect in the different sales period.

cannot rule out that possibility. Indeed, the estimated results show that the increased household income tends to increase the total insured value of livestock.

The proportion of income from livestock is positively correlated with the probability of buying IBLI during the first sales period, reflecting that households with more diversified income portfolios are less likely to rely on IBLI as a risk-coping mechanism. This view is also partly supported by the coefficient estimates on cultivated land size, which tend to show the negative impacts, implying that those households with more crop income generating capacity are less likely to rely on IBLI.[14]

As Table 3 shows, insufficient livestock holdings is an important reason provided by households for not purchasing IBLI. However, through regression analysis, we find that total household TLU holdings largely do not affect the decision to purchase IBLI independent of the share of income earned from livestock. On the other hand, wealth index shows that wealthier people are more likely to insure more animals in both the first and second sales periods.

Other socio-economic characteristics of the household and household head are also associated with IBLI demand. First, male-headed households are more likely to buy larger insurance policies in the first sales period, although they are less likely to buy IBLI in the second sales period. Second, although we *a priori* expected the education of the household to be positively associated with IBLI demand, it is actually negatively correlated in three of four models, statistically significantly so for two of them.

Households that expect livestock prices to remain constant or rise are more likely to buy IBLI and tend to insure greater animal value. On the other hand, risk

[14] The results hold true with alternative definitions of coupon recipients and the number of correct answers to quiz, especially in the second sales period, as shown in Appendix 3.

preference dummies are largely negative, and statistically significant in some cases, suggesting that risk-averse households buy IBLI more. This is consistent with the conventional theory, although several existing studies on index insurance products show mixed results (Gine et al., 2008).

5.2. Dynamic Estimation

So far, we have implicitly assumed that the demand of IBLI at each sales period is independent over time. Yet, one may argue that the second sales period choice would be conditional on the first sales period, particularly since the two coverage periods overlap. Also, as information diffuses and people learn from their own and others' experiences perceptions about and demand for IBLI may change over time. To account for such potential dynamic adoption behavior, we use a slightly modified version of the DH model. Instead of using the univariate *probit* model in the first hurdle at the second sales period, as in equation (1), we apply an endogenous switching probit model where first sales period purchasers and non-purchasers of IBLI are separated into different regimes to decide whether to buy IBLI in the second sales period. This modifies the equations (1) and (2) to:

$$d_{i1} = \begin{cases} 1\, if\;\; d_{i1}^{*} = m_{i1}\alpha_1 + \xi_{i1} > 0 \\ 0\; otherwise \end{cases} \tag{3}$$

$$d_{i2}^{1*} = I[m_{i2}\alpha_2^1 + u_{i2}^1 > 0] \tag{4}$$

$$d_{i2}^{0*} = I[m_{i2}\alpha_2^0 + u_{i2}^0 > 0] \tag{5}$$

$$y_{i2} = \begin{cases} y_{i2}^{*}\; if\;\; y_{i2}^{*} = X_{i2}\beta_2 + \varepsilon_{i2} > 0 \text{ and } d_{i2}^{*} > 0 \\ 0\; otherwise \end{cases} \tag{6}$$

where m_{i1} is the vector of household characteristics during the first sales period; α_1 is the coefficient of observed characteristics during the first sales period; ξ_{i1} is the error term during the first sales period; $I[]$ is the indicator function; d_{i2}^{1*} and d_{i2}^{0*} are latent variables for the observed demand status during the second sales period with a superscript 1 to represent purchasers and 0 non-purchasers of IBLI in the previous period; m_{i2} is the the vector of household characteristics that prospectively affect demand in the second sales period; α_2^1 and α_2^0 are regime-specific coefficients, and u_{i2}^1 and u_{i2}^0 are the regime-specific error terms for the second sales period. Error terms ξ_{i1}, u_{i2}^1, and u_{i2}^0 are assumed to be jointly and normally distributed with zero mean. The covariance matrix is

$$\Omega = \begin{pmatrix} 1 & \rho_{u1} & \rho_{u0} \\ \rho_{u1} & 1 & \rho_{01} \\ \rho_{u0} & \rho_{01} & 1 \end{pmatrix},$$

where ρ_{u1} is the correlation between the unobserved characteristics predicting purchase during the first sales period and continuous purchase during the second sales period. A positive covariance estimate suggests interperiod complementarity, perhaps by reducing liquidity constraints on coverage, or learning over time. A negative estimate suggests instead that those who purchased IBLI at the first period are less likely to adopt in the second. The parameter ρ_{u0} represents the correlation between non-purchase during the first sales period and new purchase during the second sales period. Since d_{i2}^{1*} and d_{i2}^{0*} are never observed simultaneously, the joint distribution of (u_{i2}^1, u_{i2}^0), and consequently, ρ_{01} cannot be identified, so we have to impose the assumption of unit variance. The model is estimable via a full information maximum likelihood switching probit model.[15] We then estimate the separate truncated regression in equation (6) to examine factors determining TIHV at the second sales period, conditional on purchase.

In the second sales period estimation, we add the discount premium rate and the dummy for coupon recipient in the previous sales period to the vector of regressors, allowing for persistence in the effect of initial sales period treatments in subsequent sales periods. This allows for the possibility that one-off subsidies on a product might reduce future demand as people anchor around the reduced price and become unwilling to pay more for the product later (Dupas, 2014; Fischer et al., 2014). We test whether one-shot price subsidies can have immediate impacts on uptake through the coefficient estimates on the current period discount rate, while also testing whether they have longer-term effects via the coefficient estimates on the previous period discount rate[16].

