Spring 5-9-2017

The Effect of Risk and Time Preferences on Agricultural Decisions Among Farmers in Malawi

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by

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Submitted in partial fulfillment
of the requirements for the degree of
Master of Arts Economics, Hunter College
The City University of New York

2017

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I. Introduction

The agriculture industry is essential to developing economies. In poor and developing countries, agriculture can make up more than fifty percent of total national output, and up to 80 percent of the labor force (Timmer 1988). Even as countries develop and gain wealth, agriculture "seldom declines to less than 20 percent of any country's economy" (Timmer 1988). Despite its massive share in the output of poor countries, the agriculture industry in developing areas is usually composed of household farms and individual or joint actors making production decisions. These individual agricultural producers' decisions play vital roles in the financial state of a country, national agricultural output, and the potential and path for economic growth. Understanding how these decisions are made and the factors that influence and shape these decisions for individual poor farmers is therefore of vital importance.

Agricultural producers in developing countries face incredibly high levels of risk and uncertainty. At the same time, in poor countries, insurance and credit markets are often absent and, at best, imperfect. In light of these inadequacies in insurance and credit, farmers and others must utilize imperfect mechanisms to smooth and boost consumption. For example, farmers may choose more reliable yet less productive crops, may adopt technology at slower rates, and/or may utilize a vast network of household and village financial transfers to alleviate disutility from risk and uncertainty. Understanding how poor farmers manage and mitigate risk can offer insight into seemingly suboptimal agricultural decisions; these decisions may be better explained by studying the tools available to them. Moreover, determining the risk and time preferences of poor farmers can potentially explain certain agricultural decisions that may lead to higher levels of revenue and savings, and therefore economic growth.

This study utilizes the baseline survey of a randomized control trial conducted in Malawi in 2006. Xavier Gine and Dean Yang (2009) use this full experiment to determine the relationship between insurance, credit, and technology adoption. While Gine and Yang's findings are useful in understanding the choices of poor farmers when offered credit to adopt hybrid seeds and production risk insurance, the data available in the baseline survey remains potent with fundamental relationships that have yet to be explored. The study and experiment were conducted by a multitude of organizations and NGOs in 2006. In this study, I utilize observations from 787 participating farmers in 32 locales in Malawi. I examine how risk and time preferences among these poor farmers in Malawi can shape and explain different agricultural inputs and decisions.

This paper's results show that risk and time preferences have a significant effect on agricultural production and input decisions. Allocation decisions on labor, tools, technology, and other inputs can partially be explained by participant's risk aversion and patience. These same decisions and inputs are significantly explanatory of savings and credit levels of participants. Risk and time preferences therefore can significantly explain agricultural decisions, which have real monetary and financial implications.

The remaining sections are as follows: Section 2 is on Related Literature and describes related and previously conducted studies; Section 3 is on the Data used and the empirical background of this study; Section 4 is on the Results found; Section 5 offers Discussion of the results; Section 6 concludes.

II. Literature Review

A large portion of literature in development economics focuses on the barriers and imperfections in the credit, savings, and technology markets. These three markets are usually of great important both theoretically and empirically because of their connections with household consumption, savings, and uncertainty and risk. Capital accumulation in the form of savings central to poor economies because it is most likely the only source for intertemporal consumption smoothing. Saving at a household level in poor countries "is likely to remain the predominant source of capital accumulation in developing countries" because of "threats of expropriation, repudiation and other hostile acts against foreign suppliers of capital, and donor resistance to significant increases in aid" (Gersovitz 1988). Savings is central to development theory in that it can allow for smooth consumption in face of volatility and risk in income. In poor countries, this volatility and risk is higher than in developed countries; "Saving behavior can only be understood fully after the sources of uncertainty facing decision-makers and their opportunities for responding to them are specified" (Gersovitz 1988). Insurance adoption and utilization is, therefore, an essential question in the field of development economics.

An individual's relationship with savings is inherently connected to the risk and uncertainty she faces. Gersovitz (1988) explains "a saver's exposure to these uncertainties depends not only on whether the variables are random, but also on the opportunities he has for insurance. Future agricultural income may be risky, but if these risks are insurable through crop insurance that is actuarial fair, then the individual can insure and need not take this uncertainty into account in choosing his savings." Savings, in theory offer the possibility for higher and smoother consumption. Actuarially fair insurance can offer another option for consumption smoothing and managing uncertainty and risk. Because of insurance's potentially significant role

in consumption, borrowing constraints and imperfections in insurance markets in poor countries are abundant in development economics literature.

Dercon and Christiansean (2011) summarize the literature on insurance markets in poor countries well:

> Households in poor developing countries are typically ill equipped to cope with large shocks. Formal insurance schemes are mostly absent and informal risk-sharing arrangements and savings offer only partial consumption smoothing (Morduch, 1995; Townsend, 1995, Dercon 2002). Especially the consequences of covariate shocks, such as droughts, are most often hard felt, often affecting people's welfare many years after the shock (Dercon, 2004). In anticipation of such outcomes, households, especially poorer ones, may opt for less risky technologies and portfolios in order to avoid permanent damage. Yet, these often also generate lower returns on average (Just and Pope, 1979; Rosenzweig and Binswanger, 1993).

As a result, risk may lead to poverty traps where "wealthier agents obtain higher yielding, higher risk portfolios, while smoothing their consumption."

Imperfections in insurance markets in poor countries arise because of adverse selection and moral hazard. Insurance markets may be lacking in developing countries because only the riskiest clients may seek insurance, or in other words, because of adverse selection. Moreover, moral hazard, where insurance can create and increase risky behavior, can also lead to inefficiencies in the insurance market. Trust in insurance contracts can affect the demand side of insurance markets. If farmers do not believe they will receive a fair payout, demand for insurance contracts may be low. Karlan et al. (2014) find that farmer investment is constrained by uninsured risk: "When provided with insurance against the primary catastrophic risk they face, farmers are able to find resources to increase expenditure on their farms." Demand for insurance is nevertheless affected by trust in insurance agencies, and is found to be "in subsequent years… strongly increasing with the farmer's own receipt of insurance payouts, with

the receipt of payouts by others in the farmer's social network and with recent poor rain in the village."

Insurance imperfections sometimes occur in the form of "risk rationing". Boucher, Carter, and Guirkinger (2008) highlight this phenomenon, which can lead to inefficiencies in the insurance market. Boucher et al. explain, "risk rationing occurs when insurance markets are absent, and lenders, constrained by asymmetric information, shift so much contractual risk to the borrower that the borrower voluntarily withdraws from the credit market even when she has the collateral wealth needed to qualify for a loan contract." As a result, "risk rationed individuals will retreat to lower expected return activities and occupations" Boucher et al. (2008). Again, inefficiencies in insurance markets lead to inefficient agricultural outcomes for individuals in poor countries.

A lack of insurance, or imperfect insurance markets, can lead to low adoption rates of technology and tools. Dercon and Christiaensen (2011) found in a study in Ethiopia: "Controlling for unobserved household and time-varying village characteristics, it emerges that not just ex-ante credit constraints, but also the possibly low consumption outcomes when harvests fail, discourage the application of fertilizer. The lack of insurance causes inefficiency in production choices." Applying fertilizer is a known technology to increase productivity and often decrease production risk for farmers. As seen in Ethiopia, adoption of fertilizer is limited by access to insurance. Faced with imperfect insurance markets, poor farmers may lose access to economic mobility and growth, and may take on risk mitigating behaviors that affect their output, productivity, and livelihood.

When actuarially fair insurance is present in poor countries and agrarian economies, take-up of insurance may be lower than theoretically expected. Mobarak and Rosenzweig (2012) find that take-up of insurance in India is "puzzlingly low," and may be due to informal risk sharing practices. In light of imperfect insurance, the poor may have networks and practices of sharing risk among households, friends, and villages to increase consumption. Nevertheless, these informal mechanisms are often empirically imperfect, and, for example, rainfall insurance may still provide value even when informal mechanisms are already in place. Take-up was similarly low in studies in Andhra Pradesh, India due to a similar hypothesis. Gine, Townsend, and Vickery (2008) find a 4.6% take-up of rainfall insurance (Gine 2009). Cole et al. (2013) finds a 27% take-up of rainfall insurance in Gujarat. These low take-up rates of insurance correlate well with the findings of Duflo, Banerjee, and Hornbeck's (2014) randomized control trial in Karnataka, India. When bundles with microfinance, health insurance led to a "23 percent drop-out from microfinance." Xavier Gine and Dean Yang (2009) had similar drop offs in insurance take-up when credit and weather insurance were bundled. The uninsured loan was taken up 33% more often than the insured loan in their field experiment in Malawi. The result of low take-ups was low adoption of newer, hybrid seeds that would also increase productivity and reduce weather related risks.

