Analyses of the willingness to pay for weather index insurance

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Summary

In this paper the willingness to pay for weather index insurance in rural parts of Ethiopia is analyzed. This study used the 2009 Ethiopian rural household survey data of the International Food Research Policy Institute. The Results show that those households who are less risk-averse have more willingness to pay than the risk-averse households. But the result is not consistent across all risk categories. The results also show that a unit increase in the amount of money that they would have to be given to wait for a month instead of receiving a gift of 100 Birr now increases willingness to pay to weather index insurance by small amount that’s by 0.0002 times. This means impatient households who are unable to insure themselves have more willingness to pay for insurance. A unit increase in livestock value owned by the household also increases willingness to pay for weather index insurance by 0.00017 times. A unit increase in years of schooling increase willingness to pay by 0.24 times. Those households who are educated through informal education system (stated as other education) such us adult literacy program, church/mosque schools and other literacy program have also 0.62 unites more willingness to pay than those who did not complete any education. Those households who are familiar to local financial access (those who are members of Eqqub) have 2.16 more willingness to pay for insurance than those who are not members. Moreover, those households who are involved in any of the water harvesting technologies have 3.21 more unites of willingness to pay for insurance than those who are not involved in any water harvesting technology. Besides, the results show that women, old age households and households with large land size have less willingness to pay for insurance. The increase in off-farm income of households also increases willingness to pay for insurance. The results indicate that the effect of households’ risk perception, time preference, education, familiarity with local financial products, involving in water harvesting technologies and livestock value on willingness to pay for weather index insurance are significant. However, the effects of age, sex, land size, and off-farm income on willingness to pay for weather index insurance are found statistically insignificant.
Preface

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1. INTRODUCTION

The life of most rural Households of Ethiopia is dependent on agriculture, which is highly affected by high risk of erratic monsoon rains and other uncertain shocks. Extreme hydrological variability and seasonality have constrained Ethiopia’s past economic development by negatively affecting Agricultural production, chiefly through droughts. The decision made by farmers to invest in agricultural production that depends on the vagaries of weather has returns characterized by substantial uninsurable risk. Markets for weather contingent securities to insure against this risk are limited and inaccessible to the majority of these farmers.

Households can use their own wealth (self-insurance) to smooth uncertain shocks in income. Individuals with the wealth to do this are protecting themselves against uncertainties that they cannot control. But poor households are usually unable to insure themselves during adverse shocks. There are some local collection actions that poor households respond in the face of shocks, but not perfectly; as might be expected, idiosyncratic shocks (low or late rainfall on household plots) are more likely to be insured collectively than are generalized shocks (low rainfall on most plots in the village) (Ray 1998). Informal insurance mechanisms and local social networks can have special role when insurance markets are incomplete. In the face of idiosyncratic shocks local safety nets could work to support households. On the other hand, in the incidence of covariate shocks, a majority of the households and their incomes are likely to be affected putting a strain on village-level informal insurance and safety nets. Given the heavy reliance of the performance of Ethiopian agriculture on rainfall, its variability is likely to form a major source of income shock.

Production systems in low-income developing countries are generally poorly diversified, focusing on rain-fed staple crop production and raising livestock. These activities are inherently risky and investment and production decisions by farm households are therefore made within environments that are affected by risk. Because of poorly developed or absent credit and insurance markets it is difficult to pass any of these risks to a third party (Yesuf and Bluffstone 2007). Most developing country governments are not able to provide subsidies to farm households on a persistent basis. In those settings, weather index insurance could be one solution to reduce uncertain shocks and its consequences on Individuals. Weather insurance programs are likely to have to be self-sufficient: that is, premium rates will have to cover both the indemnity, administrative and other overhead costs associated with the insurance program.
In this paper the willingness to pay for weather index insurance of Ethiopian rural households is analyzed by using different socio-economic determinant factors of willingness to pay for weather index insurance; which are risk, time preference, education, livestock value, familiarity to financial products, and involvement in any of the water harvesting technologies, land size, off-farm income and household demographics. Analyzing the willingness to pay to weather index insurance can help to the policy makers and insurance companies to widely intervene for the weather insurance product to the rural parts of Ethiopia.

The remaining parts of the thesis unfold as follows. Chapter two deal with in-depth review of both theoretical and empirical literatures on willingness to pay for the weather index insurance. Chapter three briefly explains the background, data and methodology, which basically includes description of study area, data type and source, method of analysis and model specification. Chapter four is result and discussion part of the thesis. The last chapter is devoted to the conclusion of the study.
2. LITRATURE REVIEW

In this chapter, the concept of weather insurance and willingness to pay for weather insurance, approaches of willingness to pay measurement, and empirical studies on willingness to pay for weather insurance are discussed briefly.

2.1 Theoretical literature review

Every business owner faces risks. A typical risk is that a business becomes unprofitable and must close. Other risks include the danger of a visitor or customer becoming injured on your property, an employee getting hurt on the job or crops failing because of adverse weather. Insurance is a tool that helps farmers reduce their exposure to risk. The purpose of insurance is to reduce the impact that an adverse event will have on your bottom line. Therefore, in order to offer the best possible coverage, it is important for you, the producer and business owner, to talk with your insurance agent and review how you might be exposed to a high-risk situation. Insurance can help cover the cost of unexpected events such as theft, illness or property damage (Dunlap 2006).

Financial consumer Agency of Canada (2011) defined Insurance as a way of reducing your potential financial loss or hardship. It can help cover the cost of unexpected events such as theft, illness or property damage. Insurance can also provide your loved ones with a financial payment upon your death. You pay a fee called a premium, and in exchange, the insurance company agrees to pay you a certain amount of money if the event you are insuring against is covered and happens during the term of the policy. The details of insurance protection, such as exactly which events are covered and for how much, are defined in your insurance policy. The insurance policy is a contract between you and the insurance company.