==Table 8. here ==

The results are presented in Table 8. The qualitative inference for the first sales period (Column 1) is quite similar to the previous findings of the static model. But we can now infer something about the dynamic pattern of IBLI uptake based on the correlation of the error terms (ρ_{u1}, ρ_{u0}). Among the first period purchasers (Column 2), the correlation coefficient of the first and second period purchase (ρ_{u1}) is negative and statistically significant, implying that those who purchased IBLI during the first sales period do not tend to buy it in the subsequent period as well. The first period coupon

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[15] Although the use of instruments is recommended, the model is identified by non-linearity even if the vector of observables perfectly overlap in Equations (3)–(5) (Lokshin & Glinskaya, 2009).

[16] We did not include these variables in the static model so as to make variables perfectly comparable between the first and second sales periods.

dummy is negative and significant for non-purchasers at the first sales period (Column 3). This seems to indicate that if someone was likely to purchase, that was likely to occur when they got a coupon, so having not purchased when one got a coupon is an especially good predictor that one is not likely to purchase later. The (potentially discounted) price in the first sales period has no statistically significant effect on the second sales period decision to purchase in terms of either probability or volume, indicating that there is no price anchoring effect.[17] The results imply that, in order to familiarize pastoralists with IBLI and induce initial experimentation with a new product, it may be effective to motivate them by reducing the price temporarily through discount coupons, without compromising the ability to charge full price later, although we should not infer too much from these results since we only observe two sales periods.

The factors associated with purchase during the second sales period differ between early adopters who purchased during the first sales period and non-adopters who did not purchase during the first sales period. For example, accurate knowledge of IBLI is not associated with IBLI purchase in the second sales period if a household has already bought it in the previous period, while it does for a household who has not previously purchased IBLI. Livestock holdings are statistically significantly associated with the probability of buying IBLI, once error terms are allowed to be correlated over time. Interestingly, their relationship is not monotonic, but U-shaped for early adopters and inverse-U-shaped for early non-adopters. The inversed U-shaped demand for early non-adopters seems to be consistent with the traditional view of multiple herd size equilibria, where the demand for IBLI is highest among pastoralists with herd size

[17] Because we control for the second-period price, inclusion of the first-period price or the difference between the second-period and first-period prices as an additional regressor does not alter the result.

slightly greater than the threshold at which herd dynamics bifurcate in order to avoid falling into a poverty trap (Carter & Barrett, 2006; Chantarat, Mude, Barrett, & Narayanan, 2014; Lybbert et al., 2004; Santos & Barrett, 2011). On the other hand, U-shaped demand for early adapters supports Janzen, Carter, & Ikegami (2013)'s prediction that vulnerable households with livestock holding just above the critical threshold demand index based asset insurance less due to basis risk and purchase productive assets instead.

6. Conclusions

Index insurance is increasingly recognized as a promising means of protecting the poor from losses associated with climate shocks. Attempts have been made worldwide in the past decade to introduce innovative index-based weather insurance products that should be free from the classical incentive problems and high transactions costs of conventional indemnity insurance. These products have, however, commonly suffered from low uptake rates that may be due to their coverage of transitory income losses associated with crop failure, rather than asset loss that leads to permanent income decline.

We study demand for a new index-based livestock insurance (IBLI) product introduced in southern Ethiopia among pastoralists whose permanent incomes depend heavily on livestock, in an attempt to explore factors underlying the demand for asset index insurance. We focus specifically on the role of product knowledge and price in uptake decisions, exploiting the random assignment of randomly assigned learning kits and discount coupons to identify estimates of the causal relationships between those factors and IBLI demand.

We find that IBLI uptake rates, approaching 30 percent in the initial year of product offer, exceed that of most other index-based insurance products in their pilot periods. Our estimation results show that consumer education through the provision of skit audio tapes and comics improves knowledge of the product, but that a more accurate understanding of IBLI does not significantly induce uptake. Although several prior studies conjecture that lack of understanding of the index insurance product is a key constraint on adoption, and indeed our survey respondents also reported that as a main reason for not purchasing IBLI, our empirical evidence does not strongly support this argument.

We do, however, find that price incentives created through discount coupons effectively and substantially increase current period uptake rates without lowering future demand by creating a low price reference point. It therefore appears advisable that encouragement designs of this sort can indeed help encourage uptake in the early phase of diffusion of a new index insurance product, which may in turn induce more rapid diffusion and as a result substantially enhance the resilience of households in vulnerable climates and livelihoods.