Limitations in credit markets have similar negative effects on production and potential consumption levels in poor, agrarian economies. Ideally, markets for credit should allow for consumption smoothing for even the riskiest of income streams. With poor farmers facing relatively high levels of risk, credit lines are central to questions of development, savings, and consumption. Boucher et al. explain, "in a competitive world of symmetric information and costless enforcement, credit contracts could be written conditional on borrower behavior.

Borrowers would then have access to loans under any interest rate-collateral combination that would yield lenders a zero expected profit" (Boucher 2008). However, in effect, these markets face shortcomings because of issues of information asymmetries, imperfect enforcement, and failures to adopt technology. These imperfections lead to contracts that that do not offer high interest rate and low collateral options (Boucher 2008). As a result, there is an overall lacking of formal credit in developing areas.

Gersovitz (1988) explains the effects of potential borrowing constraints that disproportionately affect the poor.

> "For one thing, the poor may be more desirous of borrowing to offset various shocks than the rich because: (1) they experience shocks that are proportionately larger, say because there are economies of scale that discourage them from diversifying their income sources; or (2) the marginal utility of consumption is such as to place a premium on very stable consumption at low incomes, say because subsistence requirements must be met; or (3) the poor save proportionately less than the rich, and so have relatively less wealth to buffer consumption."

Access to credit is therefore arguably more important for the poor, but may be in effect less available.

Credit is also limited by ex-ante and ex-post moral hazard, as well as opportunistic default. Eswaran and Kotwal (1989) find that the poor "could be less able to smooth consumption ex-post, due to credit constraints." Feder, Just and Silberman (1985) alternatively propose that information costs may be higher for the poor, or they may not be able to access credit which can lead to difficulty in financing new technology adoption (Alderman and Paxson 1994). A great deal of literature focuses on the limitations in the supply of credit in these poor countries. Information asymmetries, and borrowers honesty about their ability to fulfill contracts both affect the availability and breadth of credit available. Similar to the imperfections with

insurance markets, limitations in credit markets lead to suboptimal agricultural decisions and lower average consumption.

Finally, technology adoption may be lower in face of imperfect credit and insurance markets, and high levels of uncertainty and risk. With regards to poor agrarian economies, Timmer (1988) explains, "technical change is the source of most growth in productivity in the long run, since continued investment in capital that embodies traditional technology very quickly faces low marginal returns [Schultz (1964), Hayami and Ruttan (1985)]." Adopting new technology can lead to increase in output, lower volatility in production level, which in turn can lead to higher consumption and savings levels. Technological adoption may be low in poor countries for a multitude of reasons.

One explanation for low technological adoption rates rests in high levels of risk with limited means for risk mitigation. When "options to smooth consumption ex post" are constrained, Dercon (1996) finds farmers in Shinyanga, Tanzania utilize sweet potatoes, a less risky crop, and reduce their income by up to twenty percent in order to decrease risk. Informal risk mitigating practices may be in competition with technology adoption. Gine and Yang (2009) find that hybrid seeds, which can increase output and decrease weather related production risk, are only adopted increasingly more when farmers are offered credit to buy the seeds.

Understanding risk and uncertainty is central to understanding the mechanisms of poor farmers' lives and production choices. Poor agricultural workers are wrought with decisions and uncertainties about their income and consumption levels. These individual decisions aggregate to create developing economies' largest industry, agriculture, which is "over 50 percent of national output and up to 80 percent of the labor force…in early stages of development." Most

importantly, the effects of agricultural decisions are always relevant in a country's economy, because "'agribusiness' seldom declines to less than 20 percent of any country's economy" (Timmer 1988). The decisions poor farmers make are consistently affected by the risk and uncertainty they face. Often they "talk primarily about two topics: the weather and prices" (Timmer, 297). Farmers are consistently subject to volatile and uncertain changes in weather and price, both of which affect agricultural decisions. When making important farming decisions about what inputs and labor should be utilized, "the farmer can only guess at the prices for the output" (Timmer, 298). Risk and uncertainty with regards to weather can lead "farmers to choose crops that will resist weather extremes, particular varieties of crops that are more tolerant of weather variations, and lower levels of inputs than would be optimal in a certain world due to the risk of losing the investment altogether," and can have "aggregate consequences" because of widespread weather shocks (Timmer 1988). Therefore, incorporating risk into empirical models for agricultural decisions is most likely of value. Just (1974) explores a model that incorporates variability in price, cost, and yield on farmers in California.

James Roumasset (2002) argues that the "constraint" hypothesis is lacking in explanatory power. This hypothesis "is the proposition that farmers are rational but constrained by a variety of factors beyond their control. Farmers are said not to adopt recommended practices for example because they are constrained, not only by risk aversion but by a lack of credit, irrigation, knowledge and even good weather". Rousmasset argues these constraints are not in fact the driving forces for decisions, but instead considering "economic circumstances, market environment, climate, soil, topography, irrigation, and economic and agro-physical characteristics" may give a better picture. He furthers that "behavior models that take these difference into account have relatively high explanatory power" (Roumasset 2002).

Understanding the impact of risk and uncertainty on poor farmers is essentially tied to how poor farmers view and deal with risk. Uncertainty and risk leads to three different phenomenons: risk management, risk coping, and risk sharing (Alderman and Paxson 1994). Risk management focuses on reducing the variability of income by, for example, choosing to plant sweet potatoes because it is a safer crop. Risk coping occurs by saving, in order to cope with shocks and risk intertemporally. Risk sharing occurs when risk is shared across households, villages, and institutions. Risk coping has been discussed above with relation to saving; risk copers trade off consumption now for saving and consumption later.

Risk management is intrinsically tied to technology adoption and "crop portfolios" (Dercon and Christiaensen 2011). Farmers, in order to reduce the high levels of risk and uncertainty regarding weather and production, often utilize risk management strategies. Dercon (1996) found a case of modifying crop portfolios for farmers in Shinyanga, who planted sweet potatoes for more security, even though it led to a 20 percent decrease in income. Kurosaki and Fafchamps (2002) found another example of modifying the crop portfolio to reduce risk in Punjab Pakistan, when farmers planted Basmati rice instead of fodder. Tradeoffs between crop choices and income are a result of imperfect insurance and risk sharing mechanisms. Farmers, to avoid or minimize risk, intercrop and use geographical terrain to diversify their crops. Because of imperfections in risk management and sharing mechanisms, farmers are trading vital portions of their incomes as a form of an insurance premium. (Dercon and Christiaensen 2011).

How poor farmers deal with risk is impacted by their risk preferences. Understanding risk aversion among these agricultural decision makers can give insight to the risk management and informal risk sharing mechanisms that are utilized. Poor farmers are theorized to be risk averse, which leads to agricultural production decisions that avoid or minimize risk. Minimizing this risk

can lead to lower outputs in the future, and the persistence of poverty in the long run. Risk sharing and risk coping mechanisms, such as insurance and other rotational savings groups, are essential for increasing and smoothing consumption, which is highly valuable for the risk averse.

Experimental evidence shows that poor farmers show risk averse preferences and behaviors. Binswanger (1981) finds in a large experiment in rural India "that a portion of the observed variation among individual farmers' agricultural decisions can be related in a systematic manner to variations in the same farmer's experimentally measured degrees of risk aversion, the more risk averse choosing more conservative options." This relationship between experiment and agricultural decisions "suggests the importance of examining the significance of [their] findings for a number of models of behavior under risk, focusing on the consistency of our findings with a varied set of theoretical predictions." Binswanger et al. (1981) find that as payoffs in the experiment increased, risk aversion increased as well, which "clearly indicates that, at high levels of income, virtually all individuals are risk averse". Dillon and Scandizzo (1978) find in Northern Brazil "that a majority, but by no means all, of the farmers exhibited risk aversion and that this was more so when subsistence was at risk, and that risk aversion was more common among small owners than among sharecropper." In general, "Binswanger (1981) and Binswanger and Sillers (1983) find that 'decision makers care only about the losses and gains in a choice rather than their final wealth positions, which contrasts with expected utility theory'" (Alderman and Paxson 1994).

