Willingness to Pay for Insured Loans in Northern Ghana

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Abstract

Index insurance has been heralded as a potential solution to systemic risks faced by smallholder farmers in developing countries by covering risks such as drought, low crop yields, and low market prices. Despite its potential, demand has remained low in many early experiments and field trials. Little research has been done, however, on demand for insurance as it is coupled with other services such as loans. Here, willingness to pay for drought index insurance backed loans is investigated using contingent valuation methodology. Results demonstrate that on average the sample population has a willingness to pay high enough to sustain a market viable insured loan product without subsidization with 56% of the target population expressing a willingness to pay for an insured loan at the market price. Results also show a positive and significant WTP for individual policies and to avoid basis risk resulting from rainfall measurement.

I. Introduction

Index-based rainfall insurance (IBRI) has been heralded as a potential solution to credit constraints and low technology adoption by smallholder farmers in developing countries (Barnett & Mahul, 2007; Miranda, & Vedenov, 2015). IBRI policies make insurance payouts based on the observation of an objective rainfall index such as rainfall measures from rainfall stations or from satellite data. This is in contrast to indemnity based insurance which makes payouts based on the observation of policy holder losses. The use of the index allows the insurer to avoid costly challenges associated with indemnity insurance such as the cost of assessing and validating policy holders' losses (high transaction costs) and the ability for policy holders to affect payout probabilities with their actions (asymmetric information)(Miranda & Farrin, 2012). Avoiding such costs makes IBRI a strong candidate as a cost effective means of managing rainfall based risk for small farmers. By managing the risk of drought, IBRI should improve farmers' ability to repay loans after low rainfall seasons, reduce default risk for banks, increase overall access to credit and thereby increase modern technology adoption.

To date, pilot programs have primarily marketed IBRI directly to farmers either as independent contracts or as a requirement to receive loans (IBRI linked loans). Despite the expected benefits for smallholders, these early initiatives have been met with limited uptake by smallholder farmers without substantial subsidization(Xavier Gine, 2009; M. J. Miranda & Farrin, 2012). Empirical research has confirmed low demand for index insurance marketed both as individual contracts (Cole et al., 2009) and as IBRI linked loans (Giné & Yang, 2008). Loans linked with market price index insurance in northern Ghana also demonstrated low uptake in a recent study (Karlan, Kutsoati, McMillan, & Udry, 2011). A notable exception is a study of individually marketed IBRI in northern Ghana which found that 40 to 50% of the target population of smallholder farmers purchased insurance contracts at actuarially fair prices (Karlan, Osei, & Udry, 2013). However these results reduced drastically (to 5%) in years following the initial study when changes to the marketing strategy were adopted, confounding the initial results.

The low observed demand for index insurance is believed to be due to a variety of factors including limited understanding of the product, low trust in financial institutions, budget constraints, and imperfect correlation between the index and realized losses - also known as basis risk (Binswanger-Mkhize, 2012; Cole et al., 2013; Jensen, Barrett, & Mude, 2014). In light of these challenges, particularly basis risk, a novel

use for IBRI has been proposed: cater IBRI to meso-level risk aggregating institutions such as banks (Carter, 2011b; M. J. Miranda & Gonzalez-Vega, 2010). Banks can purchase IBRI to insure agricultural loans to protect against a drought induced wide spread default and use standard portfolio diversification and interest rates to manage idiosyncratic defaults. Banks can pass these benefits onto farmers through IBRI backed contingent credit loans which offer partial or complete debt forgiveness in the case of insurance payouts and some of all of the cost of the premium is incorporated into the price of the loan. Such loans offer considerable advantages for credit access including: (1) lower risk for strategic default relative to IBRI linked loans which pay indemnities directly to farmers (Clarke & Dercon, 2009; M. J. Miranda & Gonzalez-Vega, 2010); (2) reduced cost of insurance faced by farmers due to more efficient use of IBRI by banks; (3) improve smallholders' credit records by committing indemnities to loan repayment; and (4) improve smallholder livelihood by protecting consumption and asset levels during drought shocks (Shoji, 2010).

This study seeks to investigate the demand for IBRI linked loans and IBRI backed contingent credit loans through the use of contingent valuation. This methodology has been used widely in the investigation of index insurance demand in developing countries. Numerous studies have shown low levels of latent willingness to pay (WTP) for index insurance which is increasing in wealth, education, social network, and rainfall risk, and decreasing in risk aversion and age (Hill, Hoddinott, & Kumar, 2011b; Sarris, Karfakis, & Christiaensen, 2006). These investigations of WTP primarily focus on policies held by individual smallholders that pay indemnities to the smallholder and include insurance that covers rainfall for crops and livestock (Chantarat, Mude, & Barrett, 2009).

Our empirical analysis deviates from the existing literature on WTP for index insurance in four important ways. First, joint index insurance-credit products are investigated, capturing the demand for innovative loans rather than index insurance directly. Second, the WTP for two different loan products (i.e. IBRI linked loans and contingent credit loans) that represent two different uses of index insurance, micro-level and meso-level, respectively, are investigated. Third, the WTP methodology is used in a novel approach to value basis risk. This is done by eliciting the WTP for a third, and purely hypothetical insurance product that is identical to the IBRI linked loan except that indemnities are based on plot level rainfall, therefore establishing perfect correlation between household rainfall and weather station rainfall. The difference between the WTP for this product and for the IBRI linked loan can be interpreted as a valuation for the basis risk. Fourth, three methodological improvements are introduced from existing WTP literature into the survey design to reduce biased WTP results. These methods are: question order controls, cheap talk, and certainty scale adjustment.

The results show the following: (1) Demand for insurance is heavily impacted by price, risk aversion, and remittance income which loosely confirms the technology adoption model for index insurance demand. (2) There exists a strong willingness to pay for insured loans of all three designs with a demand for micro level insured loans that is mildly higher than meso-level insured loan. Additionally, a positive willingness to pay to avoid basis risk in rainfall measurements (design effect,(Carter, 2011a)) of roughly 4% of loan principle is found. (3) The WTP for insured loans on average exceeds the market viable insured loan costs and 56% of the sample population is willing to pay above the market viable price, therefore there exists a market viable demand for insured loans.

The remainder of the paper is organized as follows. Section II describes the data and the survey used for the study. Section III describes the WTP question design as well as the theoretical and empirical methodology employed to estimate the willingness to pay. Results are described in Section IV followed by conclusions in Section V.

II. Data

The agricultural sector in Ghana accounts for 22% of the country's GPD and employs 42% of its population (Food, 2013). Most farmers are smallholder farmers that produce at least partially for their own consumption. Usage of advanced agricultural technology such as inorganic fertilizer, herbicides, and certified seeds remains low in the country at large with 29%, 56%, and 16% of the population using these input respectively (Ghana Statistical Service, 2014). Those farmers using advanced production technologies often secure access to these technologies by obtaining credit through banks, MFIs, or NGOs. In the three northern regions of Ghana (Northern, Upper East and Upper West) the primary means of obtaining agricultural credit is through the rural and community banks (RCBs). 16 RCBs operate in the three northern regions, each chartered to operate within a particular region which corresponds to a certain ethnic/language group or a collection of ethnic/language groups. These banks offer microfinance loans to micro enterprises including small holder farmers. These banks universally employ joint liability lending structures for their loans for agricultural inputs and lend exclusively to farmer based organizations (FBOs). These FBOs often form organically by farmers as a risk sharing mechanism or for some other communal purpose. However, some groups are formed intentionally by NGOs or the Ministry of Food and Agriculture (MOFA) explicitly for the purpose of securing loans from the RCBs. These NGOs or the MOFA often assist the FBOs with extension services and support in the process of applying for agricultural loans from the RCBs. The RCBs also belong to a community of banks called the Association of Rural Banks (ARB) which assists the RCBs with product design and capacity building. We partnered with the ARB to conduct this study and focuses on the clients and potential clients of 14 of the 16 RCBs operating in the three northern regions of Ghana.