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Figure 1. IBLI Boran Household Survey Sites

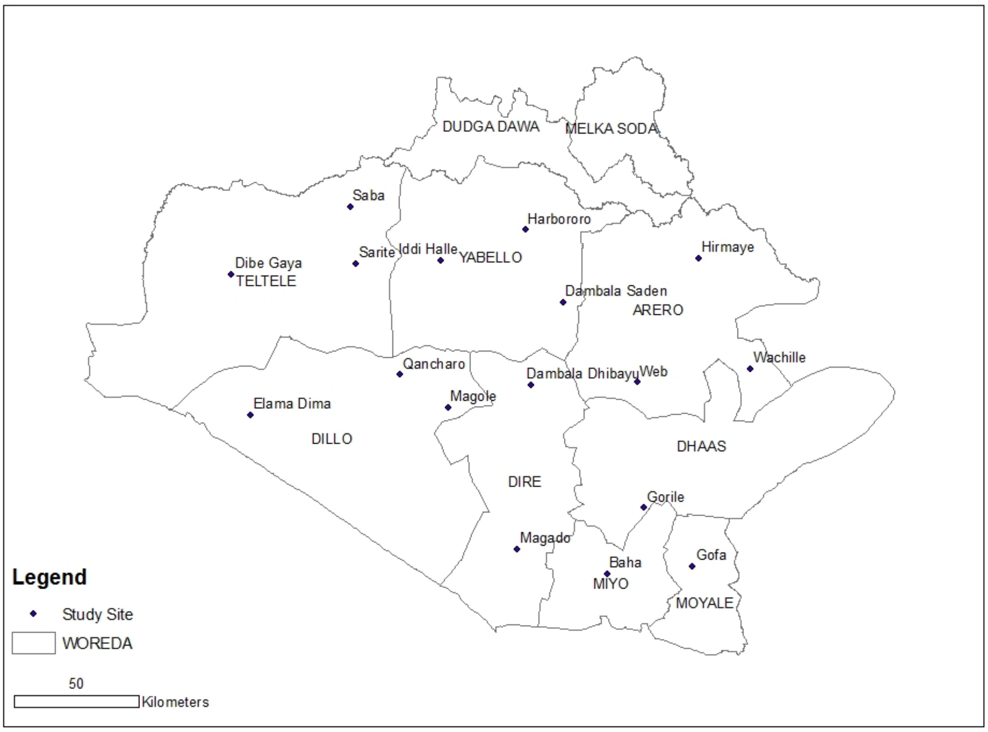


Figure 2. Calendar of the IBLI Boran contract

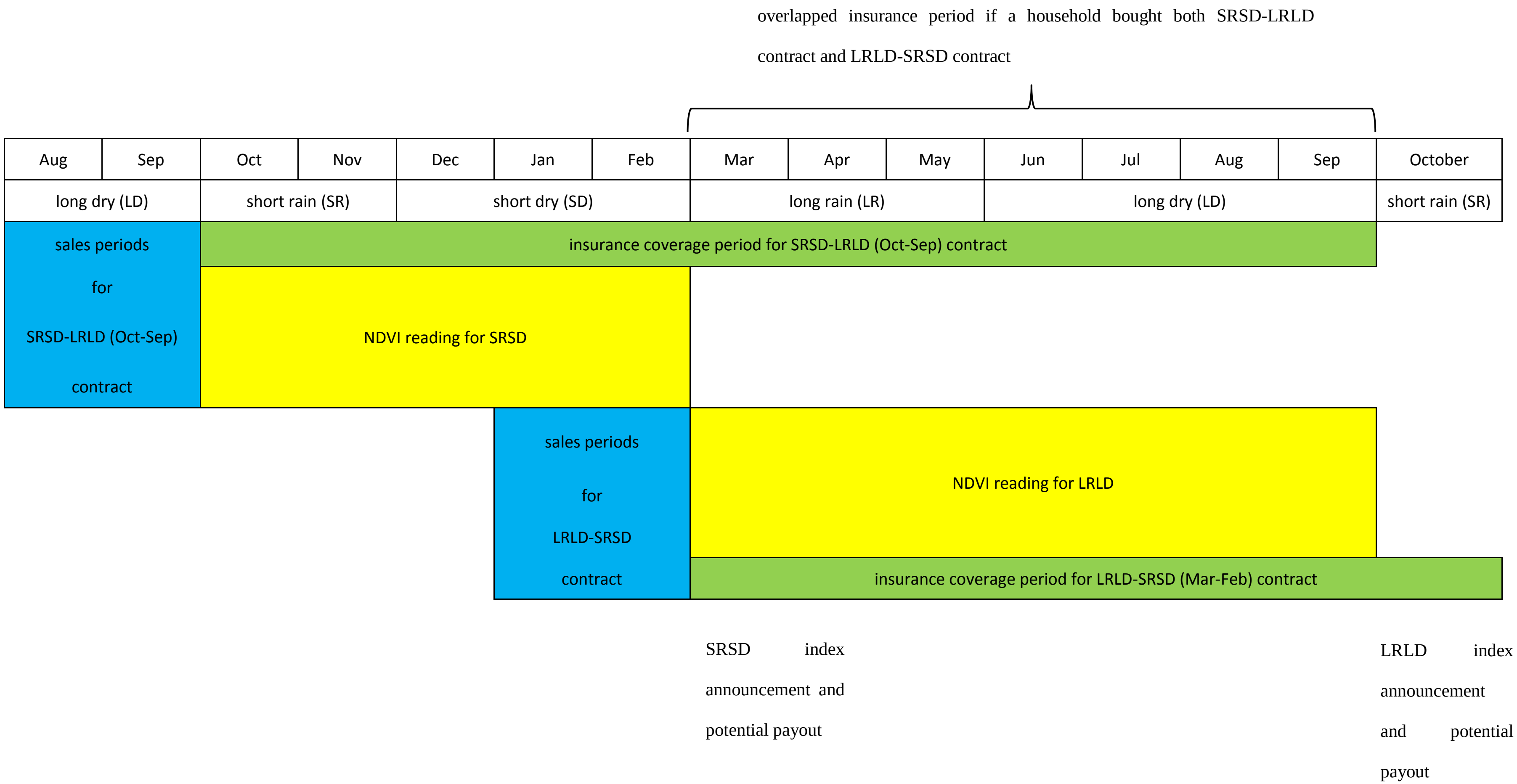
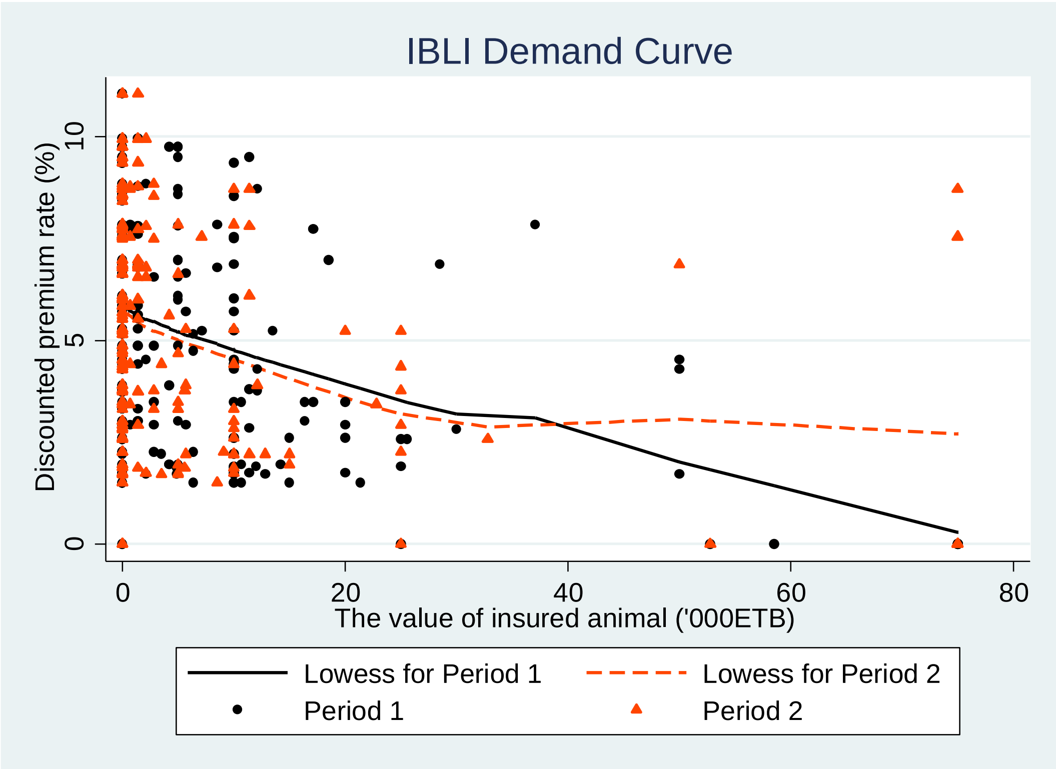