Agricultural decisions and risk management strategies can also be partially explained by time preferences. More patient farmers, those with lower discount factors, may be better at saving and making more prudent production and consumption decisions. Tanaka, Camerer, and Nguyen (2010) find in a randomized control trial in Vietnam that time preferences can help

explain income. More patient farmers had higher incomes in this experiment. Holden, Shiferaw, and Wik (1998) find in Indonesia, Zambia, and Ethiopia that rates of patience were low, which led to low levels of environmental protection. These low levels may lead to lower productivity and increased risk and uncertainty in the future. Time preferences can help explain investment, consumption, and production choices of poor farmers who may have relatively higher discount factors.

This paper will explore the link between risk and time preferences and agricultural decisions. While in much of development literature, risk and time preferences offer great explanatory power for financial and consumption decisions, their role in agricultural production choices is often overlooked. Understanding how these preferences can shape production choices, which can significantly affect savings and income levels can offer a richer picture of the mechanism by which these preferences affect economic outputs and wellbeing.

III. Data

This paper uses data from an experiment conducted in Malawi by multiple organizations and used by Xavier Gine and Dean Yang. This randomized control trial data served as the primary data in Gine's and Yang's (2009) study, "Insurance, Credit, and Technology Adoption: Field Experimental Evidence from Malawi." This paper will only utilize the results from the baseline survey conducted for this experiment to analyze fundamental relationships that were left to be explored in the data.

These organizations include the National Smallholder Farmers Association of Malawi (NASFAM), Opportunity International Bank of Malawi (OIBM), the Malawi Rural Finance Corporation (MRFC), the Insurance Association of Malawi (IAM), and the Commodity Risk Management Group (CRMG) of the World Bank. All of the participating farmers in the study at

the time were members of NASFAM, the largest farmers association in Malawi. NASFAM ensured the delivery of the hybrid seeds that were purchased with these loans. The loans themselves were provided by OIBM and MRFC, two microfinance organizations. IAM and CRMG worked to design and underwrite the insurance policies offered to the participants.

These organizations collaborated to offer loans to 32 different regions in Malawi. In 16 of the regions, participants were offered uninsured loans to take up hybrid seeds. In the other 16 regions, participants were offered loans bundled with rainfall insurance. The structure of the experiment is as follows. OIBM and MRFC offered the loans to clubs of ten to twenty farmers; individual farmers made the decision to take up the loan, but liability was to be joint for the entire club. In June and July 2006, NASFAM contacted these clubs of farmers to participate in this study. From the 159 clubs contacted, 787 farmers consented to participation. 393 of those participants were located in the treatment areas, and 394 were located in the control areas.

The farmers from the control section, the 16 areas that were offered the uninsured loan, were offered a standard contract of debt for the hybrid seeds. A deposit of 12.5% of the product was required in advance. The participants could choose between improved groundnut only or an improved groundnut and hybrid maize seed and fertilizer package. The improved groundnut was found to be more effective than traditional seeds. It produced higher yields, need less time for maturation, had higher disease resistance and drought resistance, and had higher oil content. The groundnut package (ICGV-SM 90704) offered 32 kilograms of seed, which should suffice for one acre of land. This improved groundnut was valued at MK 4692, and was to be repaid about ten months later. The participants faced an annual interest rate of about 33%. Therefore, in the ten month period, MK 1012 was payment for interest, and MK 3680 was cost of the improved groundnut. For the hybrid maize package, total cost was MK 4972.50, with MK 3900 being for

the seeds and fertilizer that was sufficient for half an acre of land, and MK 1072.50 being for the interest. This hybrid maize (DK 8051) package was similarly more efficient than traditional varieties; it had higher yield and was more resistant to disease and drought than even other hybrid varieties.

The farmers in the treatment section, the 16 areas that were offered the insured loans, were offered a bundled contract of debt for the hybrid seeds. The debt contract was identical to that offered to the control group, but they were also offered an actuarially fair rainfall insurance policy. This insurance policy was required to take up the loan. The insurance premium varied by locality. In premium on the improved groundnut package varied from MK 297.98 to MK 529.77. For the hybrid maize package, the insurance premium ranged from MK 647.16 to MK 1082.29.

The insurance plan offered was contingent on rainfall. Depending on the amount of rainfall, the insurance plan would have partial or total payouts for the principal and interest. The total cost of the insurance was a calculated actuarially fair premium and a 17.5% government surtax. The level of rainfall was measured at the nearest weather station; there were four weather stations in total. The time span of coverage was segmented into three phases, sowing, flowering, and harvest. Each of these phases had unique upper and lower threshold values that would have to be met for a payout. If the upper threshold is exceeded, no payout was given. The contract offered a payment for each millimeter of rainfall below the upper threshold. When the lower threshold was met, the contract offered a higher payout. The model of this insurance contract was specifically drafted for the improved groundnut and hybrid maize packages. The total payout to be received over the three phases would equal the loan, premium, and interest.

In September 2006, all farmers in the experiment participated in a household socioeconomic survey. This survey included questions on education, assets, savings habits, crop production, risk aversion, knowledge and trust of insurance and financial tools, and income. After the conduction of the baseline survey, participants were offered in October 2006 the option to take up the loan. The baseline survey is composed of fifteen different sections. The first section is a household roster, which is twelve questions about the composition of the household, and characteristics such as schooling, age, and literacy levels. This section also includes characteristics on the construction of the participant's home and length of time in the current village. The next section includes questions on the characteristics of the member of the NASFAM club, which will not be used in this paper. The third section is questions on land cropping patterns, such as the types of trees planted and the number of growing seasons per plot. The fourth section is on crop production, such as the types and values of seeds planted. The fifth section is on crop sales and marketing, which includes questions on the timing, value, and place of sales of agricultural outputs. The sixth section is on the participant's perceptions, primarily with regards to agriculture and weather. Questions include perceptions on levels and changes of rainfall in past years and perceptions on production levels in past years. The seventh section is on amounts, sources, and types of credit accessed in the past. The eight sections are on amounts, sources, and types of savings the household has. The ninth section is on the type of livestock owned. The tenth section is on the networks and sources of information for the participant and household. The eleventh section questions the amounts of received and given remittances. The twelfth section is on sources of income. The thirteenth section is on the willingness to pay for insurance, and is not used in this paper. The fourteenth section is on self-perceived personality, with questions including whether the participant would describe herself as optimistic and/or confident.

The final section is on risk response and risk attitudes, with questions on consumption changes in response to risk and theoretical gambles to highlight risk preferences.

The data consists of 787 consenting participants in 32 different regions. 393 participants were located in the areas offered insured loans, and the remaining 394 participants were located in the areas offered uninsured loans.

IV. Empirical Section

Methodology and Variables

The baseline survey of the MTARI study in Malawi included a variety of variables on NASFAM club farmers. These baseline characteristics collected in 2006 offer the opportunity to explore fundamental relationships that were not central to Xavier Gine and Dean Yang's (2008) paper, "Insurance, Credit, and Technology Adoption: Field Experimental Evidence from Malawi". To examine the relationship between risk and time preferences and agricultural decisions, I ran a series of Tobit regressions for each variable collected from the baseline survey. In order to account for left censoring in many of the variables created from the baseline survey and avoid bias in my coefficients, I ran a series of Tobit regressions instead of OLS regressions. OLS regression results may be found in the appendix.

All variables used in this paper can be seen in Table 1, which describes the mean, standard deviation, and maximum and minimum value of all included. First, I ran series of regressions of all explanatory variables on total savings, total credit, and net savings (savings minus credit). For each, I ran a series of four to five regressions to determine the explanatory value of the variables. Within these regressions multiple variables are likely to be endogenous

and bias coefficients. To gain a more clear understanding of the impact of risk and time preferences, I conducted the final set of regressions with more likely to be exogenous variables. Finally, to examine the relationship between agricultural decisions and these preferences, I ran a series of Tobit regressions with each decision as a dependent variable, and the risk and time preferences as the independent variables.

All variables were collected from the baseline survey. The variables are listed in Table 1. Some of the variables are descriptive characteristics of the household and participant, such as the gender of the head of household, whether or not the participant is literate, and self proclaimed characteristics such as health status, self confidence, if decisions are made joint or unilaterally, and pessimism. Among these variables, gender of head of household, literacy, self-confidence, decision making (as joint or unilateral) and pessimism are all binary variables because of the nature of questions asked in the survey. Other variables used from the baseline survey measure the financial status of the household. These variables include the total value saved in local currency (MK), the rental price of plots owned (MK), the total value of seeds used in production (MK), the total value of crops produced (MK), the variance in revenue (MK), the number of ROSCAs participating in, the value of annual income (MK), and whether or not the family faced a dramatic decrease in income in the last five years, which is a dummy variable.