The sample frame differs in two critical ways from existing literature. First, the focus is on farmer based organizations (FBOs) which are the primary bodies that seek and acquire agricultural loans in Northern Ghana. Second, the sample frame of FBOs are those that are either existing or potential agricultural loan borrowers. The sample frame of FBOs was therefore based on the existing and potential clientele for fourteen participating Rural and Community Banks (RCBs) in the three northern region of Ghana. A complete list of existing or potential client FBOs was obtained from each of these banks, totaling 791 FBOs. From this initial sample, the following five selective criteria were applied to ensure that the investigation targets the FBOs of the greatest interest. The five criteria are as follows:

1. FBOs that have been in good standing with the bank in terms of borrowing, potential groups that are qualified to receive loans and groups that have been denied loans for reasons other than past default
2. FBOs located in districts that belong to low rainfall areas (between 800-1100mm annually) for maximum impact of IBRI products
3. FBOs whose primary or secondary crop is maize due to maize specific IBRI design
4. FBOs with 7-15 members due to budget constraints and logistical concerns
5. FBOs that take out a loan of less than 10,000 GHC so as to maintain a focus on the most low income farmers groups

This process resulted in a sample of 258 farmer groups out of 791 groups. These 258 farmer groups composed the experimental sample investigated in the study. The geographic distribution of these 258 farmer groups is as follows. 97 farmer groups are located in the Northern Region in 8 districts. 132 farmer

groups are located in the Upper East Region in 9 districts. 28 farmer groups are located in the Upper West Region in 6 districts. Table 1 contains the number of farmer groups per region and district.

Table 1: Farmer Groups by Regions and Districts

Districts	Number of farmer groups
Northern	
Bonkpirigu Yongyong	13
East Mamprusi	14
West Mamprusi	26
Gushegu	12
Saboba	21
Chereponi	11
Karaga	1
Upper East	
Bongo	8
Builsa South	1
Builsa North	1
Bawku Municipal	15
Bawku West	19
Binduri	13
Bolgatanga Municipal	4
Garu Tempane	64
Kassena Nankana West	2
Kassena Nankana East	5
Upper West	
Jirapa	7
Lambussie	5
Lawra	1
Nandom	10
Sissala East	2
Sissala West	3
Total	258

The survey of these FBOs was conducted as part of a randomized control trial experiment investigating the impact of offering micro and meso level insured loans in Northern Ghana. The WTP study questions were asked during the baseline survey in February 2015 on the 258 farmer groups in the sample.

To ensure a representative sampling of farmers from each group, six farmers from each farmer group were randomly selected using a uniform distribution. The first three farmers selected were the intended respondents with the subsequent three farmers as back up farmers in the case that the first three farmers are unavailable for the interview. The replacement of the first three names took place following a simple replacement rule.[1] In total, 780 surveys were collected for the 258 groups.

[1] Replacement rule: one of the first three farmer names should be replaced only if a suitable time to conduct the interview cannot be found. In the field, we encountered a number of instances when the randomly chosen farmer had migrated, necessitating replacement.

Descriptive Statistics

Investigations of willingness to pay for insurance have thus far identified key determinants of demand. These determinants include wealth, risk aversion, risk perception, risk coping mechanisms, respondent's education level, respondent's age, and other household characteristics(Chantarat et al., 2009; Hill et al., 2011b; Norton, Osgood, Madajewicz, & Peterson, 2012; Sarris et al., 2006). Our survey was designed to capture indicators for these key variables of interest to ascertain their effect on demand for insured loans among our borrowing or potential borrowing FBO sample. These variables can also give an indication of the general characteristics of our sample population. Descriptive statistics are found in Tables 2-4.

To capture proxy variables for household wealth, data on total household income, agricultural income, remittance income and household savings was collected and used separately in the analysis. Total income was on average Ghana Cedis (GHc)[2] 2,486 which is considerably below the regional averages from the Northern, Upper East, and Upper West Regions in which we worked (GHC 12,281, 7,240, & 11,977 respectively)(Ghana Statistical Service, 2014). Agricultural income comprises a considerable proportion of total income for the households in our data. Remittance income is roughly the national average for rural households at GHC 100.9 (rural average: GHC 115.3). The majority (68%) of our household owned formal savings accounts and the average total sample formal savings was GHC 358.8. Data was also collected on ownership of major assets such as livestock (cattle) and land (land in acres and number of plots). In addition to wealth, financial access was proxied for by ownership of a formal savings account, number of loans acquired in 2014, and borrower status with local bank. 73% of the sample were current agricultural loan borrowers at the time of the survey.

To proxy for risk aversion two questions were asked. First, risk aversion was directly measured using a self-reporting technique, using a 5 point risk scale, which has been shown to closely correlate to risk aversion revealed through games (Hardeweg, Menkhoff, & Waibel, 2011). In addition to this direct response, data was collected on the use of advances/certified seeds due to the high correlation between risk aversion and use of new technologies(X. Gine, Townsend, & Vickery, 2008; Lybbert et al., 2010). 14% of this population use these seeds.

Closely related to risk aversion is risk perception and risk management. To proxy for these several data points were collected. First, to understand their perceptions of the risk of crop losses in the future, data was collected on the farmers' perception of the risk of crop loss due to drought, insects/pests, or other damage during the next farming season. Second, to allow us to control for recency bias[3] (Karlan et al., 2013)data was collected on the farmers' perceptions of last year's growing season. Only 40% of the population reported that the last growing season was a "good growing season". This indicates that there may be a high level of recency bias induced increases in our WTP estimates. To measure risk management mechanisms data was collected on the number of people that could be called on to help in a time of drought, the use of irrigation, and the mechanisms used in the past to cope with drought. The average number of people accessible to help is only 1.4 and only 5% of our population utilized irrigation. These

[2] US$ 1 = GHc 4.01 as of 5/25/2015

[3] Recency Bias = the phenomenon where the recent past is given greater weight in determining perceptions of future likelihoods. For example, farmers believe that the likelihood of a drought is higher in the future due to the experience of a recent drought.

values give an impression of a high potential welfare impact of drought insurance. Furthering this impression, Table 2 displays the various forms of drought management techniques used among the sample. The primary means of coping with drought is liquidation of assets which ultimately result in lower household wealth and potential poverty traps (Barrett et al., 2007) further supporting a strong potential welfare benefit for insurance. A variable was collected on the preference for agricultural loans in cash or in kind (both are common among the banks in our study). 43% of the sample prefers agricultural loans in cash rather than in kind which may indicate that farmers wish to reduce the risk of misusing agricultural input money. Lastly a simple measure of discounting was collected using a single question that determined whether the respondent's monthly discount rate was higher or lower than 0.5.

Table 2: Drought Coping

Coping Mechanism	Percent
Borrowing Money	17
Spending Savings	11.1
Gifts from Others	4.8
Remittances	9.3
Insurance	0.9
Selling Livestock or other assets	53.2
Migration	3.5
Other	0.3

Finally data on household characteristics were captured as well. Specifically household size, education level, and respondent age are of greatest interest due to their relationship with risk aversion and impact on WTP for insurance found in previous research (Halek & Eisenhauer, 2001; Hill et al., 2011b). The education variables are displayed in Table 3 which shows that the vast majority of the sample population has not completed any formal education. The average age of respondents is 46 and the average household size is 8 members.