Figure 3. IBLI Demand Curve



Note: The vertical axis measures the discounted premium rate (%), defined as the woreda-specific premium rate multiplied by one minus the household-specific discount rate. The horizontal axis measures the total value of insured animals, where each camel, cattle, and goat/sheep is equivalent to 15, 5, and 0.7 thousand birr, respectively. Solid and dashed lines represent the lowess smoothing curves for the first and second sales period, respectively. (n=474)

Table 1. Baseline Socio-economic Characteristics of the Sampled Households (March 2012)

	Full sample	Never purchase IBLI	Purchased IBLI in at least one sales period	*t* test p-value
Household size	6.257	6.395	6.074	0.164
	(2.486)	(2.649)	(2.243)	
% Male member	49.476	50.151	48.575	0.328
	(17.325)	(16.793)	(18.014)	
Household head characteristics				
Age	50.209	50.919	49.261	0.326
	(18.145)	(18.365)	(17.849)	
Male (=1)	0.793	0.819	0.759	0.108
	(0.405)	(0.386)	(0.429)	
% with no education	90.084	88.561	92.118	0.201
	(29.919)	(31.887)	(27.012)	
Completed years of education	0.504	0.616	0.355	0.123
	(1.826)	(2.037)	(1.490)	
Household economy				
Monthly consumption per capita (birr)	321.987	306.695	342.401	0.081*
	(220.248)	(200.531)	(243.119)	
Poverty (=1)	0.462	0.509	0.399	0.017**
	(0.499)	(0.501)	(0.491)	
Access to community land (=1)	0.572	0.576	0.567	0.843
	(0.495)	(0.495)	(0.497)	
Cultivated land size (acre)	1.420	1.353	1.508	0.425
	(2.083)	(1.899)	(2.309)	
Owned animal (TLU)	14.683	13.287	16.545	0.114
	(22.195)	(16.874)	(27.692)	
Monthly per capita income (birr)	467.381	447.129	494.417	0.276
	(466.933)	(433.578)	(507.906)	
Share (%) of income				
Crop	5.730	5.995	5.376	0.686
	(16.479)	(16.033)	(17.090)	
Livestock	59.320	56.976	62.448	0.047*

	(29.644)	(29.728)	(29.314)	
Other labor earnings	6.700	7.796	5.236	0.025*
	(12.330)	(14.197)	(9.101)	
Remittances/assistance	28.250	29.232	26.940	0.318
	(24.716)	(25.119)	(24.167)	
Observations	474	271	203	

Note: Standard deviations are in parentheses. The t-test represents the difference in characteristics between households that have never purchased IBLI and those that have in at least one sales period. *** p<0.01, ** p<0.05, * p<0.10.