Further variables measure preferences of participants with regards to risk and time. Risk aversion variables were pulled from four different questions in the baseline survey. These are tested as four different variables to determine which form of questions gives the best insight into the participants' preferences. The first risk aversion variable is created from the data results in question O18 in the baseline survey and is as follows:

O18) You are going to play a game, I am going to flip a coin. Imagine that you would get the money shown under the GREEN area if it lands on heads or the money shown under WHITE area if it lands on tails. The amount you would win depends on the bet you choose. Which bet would you choose?

The respondent is offered six different bundles to choose from, 50/50, 40/120, 30/160, 20/190, 10/210, and 0/220. With each bundle the risk and rewards both increase, so the respondent's choice can be an indicator of their risk preference. The risk aversion variable used in this paper from this question is a linear measure with values from 1 to 6, with 6 being least risk averse. There are three more measures of risk aversion offered in the survey with question O17. The participants are asked:

O17) On the face scale from where sad face means, "I always try to avoid taking risk" and smiley face means "I am fully prepared to take risks". How would you rate your willingness to take risks… (a) In general (b) with your health (c) in trying new crops varieties.

Respondents are allowed to answer each question with a value between 0 and 10, and are showed a scale with a sad face next to 0 and smiley face with 10. This is another linear indicator of risk preferences. Only the measures for new crop varieties and health are correlated and statistically significant when regressed on the first measure of risk aversion, as seen in Table 6. This may mean participants did not understand part (a), when asked how much risk they are willing to take on in general, but could better actualize the question with regards to health and crop decisions.

Time preferences are measured in two ways. Question O13 offers three different bundles where the participant can have 1000MK today, or a greater value in 30 days. If the participant

chooses any value other than the 1000MK today, it means they have a degree of patience that can be compensated by the higher bundle offered. This question's results are created into a dummy variable, *patient*, where if the respondent chooses any bundle other than the 1000MK today, they are patient. A continuous time preference variable is created with question O14, which asks:

> O14) If the answer in a, b, c is (1), then: How much would the prize have to be for you to choose to wait 30 days MK

The difference between the prizes the participant chooses and the 1000MK offered today is calculated as their discount factor. A higher discount factor is related to a lower amount of patience.

The remaining variables are all related to agricultural decisions and inputs. These variables include the number of types of trees that are planted, total acreage of plots, number of growing seasons for all plots, total amount spent on chemical protection (MK), total amount spent on fertilizer (MK), total amount spent on implementation tools (MK), total amount spent on irrigation (MK), total amount spent on manual labor (MK), total amount spent on manure (MK), total amount spent on oxen labor (MK), dummy variables for the usage of child labor or machine labor, total amount spent on manure (MK), the mean number of vendors used, the total amount of crops produced (kgs), and the ratio of sole to intercropped crops.

Results

Table 2 shows the results from regressing all of the variables listed in Table 1 on the total amount of savings the participant and/or their household has. Income and savings are positively correlated; with a 1 MK increase in income leading to a .0673 MK increase in savings. This result is most likely biased because income and savings are likely jointly determined. The mean

number of vendors is positively correlated with savings as well. Utilizing one more vendor on average correlates with a 2476 MK increase in savings. Working with more vendors may increase risk and liabilities for farmers with the possibility of more flexibility and return. This correlation may indicate that farmers who save can afford the higher risk associated with vendors. With regards to agricultural choices, the significant results are as follows. The ratio of sole to intercropped crops is also consistently statistically significant at a 5% level. If the household only has sole crops, and does no intercropping, they are likely to have 12563 MK more in savings than a household that does entirely intercropping. Intercropping and saving are two methods to potentially deal with risk, with the two potentially acting as substitutes. Intercropping may reduce the willingness of the family to save, or high saving ability may allow families to not intercrop and face higher but more volatile returns. Spending on oxen labor, chemical protection, and spending on manual labor are all statistically significant at the 1% level. 1 MK spending more on oxen labor is correlated with 7.335 MK more saving, 1MK spending on chemical protection is correlated with 6.191 MK more in savings, and 1 MK spending more on manual labor is correlated with a 2.166 MK increase in savings. Each of these choices is positively correlated with savings. Each of these choices can also be seen as investments in agricultural production. The positive correlation with savings may indicate the propensity to invest in these farmers; if willing to invest in savings, farmers may also be willing to invest in these choices for the same reasons. The total acres of land the household uses is positively correlated with savings. Each increased acre leads to 952.2 MK more in savings. Both savings and land are investments in the financial status of the family, so the positive correlation may be an indicator of the household's attitude towards investment. Households may also need to save up in order to purchase more land in the future.

Tables 3 and 4 show the results of regressing on credit and net savings respectively. For credit, spending on implementation tools is significant at the 1% level. An increase in one MK of spending on implementation tools has an increase of 5.415MK in credit. Buying implementation tools is most likely very costly up front, and may have high transaction costs associated with it. Spending on manual labor has a similar yet smaller effect with a correlated 1.063MK increase in credit. Spending on manure also has a positive correlation, with 2.62MK increase in credit for every credit dollar. This is most likely for the same reason as the relationship with manual labor. Farmers who view themselves as progressive have 7392MK less in credit than those who do not. Those who are pessimistic also have credit taken out that is 7974MK lower than those who are not. Risk aversion is negatively correlated with credit; each point of risk aversion has a correlated 2243MK less in credit. Credit is risky, and progressive, pessimistic, and/or risk averse farmers may like to avoid risk. Finally, higher variance in revenue has a small positive effect of .015 on credit, which indicates that it may be used in a negligible amount to smooth consumption. Table 4 on net savings shows similar results to those found with credit and savings. There is a positive correlation between income, plot size, chemical protection spending, manual labor spending, the mean number of vendors used, oxen labor spending, and the sole ratio.

In Table 5, we can observe the relationship between agricultural decisions and the four different measures of risk aversion and the continuous time preference variable. These ten regressions conducted ideally lessen the bias from endogeneity that the previous regressions faced. In the regressions on savings, credit, and net savings, many of the independent variables are most likely jointly determined with the dependent variables. For example, income and savings are most likely jointly determined, and would bias the coefficients. Table 5 shows the

effect of risk and time preferences on agricultural decisions; ideally these variables are less likely to be jointly determined than in prior regressions. Nevertheless, the preferences and decisions may be jointly determined and face an endogeneity problem. For example, farmers who face dramatic income shocks in recent times may answer the questions indicating they are less patient and more risk averse afterwards. In this case, coefficients may still be biased and the issues of endogeneity with risk and time preferences should be further explored.

Column 1 shows the regression of risk and time preferences on the total amount of spending on implementation tools. None of the preferences are statistically significant for this regression. Column 2 shows the regression of these preferences on variance in total revenue. The risk aversion variable is positively correlated, but not statistically significant. Risk willingness in general, when increased by one unit, is correlated with an 8554 MK increase in revenue variance, and is statistically significant at a 5% level. In other words, less risk averse farmers make decisions that are riskier, which leads to higher fluctuations in income. Risk willingness with health decisions is statistically significant at the 5% level, and is negatively correlated with revenue variance. This may indicate that riskier and higher reward streams of revenue require healthier bodies. Taking fewer risks with health may be central to obtaining higher and more volatile income streams. Column 3 shows the relationship between the preferences and the dummy variable of the household having had a dramatic decrease in income in the last five years. Only the two general risk aversion preference variables are statistically significant in this regression, and both are positive in sign. Each unit decrease in risk aversion is correlated with a 2.13% increase in the chance of having faced a dramatic risk in the past. Each unit increase in general willingness to take on risk explains a .936% increase in the chance of having faced this income decrease in the past five years. Less risk averse farmers may have made riskier decisions