Table 2: Descriptive Statistics

Variables	N	Mean	Std. Dev.
Total Income (GHC)	681	2486	1381.5
Ag Income (GHC)	780	1411.2	962.4
Remittance Income (GHC)	780	100.9	204.5
Amount Saved (GHC)	780	358.8	505.3
Savings Account (1=has savings account)	780	.68	.47
Loans	774	.65	.62
Plots (Number)	780	3	1
Land Owned (Acres)	780	2.9	3.7
Cattle	780	4.1	7.8
Borrower	780	.73	.44
Help in Drought (number of people)	780	1.4	3.1
Risk Aversion Ranking (1 lowest aversion 5 highest)	780	2.1	1.1
Good Season (1=good 2014 season)	780	.40	.49
Hybrid Seeds (1=use hybrid seeds in 2014)	780	.14	.35
Cash Loan (1= prefer loan in cash)	780	.43	.49
Discount (1=Monthly Discount Factor > 0.5)	780	.32	.47
Irrigation (1=use irrigation in 2014)	780	.05	.2
Household members (number)	780	8.41	3.3
Age	780	46	13.2

Table 3: Education

Education Level Completed	Percent
No Education	78.4
Primary School	4.7
Middle School	5.9
High School	6.8
University	4.1

III. Methodology

As mentioned above, this study seeks to investigate farmers' willingness to pay (WTP) for insured agricultural loans in northern Ghana. Specifically, there are three insured loan products under investigation. Each insured loan assumes that the full value of the loan plus interest is insured. The three products are as follows:

Product 1: Insured Agricultural Loan with an individually held insurance policy where payouts are made directly to the farmer in the case of an insurance trigger and rainfall is measured at a rainfall station (presence of basis risk in rainfall measurement/distribution)

Product 2: Insured Agricultural Loan with a bank held insurance policy where payouts are made to the bank and credited towards the outstanding debt on the loan in the case of a trigger (presence of basis risk in rainfall measurement/distribution)

Product 3: Insured Agricultural Loan with an individually held insurance policy where payouts are made directly to the farmer in the case of an insurance trigger and rainfall is measured on a farmers plot (no basis risk in rainfall measurement/distribution)

Product 1 & 2 represent potentially market viable insured loan products. Comparing the WTP for these two products will allow policy makers and banks to understand farmer preference for these options and the magnitude of that preference. Product 3 is a purely hypothetical product that is unlikely to exist in the market due to high transaction costs and information asymmetries. However estimating the WTP for this product allows for estimating the WTP to avoid basis risk in rainfall measurement and distribution by comparison with Product 1.

To determine the valuation of these IBRI loan products we employ a contingent valuation approach. This methodology utilizes precisely defined survey questions and econometrics to determine an individual and population WTP for a hypothetical product. This is a useful methodology when the product of interest is not yet available in the market and therefore demand cannot be observed from consumer behavior. Given that insured agricultural loans are not currently available in northern Ghana, the contingent valuation stated preference approach is a fitting methodology.

The WTP questions employed in this study are single bounded dichotomous choice questions. For each question, the insured loan is described and then the farmer is asked to respond yes or no to whether or not they would be willing to take out an insured loan if the repayment amount was a certain amount. The questions are designed for yes or no responses to mimic the real world situation in a market place where a price is given and the consumer chooses to purchase or not purchase the product at the stated price. Single bounded dichotomous choice methodology, asking only one yes/no question per product, is employed here to avoid bias induced by asking follow up WTP questions as with double bounded dichotomous choice questions (Haab & McConnell, 2003).

The repayment amounts, “bids”, are one of seven values which were determined based on the estimated market viable insured loan repayment amount in our sample regions. The average individual loan size for our sample was GHC 350 and the average annual interest rate was 26% and the market premium rate for drought insurance is 10% of insured value which implies a loan repayment amount of roughly GHC 485 (assuming the farmer pays for the full premium cost as a part of the repayment of the loan, which is a common structure for such contracts). The seven bid values used in the study include this repayment amount with six additional values that are ±5%, ±15%, and ±25%. (Bids: GHC 365, 415, 460, 485, 510, 560, & 605)

To improve upon the methodology in previous WTP studies for drought index insurance, three techniques were used to reduce ordering bias (the bias that arises from the order in which multiple WTP questions are asked) and hypothetical bias (the tendency for respondents to overestimate their WTP in hypothetical circumstances). To control ordering bias, the WTP questions were asked in a random order throughout the survey process and the order was recorded and used as a control variable in the regression analyses (see below). To control hypothetical bias, cheap talk and certainty scale adjustments were used (Blumenschein, Blomquist, Johannesson, Horn, & Freeman, 2008; Morrison & Brown, 2009). Cheap talk is a technique where the enumerator asks the respondent to consider their answer carefully before answering to ensure accurate responses. Certainty scale adjustment (CSA) is a technique where a follow up question is asked if the response to the WTP question is a yes. In the follow up question, the respondent is asked if they are “definitely sure” or “probably sure” of their yes answer. If the respondent answers “probably sure” the yes

is converted to a no in the regression analysis. Table 5 displays the bid values with the percentage of "no" responses with and without the certainty scale adjustment.

Table 5: Percentage of "No" Responses (Product 1)

Bids	365	415	460	485	510	560	605	Total
Without CSA	11%	17%	18%	35%	46%	46%	67%	36%
With CSA	22%	36%	39%	46%	56%	56%	77%	48%

To ensure uniform product explanation, a scripted explanation of insured loans and the insurance contract design was provided to each enumerator to use during the interview process. A copy of the full explanation and WTP question for one of the WTP questions asked in the survey can be found in Appendix A1.

Empirical Framework

To analyze responses to the WTP questions, derive individual and population WTP estimates, and investigate demand determinants, a parametric model of WTP is employed following standard practice (see e.g., (Chantarat et al., 2009; Hill et al., 2011b; Sarris et al., 2006)). The model is based on the random utility model with a linear utility function that is linear in income. Such a specification allows for the estimation of covariates given two assumptions: (1) constant marginal utility of income between states (2) an independently and identically distributed error term with mean zero.

The error term is assumed to be normally distributed here resulting in the use of probit regression model. Equation 1 displays the regression model used here. The response (Yes/No coded as 1/0) to the WTP survey question is regressed on the bid value as well as a series of covariates. The covariates include wealth and financial inclusion variables (W_i), risk aversion and perception variables (R_i), household characteristics (H_i), and district fixed effects (D_i).

$$Response_i = \alpha_1 * C + \beta * Bid_i + \alpha_2 * W_i + \alpha_3 * R_i + \alpha_4 * H_i + \alpha_5 * D_i + \varepsilon_i \quad [1]$$

Wealth and financial inclusion variable included are: agricultural income (total income is dropped due to random utility model assumptions[4]), savings, remittance income, number of loans taken, land owned, cattle owned, and borrower status. These variables are selected based on the result in existing literature that wealth has a considerable and positive impact on demand for insurance following a technology adoption model for insurance demand (Hill, Hoddinott, & Kumar, 2011a). Following this technology adoption model, remittance income is also included due to results showing that non-farm income can significantly impact new technology adoption (Diiro & Sam, 2015).

Risk aversion and perception variables are variables that proxy for the farmer's willingness to accept or take on risk, how they perceive their risks, and mechanisms they have for coping with risk. These variables include a categorical risk aversion variable, a dummy variable indicating whether last year was a good season or not, the number of people the household can call on to help in a time of drought, dummy for monthly discount rate above a 0.5, and a dummy variable indicating whether the household prefers a loan

[4] Total income is dropped due to the constant marginal utility of income assumption.

in cash or in kind. The risk aversion variable is a staple in WTP analyses for index insurance as risk aversion should significantly impact demand (Chantarat et al., 2009; Hill et al., 2011b; Sarris et al., 2006). The perception of last year's growing season is included to control for "recency bias" which is the bias that farmers give to their chances of poor weather in the future based on the experience of weather in the recent past (Karlan et al., 2013). The number of people that a household can call on for assistance proxies for social network and informal risk management for drought shocks. Cattle, included above as a wealth variable, can also be considered a risk management variable as selling of livestock is the most common drought coupling mechanism in the sample (Table 4). Discount rate is included because the decision to take out a loan given the agreement to repay a certain amount in the future will be impacted by how these costs are discounted in the future and it has been shown to be a significant determinant of demand in past research(Hill et al., 2011b).