The need of insurance

Insurance can protect you and your loved ones from financial loss if something unexpected happens. For example: Auto insurance could pay the cost of repairs to your vehicle if you have an accident, Life insurance could provide your family with money to support themselves when you die, Home or tenant insurance could pay for the cost to repair your home if there is a fire in your house, condominium or apartment Financial consumer Agency of Canada (2011).
Insurance is one alternative to manage risk in yield loss by the farmers. It is the mechanism to reduce the impact of income loss on the farmer (family and farming). Crop insurance is a means of protecting farmers against the variations in yield resulting from uncertainty of practically all natural factors beyond their control such as rainfall (drought or excess rainfall), flood, hails, other weather variables (temperature, sunlight, wind), pest infestation, etc. Crop insurance is a financial mechanism to minimize the impact of loss in farm income by factoring in a large number of uncertainties which affect the crop yields. As such it is a risk management alternative where production risk is transferred to another party at a cost called premium. It provides a good alternative both to farmers and government. Farmers get on actuarially fair insurance with swift payments at little administrative costs to the government insurance is. In both the cases cultivators pass risk in yield to another party for a premium (Singh 2010).

The theory of perfect insurance model

Ray (1998) formulated a model of perfect insurance by assuming a village which is populated by a large number of farmers. He also assumed that the farmers are all identical, though this is in no way necessary at a conceptual level. For each farmer, describe his income at each date by the equation:

\[ Y = A + \mu + \Theta \]

The income equation has three components. Think of the first (A) as each farmer’s average income and the second component (μ) is a random shock that may have the same distribution across farmers, but affects each one independently. For instance, the crop may be eaten by animals, or destroyed by bags, or there may be inappropriate application of water or fertilizer. The shock may represent a short fall of income due to a sudden spike in consumption needs; for instance, a part of income may be paid off for illness (in this case think of Y as net income after such necessary expenditures). It is a local or idiosyncratic source of uncertainty, which might happen to every farmer but happens in an independent fashion. Finally the third component (Θ) captures all the common or aggregate variation in the village. This is a source of uncertainty whose realization in any year affects all farmers in the same way. The best way to think of this is to imagine that these are common income variations stemming from the weather (the state of monsoon, for instance). Here, he regards A as average income, we should think of the random μ and Θ as having mean value equal to zero.
He added if there are a large number of farmers, all the idiosyncratic variation embodied in $\mu$ can be insured away. Farmers simply pay their realized value $\mu$ in to a common fund. Because $\mu$ is sometimes positive and sometimes negative, this amounts to saying that some farmers make positive contributions, whereas others stand to receive payouts from common fund. This way, all the idiosyncratic variation in $\mu$ can be ironed out. With the insurance fund in place, typical farmer’s is now given by:

$$\tilde{Y} = A + \Theta$$

When we compare both equations, the income stream $\tilde{Y}$ carries less risk than the original stream $Y$, because we have removed the idiosyncratic component. Average income is still $A$, of course. It follows that, if farmers are risk-averse, they prefer this system of mutual insurance. Besides, we cannot pool away $\Theta$. The reason is that the value of realization of $\Theta$ is the same for all the farmers in the village, so there is no insurance possible here. Neglecting self-insurance and credit for the moment, the village as a whole cannot mutually insure itself against a random event that affects everybody in the same way. Hence, it is not the case that under the perfect insurance scheme insured income doesn’t fluctuate at all: they do, but the source of fluctuation is the aggregate uncertainty in the system that cannot be insured away with the use of a common pool funds. This line of reasoning also suggests that one important determinant of mutual insurance is the relative significance of idiosyncratic to aggregate risk.

**How does insurance work?**

Insurance is an agreement where, for a stipulated payment called the premium, one party (the insurer) agrees to pay to the other (the policyholder or his designated beneficiary) a defined amount (the claim payment or benefit) upon the occurrence of a specific loss. This defined claim payment amount can be a fixed amount or can reimburse all or a part of the loss that occurred. The insurer considers the losses expected for the insurance pool and the potential for variation in order to charge premiums that, in total, will be sufficient to cover all of the projected claim payments for the insurance pool. The premium charged to each of the pool participants is that participant’s share of the total premium for the pool. Each premium may be adjusted to reflect any special characteristics of the particular policy. The larger the policy pool, the more predictable its results (Anderson & Brown 2005).
Under the formal arrangement, the party agreeing to make the claim payments is the insurance company or the insurer. The pool participant is the policyholder. The payments that the policyholder makes to the insurer are premiums. The insurance contract is the policy. The risk of any unanticipated losses is transferred from the policyholder to the insurer who has the right to specify the rules and conditions for participating in the insurance pool. An insurance contract covers a policyholder for economic loss caused by a peril named in the policy. The policyholder pays a known premium to have the insurer guarantee payment for the unknown loss. In this manner, the policyholder transfers the economic risk to the insurance company.

Risk, as discussed in Section I, is the variation in potential economic outcomes. It is measured by the variation between possible outcomes and the expected outcome: the greater the standard deviation, the greater the risk (Anderson & Brown 2005).

**Limits of insurance**

Ray (1998) states that, there are limits to the ability of households to insure one another, even if the income shocks are idiosyncratic. One limit is limited information about the final outcome. A person may ask for or expect transfers from his community while providing them with deliberately wrong or misleading information regarding his economic state: he might lie about the size of his harvest, he might lie about illness in the family, or, at the very least, he might be in a position to lie, in the sense that his community members do not have information to verify that the claimed occurrences indeed occur. Now, this is certainly a possibility if we extravagantly expand the notion of what a community means. It is unlikely that a farmer in one extreme of a state would be engaged in insurance with another unknown farmer in the other extreme of the state. Even if such insurance were mutually beneficial, it is very difficult to verify the underlying circumstances on which that insurance must be based. So it is certainly true that this sort of information barrier kicks in and precludes insurance over very large anonymous groups or spatial distance, even if such insurance could, in principle, be profitable for all concerned. But it is hard to say that this sort of information problem occur within the village despite it varies across the village. One of the strengths of traditional society is that they are endowed with social capital. This social capital provides a fund of socially available information that permits a community to interact in ways that would not be possible in an anonymous society. Much of social capital is simply information flow.