in the past year, which has led to dramatic shocks to income. Column 4 shows the regression of the ratio of sole to intercropped crops on risk and time preferences. Risk willingness with regards to health, and in general, are both statistically significant and positively correlated with this ratio of sole to intercropped crops. These effects are relatively small, and may indicate that the sole to intercrop ratio helps ration risk. Column 5 is the same regression with the amount spent on oxen labor as the independent variable. None of the preferences are statistically significant. Column 6 is the regression with the mean number of vendors used as the independent variable. Risk willingness in general and with regards to crops are both statistically significant with the number of vendors. Risk willingness in general is positively correlated, with a one-unit increase in risk willingness explaining a .0534 increase in mean vendors used. Each individual vendor poses a higher risk of a contract falling through or not being fulfilled as promised. Interestingly, when risk willingness with regards to crop variety is increased by one unit, the number of mean vendors decreases by .0579. This may mean that farmers who are more willing to take on risk with their crops are not willing to take on the risk of having many vendors. This result may be an indicator of the preference of risk distribution for households. Finally, more impatient farmers utilize a higher number of vendors. Statistically significant at 1%, each 1 MK increase in the time discount factor is correlated with an 8.40e-07 increase in mean vendors used. While the magnitude is small, the time discount factor had a mean of 60095.95 MK. Those who are more impatient may deal with more vendors because they can get payouts earlier rather than later, or can potentially bargain for better deals if willing to wait with more competition among vendors. Column 7 regressed the preferences on total amount spent on manure. Only risk aversion comes up as statistically significant. One unit increase in risk aversion is correlated with 340.6 MK lower spending on manure. More manure may offer less certainty in production output and can

increase risk and uncertainty. Column 8 regresses on total spent on manual labor (MK). No preferences are statistically significant except for time discount factor at the 10% level. More patient people spend less on manual labor. Column 9 shows the regression on total plot area (acres). Only risk willingness with regards to health is statistically significant. One unit increase in this risk willingness explains a .108 acres decrease in plot size. Increasing plot size may be more labor intensive, so farmers willing to invest in land may be risk averse with regards to their health (and the possibility of not being able to use their own bodies for labor). Column 10 shows the regression on total spent for chemical protection (MK). Similar to column 9, only risk willingness with regards to health is statistically significant and negative in sign. One unit increase in risk willingness explains a 176.1 MK decrease in spending on chemical protection. Farmers who invest in protecting crops are taking resources away from tools that make labor more efficient and less necessary. Allocating resources to protection means the farmer may be more unwilling to take on risks with their health because their labor is important.

All of these coefficients, for regressions found in tables two through five, were downwardly biased when using the OLS regressions shown in the appendix. These coefficients in the Tobit regression are higher than the coefficients in the OLS regression because of the left censoring of the variables. For example, when looking at the effects on savings, there are effects on savings we cannot observe with the data. When farmers would like to dissave (save negative amounts), but cannot, they record having zero savings. Frustrated farmers unable to dissave are treated the same in the data as farmers who do not wish to save. Therefore, the censored data of the frustrated farmers results in a downward biased OLS coefficient because all negative values in this case (of the frustrated farmer who wishes to dissave) are treated as zeros. In this case, the OLS estimates would appear too flat. In order to adjust for this downward bias in the OLS

regression, I run Tobit regressions and find the same statistically significant patterns, with higher coefficients, indicating that the OLS estimates were in fact biased downwards.

V. Discussion

Examining risk and time preferences on agricultural choice may offer a richer picture of the individual farmer's decision-making process. The results of this paper highlight two topics for discussion: the validity of surveying risk preferences, and risk and time preferences' explanatory power in agricultural decisions. Binswanger et. al find that farmers are risk averse and treat experimental gambles similarly to actual production choices. Yet other researchers find that these experimental are restricted by the cognitive abilities of participants and the context of the questions asked. For example, Cook et al. (2013) find in Kolkata, India "a sizeable minority had difficulty understanding the experiment, and participants were influenced by the context in which the experiments 20 occurred (these problems are not unique to our study)…[which] adds to a growing literature that suggests that risk aversion elicitation approaches are sensitive to context and cognitive abilities of participants." The baseline survey used for this paper had four different questions that elicited risk preferences. One included hypothetical gambles in increasing riskiness and payout, and three general self-reported risk willingness metrics separated with regards to general decisions, health related, and crop related. Each of these questions offered different explanatory results for the agricultural decisions the farmers had made. Moreover, each metric was only slightly correlated with one another. All of the risk preference variables correlate weakly, with the greatest correlation between risk willingness (general) and risk willingness (health) at .38. The weakest correlation was a surprising -.0173 between risk aversion (gambles) and risk willingness (health). Differences in responses to these four questions may be influenced by competency and cognitive ability. These differences may

also highlight significant differences with regards to risk preferences. As seen in the main results of this paper, farmers may be much less willing to take risks with their health when their own bodies are needed for manual labor. Understanding risk taking with regards to crop choices and health may be easier to understand compared to the relatively ambiguous question on risk willingness in general.

Each of the four risk preference measures offer significant explanatory power in the agricultural decisions focused on in this paper. Time preference seems to play less of a role in this decision making process, which may highlight the lack of flexibility in scheduling for farmers. These participants, even if highly impatient, may not have many opportunities to take large risks that potentially pay out immediately. The agricultural decisions tested in this paper, except for mean vendors used, are not well explained by time preferences potentially for this reason.

Risk preferences can explain variance in revenue and if a family faced a dramatic negative shock to income in the past five years. Risk preferences can also explain participants' allocation of resources. Those who are more risk willing with regards to their health have smaller plots, spend less on chemical protection, intercrop less, and have lower revenue variance. Higher risk willingness with regards to crops only significantly affects the mean number of vendors used, which implies that taking more perceived risks on crops decreases the willingness to take risks with more vendors. Being more risk willing in general reasonably means a higher likelihood of having faces dramatic income risk and higher revenue variance, but also more sole cropping and vendors used. Intercropping appears to be a form of risk management, with more risk willingness associated with sole cropping. Utilizing more vendors is a risky endeavor, and may not be preferred if risks are already taken with crop choices and management.

These agricultural decisions are significantly correlated with higher levels of savings. Utilizing more vendors, having more land, sole cropping, and using chemical protection and manure all explain higher levels of savings. Risk preferences, which can be separated into distinct categories with regards to in general, and with health and crops, can explain agricultural choices, which lead to higher levels of savings. These higher levels of savings, arguably, can lead to boosted and smoother consumption for families, and may offer economic mobility in the future. Therefore, risk preferences may not be correlated directly with savings, but instead through a mechanism of influencing agricultural production choices.

VI. Conclusion

Understanding how poor farmers deal with risk and uncertainty and large amounts of decision-making can offer insight into savings, consumption, and economic growth. Central to this understanding must be both risk management and risk preferences. While savings, insurance, and technology can all boost consumption and offer smoother consumption, risk and time preferences can help explain the choices farmers make. In this paper, risk preferences are explored with regards to health and with crop as well, which offers insight into nuances within risk preferences, and the potential cognitive limitations of participants.

Table 1 - Descriptive Statistics

	Obs	Mean	Standard Deviation	Min	Max
Total amount saved	1087	20023.74	51377.26	0	1010000
Total price of plot rentals	1087	8715.322	46010.63	0	1000000
Value of seeds	1087	1235.62	3096.099	0	56740
Value of crops produced	1087	9980.649	115765.9	0	3715050
Revenue Variance	1087	32423.24	334392	-456680	6532680
Number of ROSCAs	1087	0.0781969	0.2852308	0	2
Net Remittances	1087	164.8974	2078.598	-30000	28050
Income	1087	7901.594	50215.55	0	1185000
Dramatic Income Risk (past 5 yrs)	1087	0.7433303	0.4369966	0	1
Number of types of trees	1087	68.56469	404.603	0	10014
Acreage of plots	1087	4.2442	5.283635	0	70
Number of growing seasons	1087	1.012657	0.1873099	0	2
Total spent on chemical protection	1087	131.1377	959.8915	0	26025
Is child labor used?	1087	0.0340386	0.1814119	0	1
Total spent on fertilizer	1087	791.902	10450.48	0	245000
Total spent on implementation tools	1087	61.77553	1045.488	0	30000
Total spent on irrigation	1087	47.35971	405.4263	0	9000
Is machine labor used	1087	0.025759	0.1584883	0	1
Total spent on manual labor	1087	1700.919	5698.29	0	86500
Total spent on manure	1087	269.5017	1599.026	0	38900
Mean vendors	1087	1.133073	1.644556	0	18
Total spent on oxen labor	1087	211.4853	934.9459	0	15150
Total crops produced (kgs)	1087	834.8279	1920.095	0	33777
Sole ratio	1087	0.849149	0.3285485	0	1
Head of household gender	1087	0.8776449	0.3278463	0	1
Self health status	1087	1.882245	1.045435	0	5
Literate	1087	0.2106716	0.4079733	0	1
Joint decisions made in household	1087	0.7681693	0.4221957	0	1
Progressive famer	1087	1.574977	0.7101211	0	3
Pessimism	1087	1.878872	0.8905446	0	5
Self confidence	1087	2.438822	1.237714	0	4
Time discount factor	1087	60095.95	259303.9	0	3999900
Patient	1087	0.0910764	0.2878501	0	1
Risk willingness (crops)	1087	7.091076	3.513193	0	10
Risk willingness (health)	1087	4.125115	3.759945	0	10
Risk willingness (general)	1087	5.324747	3.704604	0	10
Risk aversion	1087	3.535419	2.115101	0	6