Household characteristics includes the education level of the respondent, the age of the respondent, and the size of the household. The education level of the respondent may significantly influence adoption by assisting the farmer in understanding the insurance product and its potential benefits. Age is strongly correlated with risk aversion and is commonly associated with reductions in demand (Halek & Eisenhauer, 2001). Finally household size may impact a household's need for risk management means due to the availability of multiple income sources.

Lastly, district fixed affects are included in the model to control for a variety of factors. First, the enumerator teams used in the field are strongly correlated with districts due to language differences and therefore controlling for districts will effectively control for variation in enumerators. Districts are also highly correlated with languages and bank operations (only five of the fourteen banks in our sample region operate in more than one district) and therefore these variables can control for variation in bank trust and experience, as well as cultural differences.

Given the assumption of a normally distributed error term the individual WTP estimate is calculated simply following Equation 2.

$$E[WTP_i]_\epsilon = (\alpha * Z_i)/\beta \quad [2]$$

Where Z_i is the vector of covariates and α is the parameter vector on the covariates.

IV. Results

Demand Determinants

Previous research has shown that demand for index insurance has not followed precisely the neoclassical demand expectations which are, broadly speaking, ambiguous in wealth (decreasing if inferior good, increasing if normal good), and increasing and then decreasing in risk aversion(Clarke, 2010). Rather, literature has shown that demand closely follows that of a technology adoption model similar to the behavior observed in the adoption of other technologies such as fertilizer and advanced seeds. This model predicts that demand will increase in wealth, decrease in risk aversion, and increase with education. The results for the determinant of demand for insured loans reinforces these results. Covariate marginal effect

results can be found in Table 6 where results for models with each of the three products with and without CSA are displayed.

Consistent with demand theory, the bid value is consistently and significantly negative for all regression models. We find that a 10 GHc increase in the repayment amount results in a reduction in demand for the insured loan of 2-2.5 percentage points. Variables included to proxy for wealth and financial inclusion are all positive with the exception of borrower status and are all positive when significant. Finding that borrower status has a negative effect may indicate two possible issues. One, non-borrowers may be somewhat naive regarding what they would be willing to repay if they could actually receive a bank loan. Two, high WTP among non-borrowers may be a sign that there are strong supply side credit market constraints leaving eager potential borrowers without borrowing opportunities. Remittances and savings seem to have the greatest impact among the wealth variables both showing positive impacts and significance in several models. Positive and significant results for remittances lends support to recent findings that non-farm income increases technology adoption. Access to remittance income would benefit the adoption of an insured loan because this income could be leveraged to repay higher repayment amounts on the loan in the absence of a full insurance payouts and provides a source of income that is not correlated with the farm income therefore reducing any perceived risk from adoption. Risk aversion is consistently significant and negative across models, supporting the technology adoption model and the general perception of adoption of insurance as being a risky behavior. This finding is reinforced by the positive impact of savings on demand described above. Whereas in the neoclassical expectation, savings would reduce demand for insurance by acting as a substitute, here savings indicates wealth and the ability to cope with the risk perceived in adopting the insurance. There are no significant results for discount rate, loan type preference, informal drought management, or perception of last season. Household characteristics follow the expected pattern predicted by the technology adoption model. Age has a negative and significant impact while education, when significant, has a positive impact on demand.

The patterns described above show little variation across products demonstrating the robustness of these general trends across specific products and little variation in the determinants of demand for each.

Table 6: Marginal Effects

	Product 1		Product 2		Product 3	
Variables						
Bid (100 GHC)	-0.24***	-0.2***	-.25***	-0.23***	-.24***	-.2***
Loans	-0.02	0.006	.03	0.06	.003	.005
Cattle	-0.001	-0.001	.0005	0.0	0.0	.001
Agric Income (100 GHC)	0.001	0.002	0.001	0.002	.004*	0.002
Remittances (100 GHC)	0.018**	0.033***	.004	0.02***	0.0	0.01
Savings (100 GHC)	0.001	0.00007	.001**	0.005	.01*	.01***
Borrower Status (1=borrower)	0.02	-0.03	-.07	-0.1*	-.02	-.02
Land	0.002	0.006	.001	-0.003	.013	.01*
Risk2	-0.03	-0.096***	-.05	-0.08*	-.05	-.1***
Risk3	-0.14**	-0.21***	-.09	-0.16***	-.14***	-.14***
Risk4	0-.09*	-0.12**	-.15***	-0.24***	-.13***	-.14***
Risk5	0.12	-0.04	-.02	-0.05	-.1	-.22
Help in time of draught	0.001	-0.006	.001	0.005	-.004	-.001
Discount	-0.02	-0.003	-.024	-0.05	.05	-.02
Good last season	-0.03	-0.03	-.02	-0.019	.04	.005
Number of household members	0.0001	-0.004	-.002	0.0	0.0	.005
Respondent Age	-0.003***	-0.002	-.003**	-0.001	-.003***	-.004***
Primary School	0.09	0.095	-.095	-0.08	-.09	-.1
Secondary School	-0.15**	-0.07	-.07	-0.006	-.015	-.01
High School	-0.05	-0.06	0.0	-0.04	.015	-.03
University	0.16**	0.24***	.18**	0.26***	.095	.16**
Product 1 asked first	0.12***	0.12***	-	-	-	-
Product 2 asked first	-	-	0.0	0.008	-	-
Product 3 asked first	-	-	-	-	.02	-.004
CSA	No	Yes	No	Yes	No	Yes
N	761	758	758	761	755	758

p<0.01*** p<0.05** p<0.1*

WTP Estimates and Market Viability

Using Equation 2 and regression results, individual WTP estimates and sample means were generated for each product with and without CSA. Sample average WTP results are presented in Table 7 while a distribution of individual WTP estimates for each product can be found in Appendix II. Product 1 has an average WTP of 545 without CSA and 491 with CSA. Product 2 has an average WTP of 530 without CSA and 484 with CSA. Product 3 has an average WTP of 553 without CSA and 506 with CSA.

The sample average WTP for Product 1 exceeds that of Product 2 in both models (with and without CSA). This difference is significant at the 1% level without CSA and at 10% with CSA. The additional WTP for the individual policy is equivalent to 4.3% of the loan principal without CSA and 2% of the principal with CSA.

The sample average WTP for Product 3 exceeds that of Product 1 in both models. This difference is significant at the 1% level for both and demonstrates a significant demand to avoid the basis risk induced by imperfect correlation between farm rainfall and rainfall station rainfall levels. The additional WTP to avoid this basis risk is equivalent to 2.3% of the loan principal for the model without CSA and 4% of the loan principal for the model with CSA.

Table 7: Mean WTP Estimates

Insured Loan	Without CSA (GHC)	With CSA (GHC)
Product 1: Individual Policy Holder	545 (5.83)	491 (9.75)
Product 2: Bank Policy Holder	530 (4.63)	484 (7.39)
Product 3: Individual Policy Holder w/o Basis Risk	553 (5.42)	506 (8.47)
Willingness to Pay for Individual Payout	15***	7*
Willingness to Pay to Avoid Basis Risk	8***	15***

1% confidence interval ***, 5% confidence interval **, 10% confidence interval *

Of central interest to development practitioners and banks in northern Ghana is the issue of market viability of insured loans. The predicted market viable insured loan repayment rate for the average individual loan size is GHC 485 which factors in both average interest rate and the insurance premium charged by the only drought insurance provider in the sample region. This repayment rate amounts to an effective annual loan interest rate of 39% compared to the market average in northern Ghana of 26%. Table 8 compares the effective interest rate implied by the average WTP results presented in Table 7 for the two potentially marketable insured loan products, Product 1 & Product 2. Considering the model with CSA, Product 1 has an effective interest rate of 40% which exceeds the market viable interest rate of 39% and therefore would be market viable on average. Product 2 falls slightly below with an effective interest of 38%. Perhaps of greater interest is the percentage of the population with individual WTP estimates above the market viable repayment rate. The second half of Table 8 displays these results for the marketable loans. Considering the model with CSA, very similar percentages of the sample population (56.4% and 54% for Product 1 & 2 respectively) would be willing to pay the higher interest rate for the insured loan.