Another limit stated by Ray (1998) is limited information about what led to the outcome. This is the problem of moral hazard which is the possibility of some insurable event can be
influenced by the unobservable action of the individual. Consider mutual insurance of harvests. Everyone knows that there are idiosyncratic shocks that can affect the state of the harvest on a particular plot. Water, fertilizer, or pesticides may have been badly applied (inadvertently), or there may be damage to the crop caused by events by events outside the farmer’s control, or (and this is the source of the problem), the crop may be bad because the farmer deliberately skipped on the use if these inputs. The size of the harvest may be visible for all to see (so that the first information problem is irrelevant) but why the harvest is what it is requires information of a different kind all together. The problem, of course, is that in the presence of full insurance, the incentive to deliberately under apply inputs is higher. But if the farmer deviates in this fashion, he will presumably be excluded from future access to insurance. There is also the question of social sanctions and all of this adds up to a future loss if he fails to conform today. But information considerations are once again relevant here.

2.1.1 Risk, uncertainty and agricultural insurance

Uncertainty refers to an event the outcome of which is not certain i.e. the outcome may be one of the many possible outcomes. As such it cannot be measured. But certain probability may be attached to individual outcome. Risk on the other hand refers to the impact of the uncertain outcome on the quantity or value of some economic variable. The value of the economic variable may be on either side of the mean value. Repeated events would result different outcomes having a range of values. Thus risk refers to the variations in value of an economic variable resulting from the influence of an uncertain event. Since the variations in the value are measurable risk can be measured. Agricultural production is an outcome of biological activity which is highly sensitive to changes in weather. Important weather variables such as temperature, humidity, rainfall, wind etc. influence the biological process directly or indirectly. For instance, low soil moisture due to poor precipitation in the pre-sowing period adversely affects seed germination resulting in reduced plant population. The poor precipitation during growth period results in stunted plant growth. Heavy rainfall during early growth period causes submersion of plants. Similarly hailstorms, wind and cyclones damage the standing crops by lodging and uprooting especially the perennials (trees and shrubs). High humidity may cause outbreak of pests and diseases. All these result in partial loss in yield and sometimes complete crop failure and hence reduced income to farmers. In other words, deviations in the weather variables from the normal adversely affect the crop yields and hence production and income on individual farms. As variations in weather are more a regular
phenomenon crop yields are not stable. As if all this is not enough the sword of uncertain agricultural prices always hangs on the farmers’ fate. As a consequence farm incomes fluctuate violently from year to year. These variations in income are referred to as risk. The variations in income due to changes in yield are production risk and due to changes in price marketing risk. As such risk (variations) may be measured in terms of standard deviation or coefficient of variations for yield, prices and income (Singh 2010).

Disasters hit hard. Adverse weather events such as drought, excessive rains, storms and hurricanes cause heavy losses to farmers. Disasters can often not be prevented from happening but they can, to some extent, be predicted and arrangements can be made to reduce their impact. However, in some cases, disasters cannot be predicted and farmers will have to cope with major losses after the event occurs. Agricultural insurance, including livestock, fisheries and forestry, is especially geared to covering losses from adverse weather and similar events beyond the control of farmers. It is one of the most quoted tools for managing risks associated with farming. Many pilot programs have been developed over the years, targeting especially small-scale farmers in developing countries, but agricultural insurance remains primarily a business which involves developed country farmers. Only a minor percentage of global premiums are paid in the developing world where insurance is mainly available only to larger and wealthier farmers. Insurance spreads risk across the farming industry or the economy or, in the case of international reinsurance, to the international sphere. Insurance is sold and bought in a market. The purchasers must perceive that the premiums and expected benefits offer value; the sellers must see opportunity for a positive actuarial outcome, over time, and profit. Insurance is not the universal solution to the risk and uncertainties that farmers face. It can only address part of the losses resulting from some perils and is not a substitute for good on-farm risk-management techniques, sound production and farm management practices and investments in technology (FAO/US 2014).

Agricultural production in low-income developing countries is generally poorly diversified, focusing on rain fed staple crop production and raising livestock—activities that are inherently risky. In a dynamic environment where adverse economic shocks may be more easily transmitted across geographic borders, a social protection scheme might be able to perform more effectively the task of protecting households from the adverse effects of poverty by adopting an approach that not only identifies the groups of households that are presently poor but also those that are vulnerable to economic shocks and other risks (Skoufias and Agnes, 2003). But, this problem may also be minimized using weather insurance company.
Weather related risk remains a major challenge to households in low-income economies whose livelihoods depend on agriculture. With changes in climatic conditions, agriculture has become an increasingly uncertain business. Well organized insurance markets have the potential to help mitigate the adverse consequences of such risks and consequently the provision of simple and affordable insurance products to those households has received significant attention in recent years. Recent developments in index-based weather insurance offer new possibilities of providing insurance for smallholder farmers in those areas and, as such, help farmers adapt to and build resilience against changing weather conditions. However, basis risk—residual risk left uninsured by the index—remains a key challenge to index-based weather insurance, reducing the latter’s value for farmers (Berhane et.al. 2013).

Using one’s own wealth to smooth uncertain shocks in income is called self-insurance. Essentially, individuals with the wealth to do this are protecting themselves against uncertainties that cannot control. Self-insurance can work through several channels. Stocks of cash or accumulated savings in banks can be run down (added to) for the purpose. The same can be done with grain stocks, although holding such stocks can be costly because grain is not perfectly durable. However, this may be preferred form of saving if rural banks are few and far between or if there are restrictions on the rapid liquidation of savings. Other assets may be run down or accumulated as well. Livestock and jewelry are two such assets, although these may be sold as a last resort (Ray 1998).

2.1.2 Approaches of measuring insurance

According to ARD (2011) Crop insurance products can broadly be classified into two major groups: indemnity-based insurance and index insurance.

2.1.2.1 Indemnity-Based Crop Insurance

There are two main indemnity products:

**Damage-based indemnity insurance (or peril crop insurance):**

Damage-based indemnity insurance is crop insurance in which the insurance claim is calculated by measuring the percentage damage in the field soon after the damage occurs. The damage measured in the field, less a deductible expressed as a percentage, is applied to the pre-agreed sum insured. The sum insured may be based on production costs or on the expected revenue. Where damage cannot be measured accurately immediately after the loss, the assessment may be deferred until later in the crop season. Damage-based indemnity
insurance is best known for hail, but is also used for other named peril insurance products (such as frost and excessive rainfall) (ibid).