Table 2- Effects on Savings (Tobit)

VARIABLES	(1)	(2)	(3)	(4)
Head of household gender	8676			7253
	(5.907)			(5.492)
Self reported health status	-851.5			-795.8
	(1.733)			(1.632)
Literacy	-11,140**			-5823
	(4.598)			(4.313)
Joint decision making	718.1			218.6
	(4.367)			(4.072)
Progressive farmer	-7,230***			-2969
	(2,548)			(2,411)
Pessimism	-678.3			-97.16
	(2.013)			(1.887)
Self confidence	1602			1142
	(1,459)			(1,359)
Patience	4351			2457
	(6.149)			(5.726)
Risk aversion	-275.5			-13
	(834.4)			(785.7)
Rental price of all plots		0.0294		-0.062
		(0.0374)		(0.0441)
Value of seeds		1.855***		-0.0466
		(0.562)		(0.579)
Value of crops		0.00596		-0.00595
		(0.0148)		(0.0138)
Revenue variance		0.00584		0.0053
		(0.00515)		(0.0048)
Number of ROSCAs		4971		1321
		(6,093)		(5.715)
Net remittances		-0.724		-1.262
		(0.849)		(0.797)
Income		0.0779**		0.0673**
		(-0.0349)		(0.0324)
Income shock (<5 years)		-6527		-5830
		(4.042)		(3.791)
Number of types of trees			1.832	-0.126
			(-4.315)	(4.364)
Area of plots (acres)			597.9*	952.2**
			(-350.5)	(408)
Total number of growing seasons			-8028	-6369
			(8,915)	(8,895)
Chemical protection spending			6.488***	6.191***
			(1.704)	(1.719)
Child labor			-2899	-5355
			(8,978)	(8,998)
Fertilizer spending			-0.159	-0.127
			(0.162)	(0.162)
Implementation spending			-1.842	-1.926
			(1.553)	(1.542)
Irrigation spending			3.159	2.682
			(-3.965)	(3.953)
Machine labor			-4495	-7471
			(10.506)	(10.475)
Manual labor spending			2.252***	2.166***
			(0.317)	(0.317)
Manure spending			1.851*	1.741*
			(1.014)	(1.011)
Mean number of vendors			2,394**	2,476**
			(1,001)	(1,003)
Oxen labor spending			7.845***	7.335***
			(1.813)	(1.813)
Crops produced (kgs)			1.533	1.16
			(0.952)	(1.007)
Sole ratio			12,476**	12,563**
			(5.135)	(5.137)
Risk willingness (crops)			715.6	
			(474.9)	
Time discount			-0.00386	
			(0.00638)	
Constant	18,808*	14,988***	-6185	-1527
	(10,545)	(3,585)	(10,783)	(14,020)
Sigma	56,420***	56,418***	52,576***	52,034***
	(1.331)	(1.332)	(1.239)	(1.227)
Observations	1,087	1,087	1,087	1,087

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3- Effects on Credit (Tobit)

VARIABLES	(1)	(2)	(3)	(4)
Head of household gender	611.3			1117
	(8,599)			(8.413)
Self reported health status	-460.2			-201.5
	(2,533)			(2,518)
Literacy	-4481			-1595
	(6,739)			(6,657)
Joint decision making	-7098			-6127
	(6,328)			(6,247)
Progressive farmer	-9,302**			-7,392**
	(3,742)			(3,725)
Pessimism	-7,161**			-7,974***
	(3,063)			(3,042)
Self confidence	2798			2598
	(2,136)			(2,104)
Patience	-793.2			-3277
	(8,970)			(8,823)
Risk aversion	-2,583**			-2,243*
	(1,217)			(1,206)
Rental price of all plots		-0.146		-0.105
		(0.179)		(0.206)
Value of seeds		1.230*		0.789
		(0.735)		(0.79)
Value of crops		-0.00167		-0.00345
		(0.0265)		(0.0298)
Revenue variance		0.0144**		0.0150**
		(0.00621)		(0.0061)
Number of ROSCAs		9252		4447
		(8,730)		(8,681)
Net remittances		0.338		0.46
		(1.334)		(1.365)
Income		-0.0835		-0.103
		(0.0877)		(0.0931)
Income shock (<5 years)		-12,687**		-10,110*
		(5,749)		(-5,684)
Number of types of trees			-15.83	-13.49
			(14.65)	(14.75)
Area of plots (acres)			-402.4	-421.1
			(648.9)	(742)
Total number of growing seasons			22910	24,143*
			(14,004)	(13,824)
Chemical protection spending			2.439	2.097
			(2.17)	(2.178)
Child labor			-11524	-9839
			(14,800)	(14,831)
Fertilizer spending			0.0715	0.195
			(0.224)	(0.224)
Implementation spending			5.377***	5.415***
			(1.927)	(1.906)
Irrigation spending			2.616	1.625
			(5.866)	(5.992)
Machine labor			6122	9619
			(15.266)	(15.137)
Manual labor spending			1.142***	1.063**
			(0.431)	(0.432)
Manure spending			2.926**	2.620**
			(1.27)	(1.259)
Mean number of vendors			-1635	-1407
			(1,779)	(1,761)
Oxen labor spending			-1.227	-2.413
			(2.655)	(2.698)
Crops produced (kgs)			0.365	-0.576
			(1.519)	(1.69)
Sole ratio			12162	10970
			(8.250)	(8.221)
Risk willingness (crops)			-39.04	
			(-724.3)	
Time discount			-0.00937	
			(0.0122)	
Constant	-14282	-42,902***	-82,246***	-42,860**
	(15,177)	(5,567)	(17,418)	(21,625)
Sigma	64,121***	64,491***	63,032***	61,822***
	(2,752)	(2,771)	(2,702)	(-2,638)
Observations	1,087	1,087	1,087	1,087

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4- Effects on Net Savings (Tobit)

VARIABLES	(1)	(2)	(3)	(4)
Head of household gender	9573			7985
	(6,281)			(5,902)
Self reported health status	-646.6			-599.1
	(1.833)			(1.746)
Literacy	-11,311**			-7102
	(4.870)			(4.622)
Joint decision making	1598			668.7
	(4,619)			(4,356)
Progressive farmer	-6,361**			-2464
	(2,699)			(2,583)
Pessimism	-443.9			367.9
	(2.122)			(2.014)
Self confidence	1323			1043
	(1.542)			(1.453)
Patience	5304			3693
	(6.465)			(6.098)
Risk aversion	-221.5			45.64
	(881.9)			(840.5)
Rental price of all plots		0.0325		-0.0666
		(0.0391)		(0.0468)
Value of seeds		1.512**		-0.498
		(0.606)		(0.69)
Value of crops		0.00472		-0.00585
		(0.0155)		(0.0146)
Revenue variance		0.000883		0.000287
		(0.00538)		(0.00508)
Number of ROSCAs		3711		935.2
		(6,464)		(6,125)
Net remittances		-1.074		-1.581*
		(0.899)		(-0.855)
Income		0.0867**		0.0764**
		(0.0365)		(0.0343)
Income shock (<5 years)		-6425		-6279
		(4.273)		(4.052)
Number of types of trees			-0.869	0.862
			(4.567)	(4.62)
Area of plots (acres)			613.7*	1,045**
			(372.1)	(434.9)
Total number of growing seasons			-10743	-9080
			(9,496)	(9,486)
Chemical protection spending			6.102***	6.007***
			(1.808)	(1.826)
Child labor			-1759	-4929
			(9,573)	(9,609)
Fertilizer spending			-0.21	-0.18
			(0.187)	(0.186)
Implementation spending			-2.547	-2.652
			(1.914)	(1.893)
Irrigation spending			3.429	3.059
			(4.206)	(4.195)
Machine labor			-4418	-7692
			(11.263)	(11.248)
Manual labor spending			1.901***	1.807***
			(0.339)	(0.34)
Manure spending			0.915	0.858
			(1.146)	(1.143)
Mean number of vendors			2,743**	2,920***
			(1,066)	(1,071)
Oxen labor spending			8.661***	8.139***
			(1.934)	(1.935)
Crops produced (kgs)			1.272	1.207
			(1.017)	(1.092)
Sole ratio			10,685*	10,881**
			(5.477)	(5.488)
Risk willingness (crops)			601.8	
			(506.6)	
Time discount			-0.0032	
			(0.00678)	
Constant	10654	10,656***	-5405	-4093
	(11.230)	(3.797)	(11.481)	(15.007)
Sigma	58,897***	58,907***	55,521***	54,979***
	(1.456)	(1.457)	(1.373)	(1.360)
Observations	1,087	1,087	1,087	1,087