Table 8: Market Viability

	Individual Policy Holder	Bank Policy Holder
Effective Interest Rate	40% *	38%
Percent of Population with WTP above Market Viable Repayment	56.4%	54%

- Above market viable rate compared to the market viable 39% interest rate

Also of interest to policy makers and banks is the WTP estimates for current borrowers and non-borrowers due to the desire to expand market access to agricultural loans for smallholder farmers. Results for this comparison are found in Table 9. For each product, the average WTP estimates for borrowers is lower indicating a small percentage of existing borrowers willing to pay a higher interest rate for an insured loan.

Table 9: Mean WTP Estimates by Borrower Status (with CSA)

Insured Loan	Borrower (N=553)	Non Borrower (N=197)
Individual Policy Holder	483 (10.8)	522 (25.05)
Bank Policy Holder	475 (9.22)	509 (17.22)
Individual Policy Holder w/o Basis Risk	498 (10.8)	519 (13.75)
Willingness to Pay for Individual Payout	8	13
Willingness to Pay to Avoid Basis Risk	15***	-3

Bias Controls

This analysis employs two measurable means of bias control, one for ordering bias and one for hypothetical bias. Ordering bias is controlled for by randomizing question order and including a control for question order in the regression analysis. This control variable is positive and significant for product 1 only and insignificant for the others. For product 1, being asked first increased the probability of saying yes to the WTP question. This significant result demonstrates the importance of controlling for question order.

Hypothetical bias is controlled for by introducing a certainty scale adjustment. Results for models with and without this adjustment were presented throughout this results section to demonstrate the robust impact that this correction can have. Taking for example the WTP estimates from product one, the CSA resulted in a 10% reduction in the WTP estimate.

V. Conclusions

Results presented here demonstrate the potential market viability of drought insured loan products among small farmers in northern Ghana. With an average WTP among the target population of an effective 40% interest rate on agricultural loans for an insured loan, small farmers are already on average willing to pay the market price of insured agricultural loans. Furthermore, high percentages of the population are WTP the market viable price for the insured loan which indicates that banks may be able to introduce insured loans without subsidies in the future.

The demand for an insured loan with individual payouts exceeds that for bank payouts which is consistent with the assumption that farmers would demand the flexibility that is provided by cash payouts. The more interesting story is how low this demand is. The demand for the individual payout is only 2% of the loan principal and is significant at only the 10% level. This small demand for individual payouts over bank payouts raises the interesting question of whether banks would prefer to offer insured loan like Product 1 or insured loans like Product 2. Banks would likely prefer to guarantee insurance payouts be made to the bank, rather than farmers using the payouts for consumption, endangering their loan repayment prospects. Therefore, banks may be willing to incur the 2% cost themselves and offer only contingent credit loans like product 2.

The demand to avoid basis risk in rainfall measurement is highly significant in this study and found to be 4% of the loan principal. This confirms that basis risk remains a significant barrier to demand, as is expected. Consistent with previous research, these findings support the need to develop insurance products that minimize basis risk so as to increase demand among small holders. Furthermore, banks must be careful to insure loans using the insurance contracts that minimize the basis risk experienced by the farmers they insure.

Despite the strong demand observed on average in this study, several challenges remain for banks in offering insured loans to small holder farmers. First, our sample is comprised of 73% existing borrowers whereas the demand for product 1 (for example) is market viable for 56% of the sample population. This leaves the banks with a dilemma: Do they make the insurance mandatory or do they offer their customers a choice of insured or uninsured loans? By making the insurance mandatory they protect their portfolios

more effectively from the risk of drought yet reduce the number of borrowers which is not a socially desirable outcome. However, by giving the choice to the farmers to insure or not, farmers that have lower wealth, lower education, and higher risk aversion would choose to not to borrow the insured loan and it would be these farmers that are more likely to default in the case of a drought, therefore leaving the banks without some level of the desired protection. This dilemma leaves open the need to reduce the premium cost to farmers to increase demand. One approach would exploit the advantage of a meso-level usage of index insurance by the banks covering some percentage of the insurance premium. The value of the drought risk protection to the bank should incentive the bank to incur some of this cost which would increase the share of the market that would purchase the insured loans. This would make is more feasible to make these insured loans the only loans available which would guarantee default protection for the bank. Another approach would be the use of government or NGO support to subsidize the insurance premium to increase demand. Figure A2 displays the percentage of the sample population willing to pay for loans that have 0% - 100% of the insurance premium paid for by another source.

Second, the results show that WTP estimates are lower for existing borrowers as compared to non-borrowers. This demonstrates that there may be a slight upward bias in the sample average WTP results, particularly if the higher WTP values for non-borrowers is the result of naiveté among non-borrowers about their actual WTP for agricultural loans. This may also indicate the demand for loans is quite high among potential borrowers, indicating a supply side credit constraint present in our sample region. Anecdotal evidence from meetings with banks in the field indicate that there exists a supply side credit constraint due to liquidity constraints faced by the Rural and Community Banks in northern Ghana. Addressing these liquidity constraints would therefore expand credit access to small holders in these regions. Insuring loans could ease this constraint if reduced default rates results in a higher willingness to borrow on the part of banks. Also action taken to increase savings mobilization in these regions would increase the access to agricultural credit in these regions.

The results presented here also give indications for a need to improve the WTP methodology employed for index insurance WTP studies. To the best of our knowledge, this study is the first to employ a certainty scale adjustment methodology to control for hypothetical bias which has a robust impact on the results presented here. Although it is not possible here to determine whether the CSA controlled estimates are the “true” WTP estimates, they certainly provide more conservative estimates of WTP values. If this methodology were to be employed in other studies, perhaps demand for index insurance would be found to be much lower at the individual level than was found in those studies.

Works Cited

Barnett, B. J., & Mahul, O. (2007). Weather Index Insurance for Agriculture and Rural Areas in Lower-Income Countries. *American Journal of Agricultural Economics*, *89*(5), 1241–1247. http://doi.org/10.1111/j.1467-8276.2007.01091.x

Barrett, C. B., Barnett, B. J., Carter, M. R., Chantarat, S., Hansen, J. W., Mude, A. G., … Ward, M. N. (2007). Poverty Traps and Climate Risk : Limitations and Opportunities of Index-Based Risk Financing Poverty Traps and Climate Risk : Limitations and Opportunities of Index-Based Risk Financing, (2006).

Binswanger-Mkhize, H. P. (2012). Is There Too Much Hype about Index-based Agricultural Insurance? *Journal of Development Studies*, *48*(2), 187–200. http://doi.org/10.1080/00220388.2011.625411

Blumenschein, K., Blomquist, G. C., Johannesson, M., Horn, N., & Freeman, P. (2008). ELICITING WILLINGNESS TO PAY WITHOUT BIAS : EVIDENCE FROM A FIELD EXPERIMENT *, *118*(1942), 114–137.

Carter, M. R. (2011a). *Innovations for Managing Basis Risk under Index Insurance for Small Farm Agriculture*.

Carter, M. R. (2011b). The Impact of Interlinked Index Insurance and Credit Contracts on Financial Market Deepening and Small Farm Productivity.

Chantarat, S., Mude, A. G., & Barrett, C. B. (2009). W ILLINGNESS TO P AY FOR I NDEX B ASED L IVESTOCK I NSURANCE : R ESULTS FROM A F IELD E XPERIMENT IN N ORTHERN K ENYA, 0–39.

Clarke, D. (2010). A Theory of Rational Hedging, (August), 1–14.

Clarke, D., & Dercon, S. (2009). Insurance , Credit and Safety Nets for the Poor in a World of Risk, (81).