**Yield-based crop insurance (or Multiple Peril Crop Insurance, MPCI):**

Yield-based crop insurance is coverage in which an insured yield (for example, tons/ha) is established as a percentage of the farmer’s historical average yield. The insured yield is typically between 50 percent and 70 percent of the average yield on the farm. If the realized yield is less than the insured yield, an indemnity is paid equal to the difference between the actual yield and the insured yield, multiplied by a pre-agreed value. Yield-based crop insurance typically protects against multiple perils, meaning that it covers many different causes of yield loss (often because it is generally difficult to determine the exact cause of loss) (ibid).

**2.1.2.2 Index-Based Crop Insurance**

There are two types of index product:

**Area yield index insurance:**

Here the indemnity is based on the realized average yield of an area such as a county or district, not the actual yield of the insured party. The insured yield is established as a percentage of the average yield for the area. An indemnity is paid if the realized yield for the area is less than the insured yield regardless of the actual yield on a policyholder’s farm. This type of index insurance requires historical area yield data (ARD. 2011).

In the case of area yield index insurance, a payment is made when the measured yield for the region falls below a certain predetermined limit “critical threshold” or “strike-point” (Smith & Watts, 2009).

Traditional crop insurance, whose indemnities are based on individually-assessed losses, such as named peril crop insurance and multiple peril crop insurance, has been widely considered financially unsustainable and plagued with moral hazard and adverse selection problems. Traditional crop insurance also suffers from high transaction costs, notably loss adjustment ones, which hampers both the profitability of insurers and affordability for smallholders (Binswanger-Mkhize, 2012; Carter, Galarza, & Boucher, 2007; P. Hazell, 1992).
Weather based index insurance:

Here the indemnity is based on realizations of a specific weather parameter measured over a pre specified period of time at a particular weather station. The insurance can be structured to protect against index realizations that are either so high or so low that they are expected to cause crop losses. For example, the insurance can be structured to protect against either too much rainfall or too little. An indemnity is paid whenever the realized value of the index exceeds a pre specified threshold (for example, when protecting against too much rainfall) or when the index is less than the threshold (for example, when protecting against too little rainfall). The indemnity is calculated based on a pre-agreed sum insured per unit of the index (ARD. 2011).

Weather index insurance and traditional insurance are not by definition mutually exclusive. These can co-exist and complement each other since these are really designed to target different layers of risks and different levels of administrative capabilities. However, advances in technology that lower delivery costs and loss adjustment surveys in the case of traditional crop insurance schemes will be needed to make this type of insurance financially feasible. There are significant advantages of index based insurance. It avoids the problems of moral hazard and adverse selection. Because the payment of indemnity is based on the deviations from the index and not on individual losses, no assessment of losses at the individual level is needed. The indemnity process is quick and inexpensive to administer. Additionally, the design of the product lessens the administrative and operational expenses. Despite these major advantages, acceptance of this product by both insurers and insured parties is still low. This can be explained by considering some of the constraints. From the point of view of the insurer, it can be a costly and time-consuming task to assemble the data and construct the appropriate indexes. Once the indexes are created, operational costs are low and this translates into lower premiums for insured parties. The lower premiums attract small producers who otherwise would not be able to afford insurance. The index based weather insurance products that are properly designed can become a first step to facilitate the broader development of robust rural financial markets that serve the needs of the poor in low-income countries (Ali 2013).

In the past decade, index contracts emerged and have been promoted as a powerful financial solution to address the pitfalls of traditional insurance products. Smith & Watts (2009) and more recently Binswanger-Mhkize (2012) thoroughly reviewed the landscape for index
insurance in developing countries. The basis of this approach is the underwriting of the contracts against specific perils or events “trigger” recorded at a local level. Examples of the triggers are area yield index or rainfall index.

Table 1 below compares these two mostly-used index insurance products, where index insurance products are most fully developed and applied.

**Table 1: Comparison of area yield index and weather index insurance**

<table>
<thead>
<tr>
<th></th>
<th>Area yield index</th>
<th>Weather based index</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Technical and</td>
<td>All peril cover (drought, excess rainfall, flood, pest infestation, etc.)</td>
<td>Single (sometimes multiple) peril covers (drought, excess rainfall, low temperature, etc.)</td>
</tr>
<tr>
<td>practical aspects</td>
<td>Easy-to-design index (estimated aggregate yields in a given area)</td>
<td>Technical challenges in index design</td>
</tr>
<tr>
<td></td>
<td>Low start-up costs</td>
<td>(peril, crop, farming practices, agrometeorological zone, etc.)</td>
</tr>
<tr>
<td></td>
<td>Slow claims settlement</td>
<td>Faster claims settlement</td>
</tr>
<tr>
<td>**Geographic</td>
<td>Arises when the Insurance Unit size is too large and is not homogenous in terms of agricultural production level</td>
<td>Arises when a weather station is referenced for a larger geographical area, covering areas far off from weather station</td>
</tr>
<tr>
<td>Basis Risk</td>
<td>Yield index insurance covers risk from sowing till harvesting. As Yields are estimated at harvest stage, losses if any suffered after harvest are not reflected in the yield index.</td>
<td>Weather index covers risk arising out of deviations in parametric weather exigencies only. Risks outside these parametric weather (like pests, diseases, hailstorm, flooding etc.) are not covered</td>
</tr>
<tr>
<td>**Product Basis</td>
<td>Trigger yield used in yield index insurance is a function of moving average of past 5 years’ yield and coverage level, which may range from 60 to 90 percent. In other words, the shortfall between ‘normal yield’ and ‘trigger yield’ is not protected</td>
<td>Arises because of imperfect correlation between weather index and the production process (yield)</td>
</tr>
</tbody>
</table>
2.1.3 Willingness to pay for weather Index insurance

Weather index insurance is insurance that is linked to a weather index such as rainfall, rather than a possible consequence of weather, such as crop failure. This subtle distinction resolves a number of fundamental problems that make traditional insurance unworkable in rural parts of developing countries. One key advantage is that the transaction costs are low. This makes it workable under real market conditions – both financially viable for private sector insurers and affordable to small farmers. Unlike traditional crop insurance against crop failure, the insurance company does not need to visit farmers’ fields, to determine premiums or to assess damages. Instead the insurance is designed around rainfall data (for example). If the rainfall amount is below the earlier agreed threshold, the insurance pays out. Since there is no need for the insurance company to corroborate actual losses, payouts can be made quickly and distress sales of assets avoided. This process also removes the ‘perverse incentives’ of crop insurance, where farmers may actually prefer their crops to fail so that they receive a payout. With index insurance, the payout is not linked to the crop survival or failure, so the farmer has the incentive to make the best decisions for crop survival (Barrett, C.B.et al. 2007).