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5-Agricultural Decisions on Preferences (Tobit)

VARIABLES	(1) Implementation Spending	(2) Revenue Variance	(3) Dramatic Risk	(4) Sole Ratio	(5) Oxen Labor	(6) Mean Vendors	(7) Manure Spending	(8) Manual Labor Spending	(9) Plot Area	(10) Chemical Protection Spending
Risk aversion	325.6	1,997	0.0213**	0.0034	-58.62	-0.0179	-340.6**	-298.3	0.0267	158.3
	(834.70)	(5552.00)	(0.01)	(0.01)	(63.45)	(0.04)	(164.50)	(194.60)	(0.08)	(100.30)
Risk willingness (general)	-210.2	8,554**	0.00936*	0.00794**	50.54	0.0534**	167.5	-29.58	0.0135	37.9
	(517.60)	(3594.00)	(0.01)	(0.00)	(41.36)	(0.02)	(108.20)	(126.30)	(0.05)	(64.69)
Risk willingness (crop)	162.4	-4,784	0.000297	-0.00419	3.579	-0.0579**	-49.52	163.5	0.0645	-7.897
	(501.30)	(3642.00)	(0.01)	(0.00)	(41.96)	(0.02)	(107.30)	(129.10)	(0.05)	(62.89)
Risk willingness (health)	-1,006	-6,870**	-0.00681	0.0156***	-35.29	-0.0316	-60.24	-166.2	-0.108**	-176.1***
	(648.60)	(3428.00)	(0.01)	(0.00)	(39.48)	(0.02)	(101.40)	(120.90)	(0.05)	(64.29)
Time discount	-0.0162	0.0123	4.27E-08	2.38E-08	-3.88E-05	8.40e-07***	0.000796	-0.00371*	-2.22E-08	-0.000896
	(0.02)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-34,168***	-14,750	0.569***	0.745***	-2,964***	0.648***	-7,959***	-4,729***	4.046***	-5,391***
	(9,533.00)	(33,760.00)	(0.05)	(0.03)	(429.20)	(0.23)	(1,168.00)	(1,216.00)	(0.46)	(738.40)
Sigma	16,282***	371,748***	0.571***	0.359***	3,023***	2.436***	6,825***	11,231***	5.294***	4,035***
	(3813.00)	(8879.00)	(0.02)	(0.01)	(179.80)	(0.07)	(521.70)	(439.80)	(0.11)	(313.50)
Observations	1,087	1,087	1,087	1,087	1,087	1,087	1,087	1,087	1,087	1,087

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6- Risk Regressions (OLS)

VARIABLES	Risk Aversion
Risk willingness (crop)	0.0440**
	(0.02)
Risk willingness (general)	0.0104
	(0.02)
Risk willingness (health)	-0.0244
	(0.02)
Constant	3.269***
	(0.15)
Observations	1,087
R-squared	0.006

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix

Table 2 - Effects on Savings (2006)

	(1)	(2)	(3)	(4)	(5)
Constant	29078.47 ***	25953.38***	13165.27	15051*	17069.01
	(9215.424)	(8628.561)	(8993.116)	(9166.236)	(12303.37)
Head of household- male	7295.685				5941.791
	(5150.202)				(4843.762)
Self reported health status	-370.0936				-168.0023
	(1525.05)				(1451.848)
Literate	-5141.845				-866.5015
	(3996.704)				(3797.122)
Joint decisions made in the home	-1535.817				-1874.384
	(3831.229)				(3613.623)
Self reported "progressive farmer"	-6463.097***				-2742.174
	(2242.04)				(2146.86)
Pessimism	-1945.414				-1105.012
	(1772.644)				(1680.897)
Self Confidence	1285.067				919.9851
	(1283.526)				(1208.543)
Patient	4582.369				2684.888
	(5410.306)				(5097.806)
Risk Aversion	-626.5498				-399.0371
	(734.7206)				(699.0598)
Total number of types of trees		-3.849397	-2.065095	-.3952879	-.5536257
		(4.146463)	(3.900135)	(3.956001)	(3.976799)
Total area of land (acres)		1167.748***	483.9759	751.341**	773.7249**
		(317.5041)	(311.1298)	(361.2958)	(363.8253)
Total number of growing seasons for plots		-10489.1	-10955.27	-9569.999	'-9148.424
		(8277.055)	(7805.279)	(7798.534)	(7858.579)
Spending on chemical protection (MK)			6.08507***	6.290622***	6.163882***
			(1.546002)	(1.56257)	(1.570949)
Child labor used			-4557.488	-5203.087	-6237.375
			(8042.958)	(8039.94)	(8117.605)
Spending on fertilizer			-.1921579	-.1699207	-.1466731
			(.146484)	(.1463678)	(.1478409)
Spending on general implementation tools			-1.882884	-1.918878	-1.975107
			(1.410055)	(1.406119)	(1.410943)
Spending on irrigation			1.911439	1.725821	1.28094
			(3.601453)	(3.606195)	(3.618156)
Is machine labor used			-3427.009	-4443.161	-5497.446
			(9274.786)	(9256.775)	(9329.367)
Spending on manual labor			2.161629***	2.158189***	2.091197***
			(.2860632)	(.285918)	(.2888474)
Spending on manure			1.726696*	1.750262*	1.66997*
			(.9178583)	(.9164308)	(.922256)
Mean number of vendors			1623.66*	1722.888*	1778.361**
			(891.3093)	(904.1855)	(906.7233)
Spending on oxen labor			7.998517***	7.96548***	7.551867***
			(1.624636)	(1.620767)	(1.63492)
Total crops produced (kgs)			1.199257	1.014037	.9875489
			(.858867)	(.912871)	(.9186849)
Ratio of sole to intercropped crops			8230.273*	8511.142*	8318.112*
			(4488.352)	(4499.138)	(4525.319)
Rental price of plot (MK)				-.0502216	-.0537899
				(.0396027)	(.0400251)
Total value of seeds (MK)				.0065386	-.0381792
				(.5233473)	(.5265184)
Total value of crops (MK)				-.0081441	'-.0072855
				(.0125771)	(.0126324)
Variance in revenue				.0050957	.0047806
				(.0043523)	(.0043844)
Number of ROSCAs involved in				-1134.434	-1390.645
				(5142.534)	(5170.973)
Net Remittances				-1.444276**	-1.40112**
				(.7056035)	(.7108451)
Income				.068911**	.0652884**
				(.0289565)	(.0290448)
Dramatic income risk faced in last five years				-6168.131*	-6069.602*
				(3353.726)	(3380.245)
R^2	0.0209	0.0141	0.1455	0.0229	0.16
Adjusted R^2	0.0127	0.0114	0.1335	0.0157	0.14

*Significant under a 10% significance level, **Significant under a 5% significance level, ***Significant under a 1% significance level
(Standard errors are in parentheses)