Cole, S., Gine, X., Tobacman, J., Topalova, P., Townsend, R., & Vickery, J. (2009). Barriers to household risk management: Evidence from Inda.

Cole, S., Giné, X., Tobacman, J., Townsend, R., Topalova, P., & Vickery, J. (2013). Barriers to Household Risk Management: Evidence from India. *American Economic Journal. Applied Economics*, *5*(1), 104–135. http://doi.org/10.1257/app.5.1.104

Diiro, G. M., & Sam, A. G. (2015). Agricultural Technology Adoption and Nonfarm Earnings in Uganda: A Semiparametric Analysis. *The Journal of Developing Areas*, *49*(2), 145–162. http://doi.org/10.1353/jda.2015.0013

Food, M. O. F. (2013). Facts and figures (2012), (2012).

Ghana Statistical Service. (2014). *Ghana Living Standards Survey Round 6*.

Gine, X. (2009). *Innovations in Insuring the Poor: Experience with Weather Index-based Insurance in India and Malawi*.

Gine, X., Townsend, R., & Vickery, J. (2008). Patterns of Rainfall Insurance Participation in Rural India. *The World Bank Economic Review*, *22*(3), 539–566. http://doi.org/10.1093/wber/lhn015

Giné, X., & Yang, D. (2008). Insurance , Credit , and Technology Adoption : Field Experimental Evidence from Malawi ∗.

Haab, T., & McConnell, K. (2003). *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*.

Halek, M., & Eisenhauer, J. G. (2001). Demography of Risk Aversion, *68*(1), 1–24.

Hardeweg, B., Menkhoff, L., & Waibel, H. (2011). Experimentally-validated survey evidence on individual risk attitudes in rural Thailand Experimentally-validated survey evidence on individual risk attitudes in rural Thailand, *49*(464), 1–31.

Hill, R. V., Hoddinott, J., & Kumar, N. (2011a). Adoption of weather index insurance: Learning from willingness to pay among panel of households in rural Ethiopia. *International Food Policy Research Institute*, (March), 1–27.

Hill, R. V., Hoddinott, J., & Kumar, N. (2011b). Adoption of Weather-Index Insurance: Learning from Willingness to Pay Among a Panel of Households in Rural Ethiopia, (March), 1–27.

Jensen, N. D., Barrett, C. B., & Mude, A. G. (2014). Basis Risk and the Welfare Gains from Index Insurance: Evidence from Northern Kenya, (59153).

Karlan, D., Kutsoati, E., McMillan, M., & Udry, C. (2011). Crop Price Indemnified Loans for Farmers: A Pilot Experiment in Rural Ghana. *Journal of Risk and Insurance*, *78*(1), 37–55. http://doi.org/10.1111/j.1539-6975.2010.01406.x

Karlan, D., Osei, R., & Udry, C. (2013). Agricultural decisions after relaxing credit and risk constraints *, 1–64.

Lybbert, T. J., Galarza, F. B., Mcpeak, J., Barrett, B., Boucher, S. R., Carter, M. R., … Mude, A. (2010). Dynamic Field Experiments in Development Economics : Risk Valuation, *2*(April), 176–192.

Miranda, M. J., & Farrin, K. (2012a). Index Insurance for Developing Countries. *Applied Economic Perspectives and Policy*, *34*(3), 391–427. http://doi.org/10.1093/aepp/pps031

Miranda, M. J., & Farrin, K. (2012b). Index Insurance for Developing Countries. *Applied Economic Perspectives and Policy*, *34*(3), 391–427. http://doi.org/10.1093/aepp/pps031

Miranda, M. J., & Gonzalez-Vega, C. (2010a). Systemic Risk, Index Insurance, and Optimal Management of Agricultural Loan Portfolios in Developing Countries. *American Journal of Agricultural Economics*, *93*(2), 399–406. http://doi.org/10.1093/ajae/aaq109

Miranda, M. J., & Gonzalez-Vega, C. (2010b). Systemic Risk, Index Insurance, and Optimal Management of Agricultural Loan Portfolios in Developing Countries. *American Journal of Agricultural Economics*. http://doi.org/10.1093/ajae/aaq109

Miranda, M., & Vedenov, D. V. (2015). INNOVATIONS IN AGRICULTURAL AND NATURAL DISASTER INSURANCE, *83*(3), 650–655.

Morrison, M., & Brown, T. C. (2009). Testing the Effectiveness of Certainty Scales, Cheap Talk, and Dissonance-Minimization in Reducing Hypothetical Bias in Contingent Valuation Studies. *Environmental and Resource Economics*, *44*(3), 307–326. http://doi.org/10.1007/s10640-009-9287-3

Norton, M., Osgood, D., Madajewicz, M., & Peterson, N. (2012). Evidence of Demand for Index Insurance : Experimental Games and Commercial Transactions in Ethiopia, 1–24.

Sarris, A., Karfakis, P., & Christiaensen, L. (2006). *Producer Demand and Welfare Benefits of Rainfall Insurance in Tanzania*.

Shoji, M. (2010). Does Contingent Repayment in Microfinance Help the Poor During Natural Disasters? *Journal of Development Studies*, *46*(2), 191–210. http://doi.org/10.1080/00220380902952381

Barnett, B. J., & Mahul, O. (2007). Weather Index Insurance for Agriculture and Rural Areas in Lower-Income Countries. *American Journal of Agricultural Economics*, *89*(5), 1241–1247. http://doi.org/10.1111/j.1467-8276.2007.01091.x

Barrett, C. B., Barnett, B. J., Carter, M. R., Chantarat, S., Hansen, J. W., Mude, A. G., … Ward, M. N. (2007). Poverty Traps and Climate Risk : Limitations and Opportunities of Index-Based Risk Financing Poverty Traps and Climate Risk : Limitations and Opportunities of Index-Based Risk Financing, (2006).

Binswanger-Mkhize, H. P. (2012). Is There Too Much Hype about Index-based Agricultural Insurance? *Journal of Development Studies*, *48*(2), 187–200. http://doi.org/10.1080/00220388.2011.625411

Blumenschein, K., Blomquist, G. C., Johannesson, M., Horn, N., & Freeman, P. (2008). ELICITING WILLINGNESS TO PAY WITHOUT BIAS : EVIDENCE FROM A FIELD EXPERIMENT *, *118*(1942), 114–137.

Carter, M. R. (2011a). *Innovations for Managing Basis Risk under Index Insurance for Small Farm Agriculture*.

Carter, M. R. (2011b). The Impact of Interlinked Index Insurance and Credit Contracts on Financial Market Deepening and Small Farm Productivity.

Chantarat, S., Mude, A. G., & Barrett, C. B. (2009). W ILLINGNESS TO P AY FOR I NDEX B ASED L IVESTOCK I NSURANCE : R ESULTS FROM A F IELD E XPERIMENT IN N ORTHERN K ENYA, 0–39.

Clarke, D. (2010). A Theory of Rational Hedging, (August), 1–14.

Clarke, D., & Dercon, S. (2009). Insurance , Credit and Safety Nets for the Poor in a World of Risk, (81).

Cole, S., Gine, X., Tobacman, J., Topalova, P., Townsend, R., & Vickery, J. (2009). Barriers to household risk management: Evidence from Inda.

Cole, S., Giné, X., Tobacman, J., Townsend, R., Topalova, P., & Vickery, J. (2013). Barriers to Household Risk Management: Evidence from India. *American Economic Journal. Applied Economics*, *5*(1), 104–135. http://doi.org/10.1257/app.5.1.104

Diiro, G. M., & Sam, A. G. (2015). Agricultural Technology Adoption and Nonfarm Earnings in Uganda: A Semiparametric Analysis. *The Journal of Developing Areas*, *49*(2), 145–162. http://doi.org/10.1353/jda.2015.0013

Food, M. O. F. (2013). Facts and figures (2012), (2012).