In recent decades weather-based insurance has been considered as a valuable alternative for traditional crop insurance. The main advantage of the former is that it is better suited to combat asymmetric information problems, i.e. adverse selection and moral hazard. An additional important advantage of weather-based insurance is that it reduces considerably transaction costs and thus allows a faster settlement of claims. The latter characteristic of weather-based insurance makes it particularly relevant in the context of catastrophic event management when the help must be provided within few days to a large number of affected farms (Bokusheva R. and Conradt, S, 2012).
2.2 Empirical literature review

Ethiopia is characterized by great geographic and climatic diversity. The Ethiopia economy relies heavily on the agricultural sector, which contributes 85 percent of total employment, 46 percent of GDP, and 92 percent of total exports earnings. The country has vast, untapped agricultural potential, but the agricultural sector, dominated by small-scale farmers with low productivity, is confronted with increasing population and food insecurity, very low—and declining—levels of agricultural productivity, and worsening natural resource degradation (Demel 2002). Currently, close to 20 million Ethiopians are under the threat of famine as a result of a poor rain season and will need food aid if they are to survive (Vidal 2003).

There are many factors which influence the farmer decision to buy a weather-based insurance contract. In addition to factors evaluated in the context of traditional agricultural insurance such as farm’s socio economic characteristics, risk aversion, level of production diversification, etc., for weather-based insurance the literature discusses the effect of informal insurance, basis risk and model prediction uncertainties on the farmers’ demand for insurance (Akter, 2011; Barnett, 2010; Bokusheva and Breustedt, 2012).

In the rain-fed areas of Pakistan the agricultural sector is vulnerable to multiple risks, especially due to changing climatic conditions. The landholdings are small in these areas, and the farmers are unable to cope up with the multiple risks, hence the index based insurance can serve as a risk management strategy. The farmers’ willingness to participate in the food and cash crops insurance schemes are influenced by a number of factors, especially the social capital. With the introduction of the index based insurance, the farmers’ choice for the cash crops should change as the cash crops which used to be profitable, but risky, will now be safer. By reducing the degree of riskiness in agricultural production, farmers will resort less to ex-ante risk coping mechanisms. One should therefore expect increased specialization and high profits, as farmers focus on maximizing the output of the insured crop, rather than on diversifying the weather risk through the cropping system. The weather index based insurance will thus not only introduce a more efficient and low-cost insurance but it will also provide a more transparent and actuary fair insurance products to the farmer. The provision of direct risk relief to farmers will enable them to alter their production strategies towards maximizing output, rather than diversifying risk, and to shift their demand for credit from consumption loans to investment loans. This is likely to result in increased specialization and investment,
and thus contribute to increased profits and the wellbeing of the farmers in rain-fed areas of Pakistan (Ali 2013).

Hill et al. (2011) examined which farmers would be early entrants into weather index insurance markets in Ethiopia, were such markets to develop on a large scale. They did this by examining the determinants of willingness to pay for weather insurance among 1,400 Ethiopian households that have been tracked for 15 years as part of the Ethiopia Rural Household Survey. This provides both historical and current information with which to assess the determinants of demand. They find that educated, rich, and proactive individuals were more likely to purchase insurance. Risk aversion was associated with low insurance take-up, suggesting that models of technology adoption can inform the purchase and spread of weather index insurance. They also assess how willingness to pay varied as two key characteristics of the contract were varied and find that basis risk reduced demand for insurance, particularly when the price of the contract was high, and that provision of insurance through groups was preferred by women and individuals with lower levels of education.

According to Berhane et al. (2013) weather risk remains a major challenge to farming in poor countries that face frequent droughts. Recent evidence on index-based weather insurance points to low take-up rates largely due to basis risk (i.e. residual risk left uninsured by the index). Using randomized control trials, they study to what extent traditional groups can be utilized to mitigate basis risk by retailing insurance through these groups. They find that selling insurance through Iddirs, with pre-defined sharing rules, increases take-up—suggesting that groups are better placed to reduce basis risk. They also find that insurance strengthens existing risk-sharing behavior within groups, for example, by improving access to loans from the Iddir to cover crop losses and improving perceived ability to finance emergencies. Insurance has also improved household welfare in the short term considered in this study, albeit to a limited extent.

Trang (2013) strives to find out the willingness to pay of Vietnamese farmers based on area-yield index insurance, as well as the factors that influence it. He conducted a contingent valuation study on a sample of Vietnamese farmers in Dong Thap province, using a double bound dichotomous choice procedure. He measured Farmers’ risk attitude by a gambling game, while other interested variables were collected from a household questionnaire. By using Empirical analysis using a probit model for the willingness to join and an interval data model for double bound dichotomous choice he found evidences that while most farmers
might be interested in joining the program, they will only be willing to buy the insurance at a subsidized price. He also found that the perceived high probability of agricultural risk occurrence, farmers’ risk aversion, wealth, education and complementary risk management strategies such as the sale of assets statistically influenced the decision to take up insurance. Finally he concluded that risk-averse farmers, those who do not grow rice in the risky season, and those intending to sign an interlinked contract, statistically had a lower willingness to pay. And Households with non-farm employment and savings, better knowledge of insurance, and, surprisingly, the small farmers of the community were willing to pay more for the insurance.
3. BACKGROUND, DATA AND METHODOLOGY

3.1 Study Area Description

Ethiopia is a country located in the Horn of Africa with a land size of about 1.1 million square kilometer and a population size of 93,877,025 million people in 2013. Ethiopia is bordered on the west by the Sudan, the east by Somalia and Djibouti, the south by Kenya, and the Northeast by Eritrea (CIA 2013).