Table 2. Patterns of IBLI Purchase, 2012-2013

	Full sample	Households that purchased IBLI in both 1st and 2nd sales periods	Households that purchased IBLI only in 1st sales period	Households that purchased IBLI only in 2nd sales period	Households that never purchased IBLI
1st sales period (August 2012)					
% Household buy IBLI	29.536	100.000	100.000	-	-
	(45.669)	(0.000)	(0.000)	-	-
Insured TLU	0.794	4.425	2.330	-	-
	(2.409)	(5.403)	(3.325)	-	-
Insured TLU conditional on Purchase	2.689	4.425	2.330	-	-
	(3.822)	(5.403)	(3.325)	-	-
Insured TIHV ('000 ETB)	4.153	23.242	12.159	-	-
	(12.275)	(27.492)	(16.667)	-	-
Insured TIHV ('000 ETB) conditional on purchase	14.059	23.242	12.159	-	-
	(19.299)	(27.492)	(16.667)	-	-
2nd sales period (February 2013)					
% Household buy IBLI	18.354	100.000	-	100.000	-
	(38.752)	(0.000)	-	(0.000)	-

Insured TLU	0.503	5.133	-	1.830	-
	(2.101)	(6.032)	-	(2.920)	-
Insured TLU conditional on Purchase	2.741	5.133	-	1.830	-
	(4.252)	(6.032)	-	(2.920)	-
Insured TIHV ('000 ETB)	2.639	25.850	-	10.011	-
	(10.814)	(30.052)	-	(15.806)	-
Insured TIHV ('000 ETB) conditional on purchase	14.380	25.850	-	10.011	-
	(21.734)	(30.052)	-	(15.806)	-
Observations	474	24	116	63	271

Note: Standard deviations are in parentheses.

Table 3. Most important reported reasons for non-purchase of IBLI, 2012-2013

	1st sales period Aug 2012		2nd sales period Feb 2013	
	Number of observations	%	Number of observations	%
Do not have money to spend on insurance	71	24.7	99	31.5
Did not understand insurance well enough to buy it	100	34.7	49	15.6
Did not have an opportunity to buy it	50	17.4	65	20.7
Do not have enough animals	41	14.2	57	18.2
Waiting to see what happens to the people who bought insurance	11	3.8	20	6.4
Do not think insurance will help me	7	2.4	7	2.2
Afraid of uncertainty in insurance	2	0.7	9	2.9
Do not trust any insurance companies	3	1.0	3	1.0
Can rely on family and friends	2	0.7	4	1.3
Discouraged by someone in the community	1	0.4	1	0.3
Total	288	100	314	100

Table 4. Percent of households that learned about IBLI from potential sources, 2013

DA	86.2
ILRI staff	67.1
Friends/Neighbors	48.0
Community Meeting	47.3
Discount Coupon	48.7
Comic	24.7
Skit	12.4
Oromia Insurance Company	9.1

Table 5. The Number of Correct Answers to IBLI Quiz by Recipient of Learning Kits, 2013

	No kit	Kit	t-test *p-value*
1st sales period	4.461	4.419	0.828
	(0.121)	(0.146)	
2nd sales period	4.207	4.960	0.000***
	(0.118)	(0.141)	

Note: "Kit" refers to the sample of households that received either a skit or comic in the reference period. Standard errors are in parentheses. *** $p<0.01$

Table 6: First stage estimation results: IBLI understanding

Dependent variable: The number of correct answers to quiz	
Coupon at the 1st sales period (=1)	0.628***
	(0.234)
Comic at the 1st sales period (=1)	0.281
	(0.240)
Skit at the 1st sales period (=1)	-0.333
	(0.268)
Coupon at the 2nd sales period (=1)	0.143
	(0.240)
Comic at the 2nd sales period (=1)	1.136***
	(0.233)
Skit at the 2nd sales period (=1)	0.580**
	(0.244)
Per capita household income ('000 ETB)	-0.155
	(0.283)
TLU	0.007
	(0.010)
TLU squared	-0.000
	(0.000)
Proportion of income from livestock	0.001
	(0.003)
Cultivated land (acre)	0.001
	(0.054)
Wealth index	0.016
	(0.109)
HH size	-0.050
	(0.047)
Head age	0.001
	(0.031)
Head age squared	-0.000
	(0.000)
Head male (=1)	0.388
	(0.238)

Head’ completed years of education	0.127**
	(0.054)
Expected mortality rate	-0.002
	(0.003)
Expected livestock price (unchange) (=1) [a]	-0.402
	(0.365)
Expected livestock price (higher) (=1) [a]	0.191
	(0.215)
Moderate risk averse (=1) [b]	0.027
	(0.224)
Less risk averse (=1) [b]	-0.250
	(0.211)
Constant	3.952***
	(0.920)
Woreda dummy variables	YES
Observations	474
R-squared	0.188
Joint F-test on Comic and skit tape dummies in both periods	7.56***
Joint F-test on Comic and skit tape dummies only in the 2nd period	12.78***

Note: Heteroscedasticity robust clustered standard errors at the study-site level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

[a] The omitted category is that expected livestock price becomes lower. [b] The omitted category is extremely risk averse.