Ghana Statistical Service. (2014). *Ghana Living Standards Survey Round 6*.

Gine, X. (2009). *Innovations in Insuring the Poor: Experience with Weather Index-based Insurance in India and Malawi*.

Gine, X., Townsend, R., & Vickery, J. (2008). Patterns of Rainfall Insurance Participation in Rural India. *The World Bank Economic Review*, *22*(3), 539–566. http://doi.org/10.1093/wber/lhn015

Giné, X., & Yang, D. (2008). Insurance , Credit , and Technology Adoption : Field Experimental Evidence from Malawi ∗.

Haab, T., & McConnell, K. (2003). *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*.

Halek, M., & Eisenhauer, J. G. (2001). Demography of Risk Aversion, *68*(1), 1–24.

Hardeweg, B., Menkhoff, L., & Waibel, H. (2011). Experimentally-validated survey evidence on individual risk attitudes in rural Thailand Experimentally-validated survey evidence on individual risk attitudes in rural Thailand, *49*(464), 1–31.

Hill, R. V., Hoddinott, J., & Kumar, N. (2011a). Adoption of weather index insurance: Learning from willingness to pay among panel of households in rural Ethiopia. *International Food Policy Research Institute*, (March), 1–27.

Hill, R. V., Hoddinott, J., & Kumar, N. (2011b). Adoption of Weather-Index Insurance: Learning from Willingness to Pay Among a Panel of Households in Rural Ethiopia, (March), 1–27.

Jensen, N. D., Barrett, C. B., & Mude, A. G. (2014). Basis Risk and the Welfare Gains from Index Insurance: Evidence from Northern Kenya, (59153).

Karlan, D., Kutsoati, E., McMillan, M., & Udry, C. (2011). Crop Price Indemnified Loans for Farmers: A Pilot Experiment in Rural Ghana. *Journal of Risk and Insurance*, *78*(1), 37–55. http://doi.org/10.1111/j.1539-6975.2010.01406.x

Karlan, D., Osei, R., & Udry, C. (2013). Agricultural decisions after relaxing credit and risk constraints *, 1–64.

Lybbert, T. J., Galarza, F. B., Mcpeak, J., Barrett, B., Boucher, S. R., Carter, M. R., … Mude, A. (2010). Dynamic Field Experiments in Development Economics : Risk Valuation, *2*(April), 176–192.

Miranda, M. J., & Farrin, K. (2012a). Index Insurance for Developing Countries. *Applied Economic Perspectives and Policy*, *34*(3), 391–427. http://doi.org/10.1093/aepp/pps031

Miranda, M. J., & Farrin, K. (2012b). Index Insurance for Developing Countries. *Applied Economic Perspectives and Policy*, *34*(3), 391–427. http://doi.org/10.1093/aepp/pps031

Miranda, M. J., & Gonzalez-Vega, C. (2010a). Systemic Risk, Index Insurance, and Optimal Management of Agricultural Loan Portfolios in Developing Countries. *American Journal of Agricultural Economics*, *93*(2), 399–406. http://doi.org/10.1093/ajae/aaq109

Miranda, M. J., & Gonzalez-Vega, C. (2010b). Systemic Risk, Index Insurance, and Optimal Management of Agricultural Loan Portfolios in Developing Countries. *American Journal of Agricultural Economics*. http://doi.org/10.1093/ajae/aaq109

Miranda, M., & Vedenov, D. V. (2015). INNOVATIONS IN AGRICULTURAL AND NATURAL DISASTER INSURANCE, *83*(3), 650–655.

Morrison, M., & Brown, T. C. (2009). Testing the Effectiveness of Certainty Scales, Cheap Talk, and Dissonance-Minimization in Reducing Hypothetical Bias in Contingent Valuation Studies. *Environmental and Resource Economics*, *44*(3), 307–326. http://doi.org/10.1007/s10640-009-9287-3

Norton, M., Osgood, D., Madajewicz, M., & Peterson, N. (2012). Evidence of Demand for Index Insurance : Experimental Games and Commercial Transactions in Ethiopia, 1–24.

Sarris, A., Karfakis, P., & Christiaensen, L. (2006). *Producer Demand and Welfare Benefits of Rainfall Insurance in Tanzania*.

Shoji, M. (2010). Does Contingent Repayment in Microfinance Help the Poor During Natural Disasters? *Journal of Development Studies*, *46*(2), 191–210. http://doi.org/10.1080/00220380902952381

Appendix

A.1: Survey WTP Question

E.4 Willingness to Pay

We are now on the last section of the survey. In this section you will be asked three hypothetical questions about whether or not you would take out certain loan products that are insured with drought insurance given how much you would have to pay back on the loan to receive it. At this time these loans are not available on the market and they may never become available. I will describe the loans in a few moments.

The goal of these questions is to understand how valuable farmers think these products are. For each question I will introduce the loan product. I will then ask you if you would take out this loan given an

amount that you would have to repay. I will give you the amount in the question. To my question, you can respond yes, no, or you may decline to answer if you wish for any reason. These answers will not directly impact loans you receive this year but could help banks to design loans in the future.

Insured Loan Description

An Insured Loan is like the loan you take out from the bank. The repayment schedule is the same, however the amount you need to repay may be a little higher because this loan comes with insurance.

Insurance is a product that people can buy to help them deal with different risks that they face in life. There are many kinds of risks and therefore many kinds of insurance. One common kind of insurance is health insurance, which helps people deal with the risk of having large expenses due to medical care. When you buy health insurance, you pay the insurance company small amounts of money at a time and then the insurance company will pay the doctor to treat you when you get sick. If you don't get sick, the insurance company does not pay anything out for you, if you do get sick, they pay money to help you cover the costs of the doctor.

Similar to health insurance, there is drought insurance that helps people deal with the risk of experiencing a drought. It is this kind of insurance you would get if you chose to take out an insured loan. With drought insurance money is paid to the insurance company and if there is a drought in your region, there will be a payout from the insurance company that will help you cope with the effects of the drought. If there is no drought then there will not be any payout from the insurance company. It is just like health insurance.

The Drought Insurance covers the three main stages of the maize growing cycle:

1. The germination phase
2. The crop growth phase
3. The flowering phase

The insurance will payout certain amounts during each phases if there are drought conditions during this phase.

The germination phase: This phase is from early June to mid July. This is the time when the crops are coming out of the ground and are very young. During this phase, if there is never a 10 day period with more than 25 mm of rain or if there are more than 12 consecutive days with less than 2.5 mm of rainfall each the insurance will payout 25% of the value of your loan. If your loan were for 350 GHC then the insurance will payout 87.50 GHC.

The Crop Growth Phase: This phase is from late June to late September. This is the time when the crops start small but grow a lot. During this phase, if there are more than 12 consecutive days with less than 2.5 mm of rain, there will be a payout. This payout increases with every additional consecutive day of less than 2.5mm of rainfall. If there are 24 consecutive days with less than 2.5 mm of rain each, the insurance will payout 50% of the value of your loan. If your loan were for 350 GHC then the insurance will payout 175 GHC. (See table 1 for more details)

The Flowering Cover Phase: This phase is from early August to late September. This is the phase when the maize crop matures. During this phase, if the total rainfall drops below 150mm of rain for the whole time

period, the insurance will make a payout. This payout increases when there is less and less rainfall. If there is 75mm or rainfall or less, the insurance will payout 100% of the value of the loan. If your loan were for 350 GHC then the insurance would payout 350 GHC. (See table 2 for more details)

Stipulations

1. With this insurance policy you will never receive a payout more than the full value of your loan.
2. The drought insurance only covers losses due to drought and not crop losses caused by any other cause such as insects, crop disease, or animal damage.
3. Rainfall measures are recorded by the Ghana Meteorological Agency; not by you, GAIP, your bank, or any other organization.
4. The insurance does not make payouts every year, but only in years when there are drought conditions. In the past 30 years there has been 10 years in which there has been some payout.