Ethiopia is a federal country divided into 11 regions. Each region is sub-divided into zones and the zones into woredas, Woredas are divided into Peasant Associations (PA), or kebeles, an administrative unit consisting of a number of Households.

Figure 3.1 Map of Ethiopia

Source: (CIA 2013)
Figure 3.2 Ethiopian Rural Household survey villages

According to World Bank (2013) Ethiopia is one of the world’s oldest civilizations; Ethiopia is also one of the world’s poorest countries. The country’s per capita income of $410 is substantially lower than the regional average (Gross National Income, Atlas Method). The government aspires to reach middle income status over the next decade. The economy has experienced strong and broad based growth over the past decade, averaging 10.6% per year in 2004/05 - 2011/12 compared to the regional average of 4.9%. Expansion of the services and agricultural sectors account for most of this growth, while manufacturing sector performance was relatively modest. Private consumption and public investment explain demand side growth with the latter assuming an increasingly important role in recent years. Economic growth brought with it positive trends in reducing poverty, in both urban and rural areas. While 38.7% of Ethiopians lived in extreme poverty in 2004-2005, five years later this was 29.6%, which is a decrease of 9.1 percentage points as measured by the national poverty line, of less than $0.6 per day. Using the Growth and Transformation Plan (GTP), the target is to reduce this further to 22.2% by 2014-2015. Ethiopia has achieved the Millennium Development Goals (MDGs) for child mortality and is on track for achieving them in gender parity in education, HIV/AIDS, and malaria. Good progress has been achieved in universal primary education, although the MDG target may not be met. The Government of Ethiopia’s
current five-year development plan (2010/11-2014/15), the Growth and Transformation Plan (GTP), is geared towards fostering broad-based development in a sustainable manner to achieve the MDGs. The GTP envisions a major leap in terms of not only economic structure and income levels but also the level of social indicators. Key goals include:

- Rapid economic growth, targeted for 11% per year at worst and, at best, to double the size of the economy by 2015, with GDP per capita expected to reach $698 by 2015
- Agricultural production is to double, to ensure food security in Ethiopia for the first time
- An increased contribution from the industrial sector, particularly focused on increased production in sugar, textiles, leather products and cement
- Foreign exchange reserves are projected to increase and the Birr is to depreciate by five percent against the dollar each year
- The roads network should increase from 49,000 km to 64,500 km by 2015
- Power generation capacity will increase from the current 2,000 MW to 8,000 MW, and the number of customers from the current two million to four million by 2015
- Construction of 2,395 km of railway line
- Achievement of all Millennium Development Goals (MDGs).

The country has diverse agro-ecological environment. Around 55 percent of the total land area constitutes moisture-stressed arid, semi-arid and sub-moist areas with less than 120 days of crop growing period. These drier areas are commonly low in soil fertility and high in rainfall variability and drought risk. Areas with a longer and dependable period with minimum of 120 crop growing days are found in the remaining 45 percent of the total land area, particularly in the highlands (ADBG, 2008).

3.2 Types and Sources of Data

This study principally used the 2009 Ethiopia Rural Household Survey (ERHS) which is collected by International Food Policy Research Institute (IFPRI). The latest data available which is collected in the year 2009 was used for this study. In the survey a total of 24 villages composed of four biggest regions, Oromiya, Amhara, Tigray and Southern Nationions’ and Nationality People (SNNP), were covered giving a total sample of 1477 households. The villages were selected in such a way that the data will account for the diversity in the farming
systems in the country. The sample was stratified within each village to ensure that a representative number of landless households were also included. Similarly, an exact proportion of female headed households were included via stratification. Topics addressed in the survey include household characteristics, agriculture and livestock information, food consumption, health, women’s activities, as well as community level data on electricity and water, sewage and toilet facilities, health services, education, NGO activity, migration, wages, and production and marketing (Dercon and Hoddinott 2011).