Table 7. Second stage estimation results on demand for IBLI (static double hurdle model)

Sales Period	1st		2nd	
Dependent variable	Dummy for IBLI purchase	Total insured herd value	Dummy for IBLI purchase	Total insured herd value
Estimation model	Probit	Truncated regression	Probit	Truncated regression
# correct answer on IBLI quiz: predicted	-0.292**	-1.591	0.206*	6.811
	(0.141)	(4.839)	(0.118)	(5.794)
Period specific coupon recipient (=1)	0.460**	-21.517	0.113	-35.702
	(0.205)	(25.365)	(0.334)	(64.720)
Household-period specific premium rate	-0.125***	-15.583***	-0.194***	-19.053***
	(0.029)	(3.630)	(0.049)	(2.861)
Per capita household income ('000 ETB)	-0.087	21.245**	0.127	13.280*
	(0.156)	(8.605)	(0.141)	(7.886)
Proportion of income from livestock	0.008**	0.109	0.000	0.165
	(0.003)	(0.163)	(0.003)	(0.175)
Cultivated land (acre)	0.033	1.766*	-0.116***	-3.271*
	(0.030)	(0.963)	(0.041)	(1.762)
TLU	-0.012	0.344	0.007	0.144
	(0.012)	(0.309)	(0.011)	(0.385)
TLU squared	0.000	-0.003*	0.000	-0.001
	(0.000)	(0.002)	(0.000)	(0.002)
Wealth index	0.046	2.874**	-0.069	9.660**
	(0.038)	(1.374)	(0.070)	(3.930)
HH size	-0.023	4.264	0.008	0.083
	(0.031)	(2.708)	(0.035)	(1.724)
Head age	-0.009	2.121	-0.026	0.613

	(0.021)	(1.786)	(0.028)	(1.159)
Head age squared	0.000	-0.021	0.000	-0.003
	(0.000)	(0.015)	(0.000)	(0.009)
Head male (=1)	0.086	29.431**	-0.373**	13.963
	(0.183)	(12.353)	(0.156)	(10.065)
Head' completed years of education	0.012	-7.536***	-0.127**	-2.988
	(0.029)	(2.349)	(0.060)	(2.157)
Expected mortality rate	-0.001	-0.090	0.002	-0.200
	(0.002)	(0.108)	(0.003)	(0.125)
Expected livestock price (unchange) (=1) [a]	-0.087	13.067	0.549**	-0.525
	(0.278)	(11.463)	(0.274)	(8.332)
Expected livestock price (higher) (=1) [a]	0.193	-1.273	0.073	25.490*
	(0.138)	(8.182)	(0.204)	(13.758)
Moderate risk averse (=1) [b]	0.020	-21.147**	0.105	6.387
	(0.174)	(9.758)	(0.194)	(13.059)
Less risk averse (=1) [b]	-0.127	-11.124	-0.491**	-18.496
	(0.117)	(9.560)	(0.201)	(15.172)
Constant	1.003	-1.457	-0.744	0.887
	(0.914)	(56.217)	(0.819)	(95.815)
Woreda dummies	YES	YES	YES	YES
Observations	474	474	474	474

Note: Clustered standard errors at the study-site level are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

[a] The omitted category is that expected livestock price becomes lower. [b] The omitted category is extremely risk averse.

Table 8. Dynamic endogenous switching model of demand for IBLI (Double Hurdle Model)

Sales period	1st	2nd		
Dependent variable	Dummy for IBLI purchase			Total insured herd value
Estimation model	Switching probit			Truncated regression
1st sales period demand status		Purchase	Non-purchase	
	(1)	(2)	(3)	(4)
# correct answer on IBLI quiz: predicted	-0.263*	-0.613*	0.569***	6.011
	(0.137)	(0.367)	(0.113)	(4.929)
1st period coupon (=1)	0.401*	0.243	-0.803**	-30.380
	(0.222)	(1.077)	(0.354)	(18.908)
Household-round specific premium rate at the 1st period	-0.126***	-0.084	0.013	-4.214
	(0.030)	(0.120)	(0.045)	(3.278)
2nd period coupon (=1)		-1.978	0.349	-18.950
		(1.254)	(0.392)	(53.030)
Household-round specific premium rate at the 2nd period		-0.651***	-0.144***	-15.128***
		(0.205)	(0.044)	(2.856)
Per capita household income ('000 ETB)	-0.090	2.451***	0.060	10.982
	(0.152)	(0.859)	(0.159)	(8.084)
Proportion of income from livestock	0.008**	0.030**	-0.004	0.184
	(0.003)	(0.013)	(0.003)	(0.135)
Cultivated land (acre)	0.038	-0.407***	-0.087***	-2.202
	(0.031)	(0.106)	(0.033)	(1.569)
TLU	-0.012	-0.046	0.025**	0.222
	(0.012)	(0.030)	(0.010)	(0.352)
TLU squared (‘000)	0.119	0.656***	-0.177*	-0.857
	(0.091)	(0.227)	(0.101)	(1.700)