Payout Schedule

1. Payouts are issued at one time at the end of the growing season.
2. Payouts can be made directly to you or to the bank for payment of loans. When it is paid directly to you, it will be paid in cash and delivered by an insurance agent.

E.4.1.a

This Drought insured loan is a loan with an insurance policy designed to cover the risk of drought for maize during the 2015 farming season. In the case of severe drought, you would be compensated with a cash payout made directly to you.

The amount of the insurance payout will be determined by rainfall measured at a local rainfall station within 15 kilometer from your plot of land. There is a small chance that the rainfall measured at the station will not perfectly match the rainfall you experience on your farm plot. If you do not experience a drought but the rain fall station does, you will receive a payout anyways. If you do experience a drought but the rain fall station does not, you will not receive a payout. If there is a severe drought here it is very likely that there will also be one at the station.

Now that I have explained this I will proceed with the first question. But first I would like to ask you to please take a moment to think after each question before you answer and try to answer in the way that you would if I was really selling the loan products to you for the offered price. These questions are important for our research so we appreciate your effort to answer them as accurately as possible.

Imagine that you wish to take out a loan for 350 GH¢ and the bank offers the insured loan that I just described to you.

Would you take out this insured loan if you had to pay _____ GH¢ to pay off the loan? (1. Yes, 0. No (skip to next WTP question), 888. Did not say (skip to next WTP question))

_____

E.4.1.b

How sure are you that you would take out this loan if you had to pay _____ GH¢ to pay off this insured loan? (1. Definitely sure, 2. Probably sure, 888. Did not say)

_____

A.2: Distribution of Individual WTP Estimates

Figure A1: Distribution of WTP Estimates for Product 1

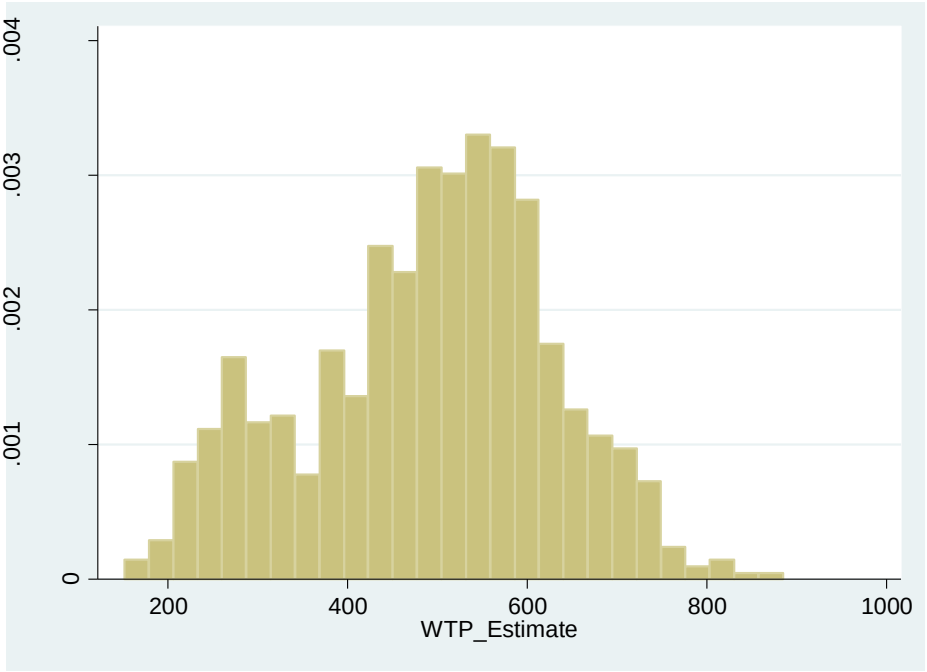


Figure A2: Distribution of WTP Estimates for Product 2

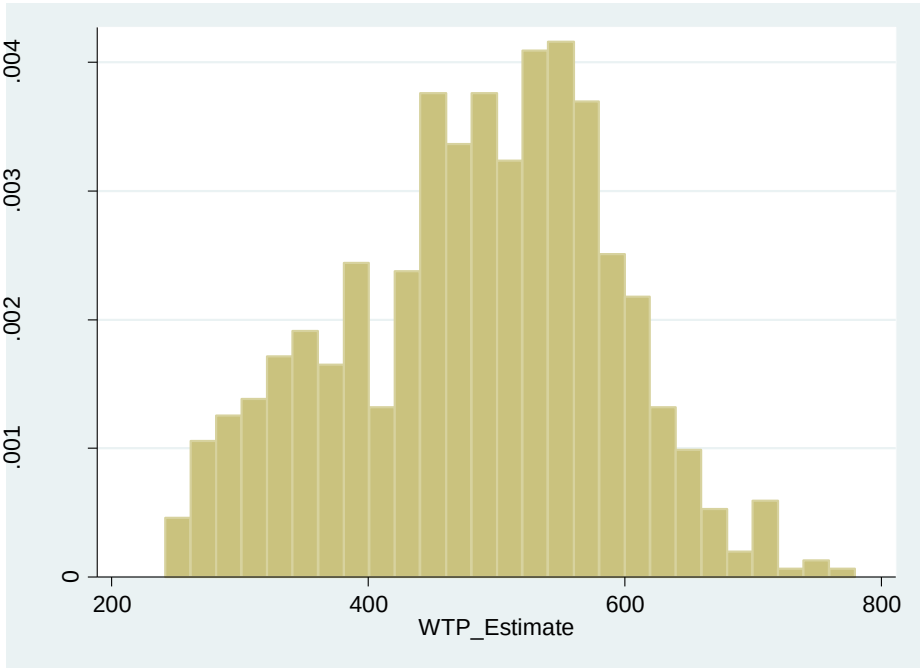
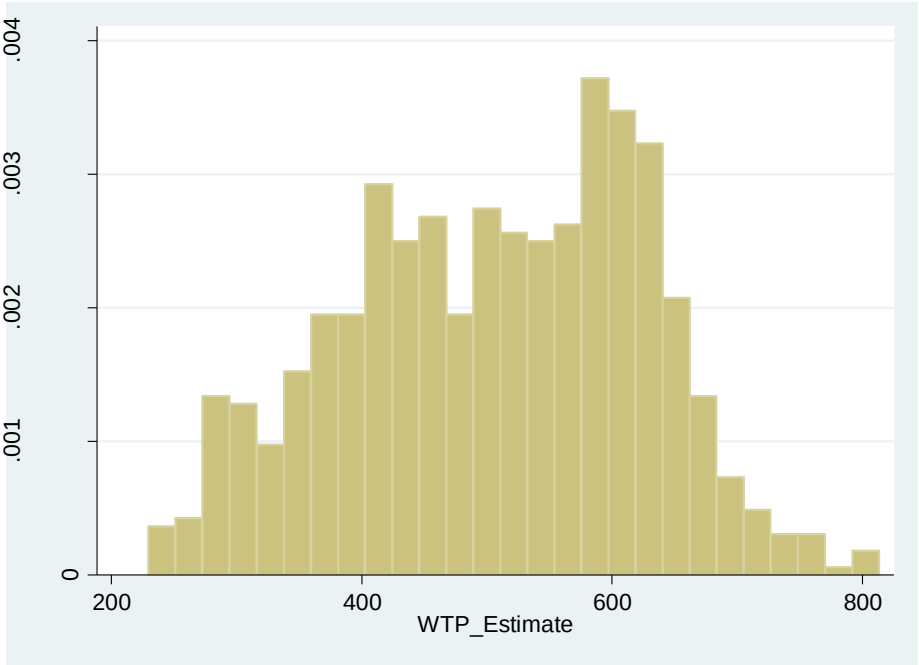


Figure A3: Distribution of WTP Estimates for Product 3



A3: Subsidized Market Viability

Figure A2: Percentage of Sample Population WTP above Insured Loan Repayment Rate at Subsidized Levels