**Table 2: Characteristics of sample sites**

<table>
<thead>
<tr>
<th>Survey Site</th>
<th>Location</th>
<th>Description</th>
<th>Main crops Mean</th>
<th>Perennial Crops?</th>
<th>mean Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haresaw</td>
<td>Tigray</td>
<td>Poor and vulnerable area.</td>
<td>Cereals</td>
<td>no</td>
<td>558</td>
</tr>
<tr>
<td>Geblen</td>
<td>Tigray</td>
<td>Poor and vulnerable area; Used to be quite wealthy.</td>
<td>Cereals</td>
<td>no</td>
<td>504</td>
</tr>
<tr>
<td>Dinki N.</td>
<td>Shoa</td>
<td>Badly affected by 1984/85 famine; not easily accessible even though near Debre Berhan</td>
<td>Millet, teff</td>
<td>no</td>
<td>1,664</td>
</tr>
<tr>
<td>Debre Berhan</td>
<td>N. Shoa</td>
<td>Highland site. Near town</td>
<td>Teff, barley, beans</td>
<td>no</td>
<td>919</td>
</tr>
<tr>
<td>Yetmen</td>
<td>Gojjam</td>
<td>Near Bichena. Ox-plough cereal farming system of Highlands.</td>
<td>Teff, wheat, and beans</td>
<td>no</td>
<td>1,241</td>
</tr>
<tr>
<td>Shumsha</td>
<td>S.Wollo</td>
<td>Poor area in neighborhood of airport near Lalibela</td>
<td>Cereals</td>
<td>no</td>
<td>654</td>
</tr>
<tr>
<td>Sirbana Godeti</td>
<td>Shoa</td>
<td>Near Debre Zeit. Rich area. Much targeted by agricultural Policy. Cereal, ox-plough system</td>
<td>Teff</td>
<td>no</td>
<td>672</td>
</tr>
<tr>
<td>Adele Keke</td>
<td>Hararghe</td>
<td>Highland site. Drought in 1985/86</td>
<td>Millet, maize, coffee, chat</td>
<td>yes, no food</td>
<td>748</td>
</tr>
<tr>
<td>Korodegaga</td>
<td>Arssi</td>
<td>Poor cropping area in Neighborhood of rich valley.</td>
<td>Cereals</td>
<td>no</td>
<td>874</td>
</tr>
<tr>
<td>Turfe Kechemane</td>
<td>S.Shoa</td>
<td>Near Shashemene. Oxplough, Rich cereal area. Highlands.</td>
<td>Wheat, barley, teff, potatoes</td>
<td>yes, some</td>
<td>812</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>--------------------------------------------------------</td>
<td>-------------------------------</td>
<td>----------</td>
<td>-----</td>
</tr>
<tr>
<td>Imdibir</td>
<td>Shoa (Gurage)</td>
<td>Densely populated enset Area</td>
<td>Enset, chat, coffee, maize</td>
<td>yes, including food</td>
<td>2,205</td>
</tr>
<tr>
<td>Aze Deboa</td>
<td>Shoa (Kembata)</td>
<td>Densely populated. Long tradition of substantial seasonal and temporary Migration.</td>
<td>Enset, coffee, maize, teff, sorghum</td>
<td>yes, including food</td>
<td>1,509</td>
</tr>
<tr>
<td>Addado</td>
<td>Sidamo (Dilla)</td>
<td>Rich coffee producing area; Densely populated.</td>
<td>Coffee, enset</td>
<td>yes, including food</td>
<td>1,417</td>
</tr>
<tr>
<td>Gara Godo</td>
<td>Sidamo (Wolayta)</td>
<td>Densely packed enset farming Area. Famine in 1983/84. Malaria in mid-88.</td>
<td>Barley, enset</td>
<td>yes, including food</td>
<td>1,245</td>
</tr>
<tr>
<td>Doma</td>
<td>Gama Gofa</td>
<td>Resettlement Area (1985); Semi-arid; experienced droughts throughout the 1980s; remote.</td>
<td>Enset, maize</td>
<td>yes, some</td>
<td>1,150</td>
</tr>
</tbody>
</table>

Source: Community survey ERHS, Bevan and Pankhurst (1996), and Dercon and Hoddinott (2004).

The above table (table 2) shows the characteristics of the sample sites. These sample sites are characterized with different agro ecologies such as crop types and mean annual rainfall.

The ERHS 2009 data was originally organized differently, than used in this study, so STATA data management methods (recode, merge, filter, etc.) were used and a clean data is developed.
3.3 Method of Analysis

The analysis basically employed both descriptive and econometric methods. Descriptive statistics (mean, percentage, range, etc.) is used to summarize the variables and to describe the study area. Multiple linear regression model with OLS estimation is used to analyze the effect of Household demographics, Household risk perception, access to micro finance, House hold off-farm income, Livestock value, involvement in Water harvesting technologies, land holdings on Household willingness to pay for the weather index insurance. Before embarking on the analysis methods, it’s crucial to start by defining the variables.

3.3.1 Variable Definition

The variables that are used in determining the willingness to pay for weather index insurance are defined briefly as follows.

WILLINGNESS TO PAY TO WEATHER INDEX INSURANCE:

This is the outcome variable. The willingness-to-pay module began by describing the closest weather station to the respondents’ home and the amounts of rain observed at that station. A hypothetical insurance contract was then described in terms of a “well-known Ethiopian insurance company” offering a payment of 1,500 Ethiopian birr (ETB) when rainfall at the closest weather station fell below a certain level. Respondents were then asked if they would be willing to buy this insurance for a monthly premium of three values (X, Y, Z) with X the minimum and Y the maximum values that was randomly selected to lie (in increments of ETB 5) between ETB 10 and ETB 40. This interval was chosen so as to encompass the actuarially fair price of this insurance (ETB 25 monthly), a markup of up to 60 percent on the fair price (that would account for costs associated with marketing, administering, and reinsuring the insurance product), as well as the possibility that this insurance might be subsidized. First the respondents were asked if they would be willing to pay X Birr every month to this insurance company for twelve months to buy this insurance for one year. Then those who said yes to X were also asked if they would be willing to pay Y, and those who said no to X were asked if they would be willing to pay Z. If the respondents answer were no for both X and Z, they are assumed to be in between zero and Z and the average value of zero and Z, i.e. Z/2, is taken as willingness to pay of those respondents. If they say no to X and yes to Z, their willingness to pay is in between Z and X and the average value of Z and X is taken as their willingness to
pay. If they say yes to X and no to Y, they are in between X and Y and the average value of X and Y is taken as their willingness to pay. If they say yes for both X and Y, Y is taken as their willingness to pay. Finally, a continuous variable was developed in this way by using STATA.

**Determinants of willingness to pay to weather index insurance:**

- **Age (AGE)**: This refers to the age of the household head measured in years.

- **Sex (MALE HEAD)**: This refers to the sex of the household head measured as 1 if household head is male 0 otherwise.

- **Education (EDUCATION)**: This is educational level of the household head measured in years of schooling, giving zero value for illiterate.

- **Other Education (OTHER EDUCATION)**: This is also a dummy variable which is measured as 1 if there is other education such as Adult literacy program participation, other literacy program and Some Church/Mosque School, and 0 otherwise.

- **Off-farm income (OFF-FARM INCOME)**: This is a continuous variable which is the income of the household members from off-farm activity in the last four months in terms of money.

- **Livestock (LIVESTOCK VALUE)**: This is the total value of the livestock owned by the household in terms Money.

- **Land holding (LAND)**: This refers to the area of plot of land allotted for crop production. The unit of measurement for area is also different in different parts of the country; hence the data was changed to hectare for smoothness. Accordingly, the hectare of plot of land used for crop production was used in the analysis.

- **Eqqub (EQQUB)**: This is a traditional micro finance measured as 1 if the household and/or members of the household a member of an Eqqub and 2 otherwise.

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1 The words written in the brackets are terms used in the analysis.