Wealth index	0.044	-0.188	-0.239***	7.909**
	(0.041)	(0.132)	(0.081)	(3.691)
HH size	-0.024	0.129	-0.012	-0.737
	(0.030)	(0.099)	(0.041)	(1.470)
Head age	-0.008	0.010	-0.021	0.581
	(0.023)	(0.048)	(0.035)	(1.019)
Head age squared	0.000	-0.001	0.000	-0.003
	(0.000)	(0.000)	(0.000)	(0.009)
Head male (=1)	0.074	0.138	-0.556***	10.769
	(0.165)	(0.738)	(0.187)	(9.763)
Head' completed years of education	0.009	-0.436***	-0.150*	-2.446
	(0.027)	(0.143)	(0.079)	(2.454)
Expected mortality rate	-0.000	-0.005	0.003	-0.130
	(0.002)	(0.008)	(0.004)	(0.118)
Expected livestock price (unchange) (=1) [a]	-0.062	-0.079	0.660**	-2.910
	(0.240)	(0.618)	(0.294)	(9.232)
Expected livestock price (higher) (=1) [a]	0.231*	-0.130	0.064	17.693
	(0.135)	(0.397)	(0.195)	(13.519)
Moderate risk averse (=1) [b]	0.018	-0.159	0.120	7.596
	(0.176)	(0.431)	(0.158)	(11.895)
Less risk averse (=1) [b]	-0.118	-0.602	-0.382*	-14.431
	(0.113)	(0.601)	(0.213)	(14.325)
Constant	0.891	3.411	-2.473***	32.847
	(0.884)	(2.822)	(0.730)	(66.968)
Woreda dummy variables	YES	YES	YES	YES
ρ_{u1}		-0.326**		

		(0.151)		
ρ_{u0}			-14.813	
			(98.551)	
Observations	474	474	474	474

Note: Clustered standard errors at the study-site level are in parentheses. *** p<0.01, ** p<0.05, * p<0.001

[a] The omitted category is that expected livestock price becomes lower. [b] The omitted category is extremely risk averse.

Appendix 1. Number of sample households that received a discount coupon

Sales period	1st		2nd	
	Self-report	Administrative record	Self-report	Administrative record
Coupon Recipients	213	380	212	383
% discounted				
0	324	94	330	91
10	16	43	21	46
20	17	44	22	45
30	14	42	13	49
40	16	49	12	50
50	18	46	17	42
60	15	43	22	43
70	18	50	13	45
80	31	53	18	53
100	5	10	6	10

Appendix 2. Definition of variables in the regression analysis

Variables	Type	Definition	Data source	Mean	s.d.
1st period IBLI (=1)	dummy	1 if a household purchased IBLI at the 1st sales period	2nd round		
# correct answer out of eight	Integer	# correct answers to quiz on IBLI.	2nd round	4.45	2.03
1st period coupon (=1)	dummy	1 if a household receives discount coupon at 1st sales period	2nd round	0.80	0.40
Household-period specific premium rate at 1st period	Numeric	woreda premium rate * (1- household-level discount rate at 1st sales period)	2nd round	5.54	2.69
2nd period coupon (=1)	dummy	1 if a household receives discount coupon at 2nd sales period	2nd round	0.81	0.39
Household-period specific premium rate at 2nd period	Numeric	woreda premium rate * (1- household-level discount rate at 2nd sales period)	2nd round	5.59	2.66
Moderate risk averse and less risk averse	dummy	In the field risk tolerance is elicited through the following instruction: In this game, I offer a chance for you to choose one of the six lotteries displayed in the next image, which may allow you to earn from 0 to 200 Birr depending on your choice of lottery and your luck. The total amount of reward you will get will depend on the outcome of the lottery you choose, which will depend on the outcome of a coin that I am going to flip. Those who choose game (0) or (1) are categorized as extremely risk-averse, (2) or (3) are moderately risk-averse, and (4) or (5) are less risk-averse.	1st round	moderate risk-averse	
		(A) 50 50		0.27	0.45

		(B) 45 95		less risk-averse	
		(C) 40 120		0.36	0.48
		(D) 30 150			
		(E) 10 190			
		(F) 0 200			
Monthly per capita household Income ('000ETB)	Numeric	Monthly per capita household income ('000ETB), including earnings and self-consumed value of self-employed and employed agricultural and non-agricultural activities, and non-labor earnings, such as remittances and governmental assistance.	1st round	467.38	466.93
TLU and its squared	Numeric	# of TLU owned at the timing of the baseline survey and its squared	1st round	14.68	22.20
Wealth index	Numeric	Wealth index computed by the principal component analysis from more than 30 assets, including durables and productive assets, household facilities.	1st round	-0.001	1.00
Expected mortality rate	Numeric	Subjective expected mortality rate within a year elicited at the baseline survey	1st round	48.27	28.39
Expected livestock price (no change=1)	dummy	1 if a household expects the price of livestock to remain the same within a year from the baseline survey	1st round	0.12	0.32
Expected livestock price (increase=1)	dummy	1 if a household expects the price of livestock to rise within a year from the baseline survey	1st round	0.57	0.50
Cultivated Land (acre)	Numeric	Total cultivated area	1st round	1.42	2.08
HH size	Integer	the number of household members at the timing of the baseline survey		6.26	2.49

Head age and its squared	Integer	age of household head at the time of the baseline survey	1st round	50.21	18.15
Head male (=1)	dummy	1 if a household head is male at the time of the baseline survey	1st round	0.79	0.41
Head education	Integer	years of completed education of the household head at the time of the baseline survey	1st round	0.50	1.83

Appendix 3. Second stage estimation results on demand for IBLI (Double Hurdle Model) with alternative definition of key variables