Table 3 - Effects on Credit

	(1)	(2)	(3)	(4)
Constant	11026.99**	5976.699***	1193.845	6184.373
	(5573.065)	(1953.264)	(3216.646)	(7879.743)
Head of household- male	2026.174			1887.119
	(3114.606)			(3102.208)
Self reported health status	-357.5365			-261.709
	(922.2801)			(929.8423)
Literate	-1326.881			-462.2193
	(2417.023)			(2431.883)
Joint decisions made in the home	-5048.641**			-4419.911*
	(2316.951)			(2314.36)
Self reported "progressive farmer"	-1840.291			-1489.239
	(1355.883)			(1374.966)
Pessimism	-895.1317			-961.9425
	(1072.014)			(1076.538)
Self Confidence	850.8657			769.7833
	(776.2173)			(774.0166)
Patient	1488.186			737.4086
	(3271.904)			(3264.911)
Risk Aversion	-540.1347			-471.6262
	(444.3253)			(447.7158)
Total number of types of trees				-.6196356
				(2.546958)
Total area of land (acres)				78.78061
				(233.0135)
Total number of growing seasons for plots				2210.941
				(5033.06)
Spending on chemical protection (MK)			.2898708	.3274367
			(.9826957)	(1.006121)
Child labor used			-1977.396	-2117.252
			(5104.47)	(5198.954)
Spending on fertilizer			.0322782	.0473375
			(.0914957)	(.0946853)
Spending on general implementation tools			3.997538***	3.953489***
			(.8934888)	(.9036445)
Spending on irrigation				-.7523714
				(2.317263)
Is machine labor used			-2265.968	-2508.411
			(5860.259)	(5975.032)
Spending on manual labor			.6013465***	.514193***
			(.1703301)	(.1849935)
Spending on manure			.8172603	.7492868
			(.5798305)	(.5906627)
Mean number of vendors			-387.6083	-293.7937
			(563.7879)	(580.7148)
Spending on oxen labor			-1.048404	-1.23217
			(1.031554)	(1.047091)
Total crops produced (kgs)				.1464093
				(.5883756)
Ratio of sole to intercropped crops			3086.898	3048.764
			(2822.122)	(2898.26)
Rental price of plot (MK)		.0006773		-.0054049
		(.0204738)		(.0256342)
Total value of seeds (MK)		.1796666		-.0398007
		(.3071508)		(.3372109)
Total value of crops (MK)		.0024074		.0015856
		(.0081189)		(.0080905)
Variance in revenue		.0058309**	.0058168**	.0054467*
		(.0028199)	(.0027641)	(.002808)
Number of ROSCAs involved in		1070.845		271.898
		(3303.483)		(3311.772)
Net Remittances		.1643746		.0870263
		(.4521974)		.4552637
Income		-.0099072		-.0111713
		(.0188008)		.0186018
Risk willingness w/ crops			-147.6872	
			(264.4536)	
Dramatic income risk faced in last five years		-3845.42*		-2966.459
		(2162.106)		(2164.892)
R^2	0.0114	0.0079	0.0437	0.0538
Adjusted R^2	0.0032	-0.0004	0.0321	0.0251

*Significant under a 10% significance level, **Significant under a 5% significance level, ***Significant under a 1% significance level
(Standard errors are in parentheses)

Table 4 - Effects on Net Savings

	(1)	(2)	(3)	(4)	(5)
Constant	18051.48*	16383.24***	13165.27	14360.16	10884.64
	(10754.28)	(3665.018)	(8993.116)	(10769.09)	(14815.05)
Head of household- male	5269.511				4054.673
	(6010.22)				(5832.596)
Self reported health status	-12.55715				93.70668
	(1779.714)				(1748.237)
Literate	-3814.964				-404.2822
	(4664.102)				(4572.288)
Joint decisions made in the home	3512.824				2545.527
	(4470.995)				(4351.329)
Self reported "progressive farmer"	-4622.807*				-1252.935
	(2616.432)				(2585.133)
Pessimism	-1050.282				-143.0694
	(2068.653)				(2024.046)
Self Confidence	434.2012				150.2018
	(1497.858)				(1455.262)
Patient	3094.182				1947.48
	(6313.758)				(6138.501)
Risk Aversion	-86.41512				72.58907
	(857.4096)				(841.7699)
Total number of types of trees		-3.849397	-2.065095	-1.066905	.0660098
		(4.146463)	(3.900135)	(4.670339)	(4.788646)
Total area of land (acres)		1167.748***	483.9759	428.0087	694.9443
		(317.5041)	(311.1298)	(372.5721)	(438.0987)
Total number of growing seasons for plots		-10489.1	-10955.27	-12137.64	-11359.36
		(8277.055)	(7805.279)	(9346.674)	(9462.874)
Spending on chemical protection (MK)			6.08507***	5.767064***	5.836445***
			(1.546002)	(1.851309)	(1.891651)
Child labor used			-4557.488	-2286.832	-4120.123
			(8042.958)	(9631.291)	(9774.78)
Spending on fertilizer			-.1921579	-.2204826	-.1940106
			(.146484)	(.1754118)	(.178022)
Spending on general implementation tools			-1.882884	-5.870712***	-5.928597***
			(1.410055)	(1.688514)	(1.698981)
Spending on irrigation			1.911439	2.651214	2.033311
			(3.601453)	(4.312673)	(4.356787)
Is machine labor used			-3427.009	-1025.522	-2989.036
			(9274.786)	(11106.38)	(11233.92)
Spending on manual labor			2.161629***	1.587348***	1.577004***
			(.2860632)	(.3425554)	(.3478144)
Spending on manure			1.726696*	.9452997	.9206834
			(.9178583)	(1.099118)	(1.110531)
Mean number of vendors			1623.66*	2018.784*	2072.154*
			(891.3093)	(1067.326)	(1091.827)
Spending on oxen labor			7.998517***	9.088327***	8.784037***
			(1.624636)	(1.945471)	(1.968682)
Total crops produced (kgs)			1.199257	1.002663	.8411396
			(.858867)	(1.028477)	(1.106231)
Ratio of sole to intercropped crops			8230.273*	5033.942	5269.348
			(4488.352)	(5374.718)	(5449.144)
Rental price of plot (MK)		.0217325			-.048385
		(.0393071)			(.048196)
Total value of seeds (MK)		1.425613**			.0016215
		(.5870271)			(.6340049)
Total value of crops (MK)		.0004482			-.008871
		(.0155902)			(.0152112)
Variance in revenue		-.0006942			-.0006661
		(.005412)			(.0052795)
Number of ROSCAs involved in		676.4798			-1662.543
		(6343.282)			(6226.606)
Net Remittances		-1.103489			-1.488146*
		(.8676961)			(.8559611)
Income		.0833531**			.0764597**
		(.0360076)			(.0349741)
Dramatic income risk faced in last five years		-3386.48			-3103.144
		(4143.811)			(4070.308)
R^2	0.0209	0.0132	0.1455	0.0884	0.0986
Adjusted R^2	0.0127	0.0059	0.1335	0.0757	0.0713

*Significant under a 10% significance level, **Significant under a 5% significance level, ***Significant under a 1% significance level
(Standard errors are in parentheses)

Table 5- Agricultural Decisions on Preferences

VARIABLES	(1) Implement Spending	(2) Revenue Variance	(3) Dramatic Risk	(4) Sole Ratio	(5) Oxen Labor	(6) Mean Vendors	(7) Manure Spending	(8) Manual Labor Spending	(9) Plot Area	(10) Chemical Protection Spending
Risk Aversion	-2.515	1246	0.0159**	0.00308	-10.81	-0.0122	-44.61*	-77.36	0.0298	14.8
	(15.08)	(4807)	(0.00627)	(0.00465)	(13.48)	(0.0235)	(23.01)	(82.07)	(0.076)	(13.8)
Risk Willingness (general)	-2.151	6,201**	0.00691*	0.00661**	1.279	0.0288*	4.366	23.5	0.0138	5.376
	(9.73)	(3102)	(0.00405)	(0.003)	(8.70)	(0.0152)	(14.85)	(52.95)	(0.049)	(8.907)
Risk Willingness (crop)	-3.619	-4055	0.000167	-0.00368	-2.856	-0.0330**	-0.351	-0.62	0.0614	-1.979
	(9.833)	(3135)	(.00409)	(0.003)	(8.79)	(0.0153)	(15.01)	(53.51)	(0.0496)	(9.002)
Risk Willingness (health)	1.494	-5,977**	-0.005	0.0141***	3.415	-0.0219	12.58	-76.53	-0.108**	-19.01**
	(9.261)	(2952)	(0.00385)	(0.00286)	(8.279)	(0.0144)	(14.13)	(50.4)	(0.0467)	(8.478)
Time Discount	-3.25E-05	1.21E-03	3.20E-08	2.03E-08	4.03E-05	6.59e-07***	4.75E-05	-4.16E-04	-3.10E-08	3.48E-05
	(1.23E-04)	(3.91E-02)	(5.10E-08)	(3.78E-08)	(1.10E-04)	(1.91E-07)	(1.87E-04)	(6.68E-04)	(6.18E-07)	(1.12E-04)
Constant	103.6	48,331*	0.668***	0.770***	246.6***	1.308***	351.7**	2,194***	4.076***	140.5*
	(91.13)	(29052)	(0.0379)	(0.0281)	(81.47)	(0.142)	(139.1)	(496)	(0.459)	(83.43)
Observations	1087	1087	1087	1087	1087	1087	1087	1087	1087	1087
R-squared	0	0.007	0.01	0.038	0.001	0.019	0.005	0.003	0.006	0.006

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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