	Panel A Non-predicted value of # correct answer to quiz				Panel B Self-reported value of % discount			
Sales period	1st		2nd		1st		2nd	
Dependent variable	Dummy to purchase IBLI	Total insured herd value	Dummy to purchase IBLI	Total insured herd value	Dummy to purchase IBLI	Total insured herd value	Dummy to purchase IBLI	Total insured herd value
# correct answer on IBLI quiz:	0.202***	4.499**	0.114***	1.078	-0.254**	26.059**	0.108	33.767***
	(0.043)	(1.870)	(0.042)	(6.974)	(0.107)	(11.297)	(0.130)	(7.554)
Period specific coupon recipient (=1)	0.216	-22.387	0.228	-30.353	1.269***	14.816	0.999***	-90.926***
	(0.228)	(24.891)	(0.311)	(69.161)	(0.228)	(35.805)	(0.250)	(24.686)
Household- period specific premium rate	-0.126***	-15.039***	-0.185***	-18.690***	-0.069**	-7.404*	-0.001	-14.547***
	(0.032)	(3.528)	(0.047)	(4.011)	(0.033)	(4.093)	(0.038)	(2.800)
Per capita household income ('000 ETB)	-0.047	24.842***	0.117	13.616*	-0.055	31.331	0.168	52.783***
	(0.159)	(9.113)	(0.153)	(7.960)	(0.154)	(26.133)	(0.154)	(18.034)
Proportion of income from livestock	0.009***	0.122	0.000	0.174	0.006**	0.069	0.000	-0.386
	(0.003)	(0.150)	(0.003)	(0.201)	(0.002)	(0.571)	(0.003)	(0.352)
Cultivated land (acre)	0.034	1.303	-0.124***	-2.974	0.034	2.768	-0.135**	-9.103***
	(0.033)	(1.021)	(0.042)	(2.080)	(0.036)	(4.350)	(0.053)	(2.876)
TLU	-0.013	0.149	0.008	0.112	-0.002	2.695	0.007	-0.406
	(0.014)	(0.276)	(0.012)	(0.342)	(0.008)	(2.218)	(0.010)	(0.865)
TLU squared	0.000	-0.002	0.000	-0.001	0.000	-0.021	0.000	-0.001
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.017)	(0.000)	(0.003)
Wealth index	0.072*	1.891	-0.066	9.549**	0.075**	6.899	-0.024	29.641***
	(0.040)	(1.283)	(0.070)	(4.256)	(0.036)	(7.135)	(0.076)	(9.798)

HH size	-0.005	4.870*	-0.000	-0.565	-0.066***	3.367	0.010	5.078**
	(0.029)	(2.554)	(0.038)	(1.261)	(0.025)	(5.664)	(0.034)	(2.557)
Head age	-0.011	2.598	-0.024	0.638	0.000	0.866	-0.003	7.352**
	(0.021)	(1.719)	(0.031)	(1.170)	(0.021)	(4.098)	(0.028)	(3.400)
Head age squared	0.000	-0.025*	0.000	-0.005	-0.000	-0.012	0.000	-0.053**
	(0.000)	(0.014)	(0.000)	(0.009)	(0.000)	(0.036)	(0.000)	(0.026)
Head male (=1)	-0.096	27.591**	-0.334**	17.218*	0.083	64.041	-0.383**	95.749***
	(0.168)	(11.686)	(0.155)	(9.586)	(0.184)	(53.091)	(0.192)	(23.062)
Head' completed years of education	-0.050	-8.440***	-0.127**	-1.812	-0.034	-8.456	-0.060	3.557
	(0.033)	(2.588)	(0.063)	(1.992)	(0.039)	(6.198)	(0.070)	(4.942)
Expected mortality rate	0.000	-0.035	0.001	-0.163	0.000	-0.119	0.002	-0.376
	(0.002)	(0.099)	(0.003)	(0.163)	(0.002)	(0.262)	(0.004)	(0.267)
Expected livestock price (unchange) (=1) [a]	0.054	13.061	0.535*	-0.101	0.037	64.676	0.610**	55.535**
	(0.244)	(10.251)	(0.282)	(9.299)	(0.226)	(41.012)	(0.279)	(27.660)
Expected livestock price (higher) (=1) [a]	0.172	-0.692	0.072	26.916*	0.094	8.417	0.245	114.608***
	(0.147)	(8.013)	(0.203)	(14.446)	(0.134)	(32.230)	(0.195)	(41.931)
Moderate risk averse (=1) [b]	0.017	-21.219**	0.131	4.827	-0.024	-83.594*	0.049	1.338
	(0.193)	(9.369)	(0.193)	(11.680)	(0.172)	(46.712)	(0.186)	(23.159)
Less risk averse (=1) [b]	-0.022	-11.383	-0.529***	-22.773*	-0.136	-68.167	-0.579***	-29.756
	(0.129)	(10.104)	(0.198)	(13.697)	(0.135)	(42.352)	(0.205)	(24.690)
Constant	-1.246*	-48.387	-0.460	20.801	0.293	-198.694	-2.431**	-382.218**
	(0.731)	(55.834)	(0.765)	(120.337)	(0.711)	(165.018)	(1.066)	(179.028)
Woreda dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	474	474	474	474	474	474	474	474

Note: Clustered standard errors at the study-site level are in parentheses. *** p<0.01, ** p<0.05, * p<0.001

[a] The omitted category is that expected livestock price becomes lower. [b] The omitted category is extremely risk averse.