2 Eqqub is an informal financial market mostly used in rural parts of Ethiopia that is owned by a group of people and used as a saving and credit market.
• Involving in any water harvesting technologies (WATER HARVESTING): This is also a dummy variable which is measured as 1 if the household is involved in any water harvesting and 2 otherwise.

• Risk perception (RISK): This is a categorical variable on which households were asked by imagining that they are going to the market to sell a bag of maize and to select which condition would they prefer from the following choices:
  1. To be certain you will receive 250 Birr for one bag
  2. Have equal chance that you will be paid 200 Birr or 400 Birr
  3. Have equal chance that you will be paid 150 Birr or 550 Birr
  4. Have equal chance that you will be paid 100 Birr or 700 Birr
  5. Have equal chance that you will be paid nothing or 1000 Birr
Those who chose the first condition are risk-averse households and those who chose the fifth condition are less risk-averse households. Risk-aversion decreases from first to last condition.

• Time preference (TIME PREFERENCE): Purchasing insurance requires an individual to set aside money in the present for an event that may occur in the future. As such, an individual’s discount rate is also likely to influence the decision of whether or not to buy. The data is collected on time preferences by asking individuals to consider a situation in which they were about to receive a gift. They could choose to receive the gift of ETB 100 today or could instead choose to receive a gift of ETB 100 + X one month from now, where X was increased from ETB 25 to the point at which the household chose to wait.

3.3 Model specification: The multiple linear regression model

The Multiple Linear Regression Model and its estimation using ordinary least squares (OLS) is doubtless the most widely used tool in econometrics. It allows to estimate the relation between a dependent variable and a set of explanatory variables. The dependent variable is an interval variable, i.e. its values represent a natural order and differences of two values are meaningful. The dependent variable can, in principle, take any real value between $-\infty$ and $+\infty$. 
The multiple linear regression model assumes a linear (in parameters) relationship between a dependent variable $y_i$ and a set of explanatory variables $x' = (x_{i0}, x_{i1} \ldots x_{ik})$. $x_{ik}$ is also called an independent variable, a covariate or a regressor. The first regressor $x_{i0} = 1$ is a constant unless otherwise specified. Consider a sample of N observations $i = 1, \ldots, N$. Every single observation $i$ follows:

$$y_i = x'_{i}\beta + u_i$$

Where $\beta$ is a $(K + 1)$-dimensional column vector of parameters, $x'_{i}$ is a $(K + 1)$-dimensional row vector and $u_i$ is a scalar called the error term.

The whole sample of N observations can be expressed in matrix notation,

$$y = X\beta + u$$

Where $y$ is a $N$-dimensional column vector, $X$ is a $N \times (K + 1)$ matrix and $u$ is a $N$-dimensional column vector of error terms, i.e.

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_N \end{bmatrix} = \begin{bmatrix} 1 & x_{11} & \ldots & x_{1k} \\ 1 & x_{21} & \ldots & x_{2k} \\ \vdots \\ 1 & x_{N1} & \ldots & x_{Nk} \end{bmatrix}\begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix} + \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_N \end{bmatrix}$$

$$N \times 1 \quad N \times (K+1) \quad (K+1) \times 1 \quad N \times 1$$

The data generation process (dgp) is fully described by a set of assumptions. Several of the following assumptions are formulated in different alternatives. Different sets of assumptions will lead to different properties of the OLS estimator.

**OLS1: linearity**

$$y_i = X'_{i}\beta + u_i \text{ and } E(u_i) = 0$$

OLS1 assumes that the functional relationship between dependent and explanatory variables is linear in parameters, that the error term enters additively and that the parameters are constant across individuals $i$. 

25
**OLS2: Independence**

\( \{x_i, y_i\}_{i=1}^{N} \) i.i.d (independent and identically distributed)

OLS2 means that the observations are independently and identically distributed. This assumption is in practice guaranteed by random sampling.

**OLS3: Exogeneity**

a. \( u_i \mid x_i \sim N(0, \delta^2_i) \)

b. \( u_i \) and \( x_i \) are independent to each other.

c. \( E(u_i \mid x_i) = 0 \) (mean independent)

d. \( \text{Cov} (x_i, u_i) = 0 \) (uncorrelated)

OLS3a assumes that the error term is normally distributed conditional on the explanatory variables. OLS3b means that the error term is independent of the explanatory variables. OLS3c states that the mean of the error term is independent of the explanatory variables. OLS3d means that the error term and the explanatory variables are uncorrelated. Either OLS3a or OLS3b imply OLS3c and OLS3d. OLS3c implies OLS3d.

**OLS4: Error Variance**

a. \( V (u_i \mid x_i) = \delta^2 < \infty \) (homoscedasticity)

b. \( V (u_i \mid x_i) = \delta^2 = g(x_i) < \infty \) (conditional heteroscedasticity)

OLS4a (homoscedasticity) means that the variance of the error term is a constant. OLS4b (conditional heteroscedasticity) allows the variance of the error term to depend on the explanatory variables.

**OLS5: Identifiability**

\( \text{rank}(X) = K + 1 < N \) and

\( E (x_i \mid x^-) = Q_{xx} \) is positive definite and finite

The OLS5 assumes that the regressors are not perfectly collinear, i.e. no variable is a linear combination of the others. For example, there can only be one constant. Intuitively, OLS5 means that every explanatory variable adds additional information. OLS5 also assumes that all regressors (but the constant) have non-zero variance and not too many extreme values.
**Estimation with OLS**

Ordinary least squares (OLS) minimize the squared distances between the observed and the predicted dependent variable $y$:

$$S(\beta) = \sum_{i=1}^{N} (y_i - x_i \beta)^2 = (y - X\beta)'(y - X\beta) \rightarrow \beta_{\text{min}}.$$  

The resulting OLS estimator of is:

$$\hat{\beta} = (X'X)^{-1}X'y$$

Given the OLS estimator, we can predict the dependent variable by $\hat{y}_i = x_i' \hat{\beta}$ and the error term by $\hat{u}_i = y_i - x_i' \hat{\beta}$ is called the **residual**.

The willingness to pay of the weather index insurance is denoted by vector $y$ and the parameter $\beta$ denotes the vector of coefficient of the determinants of willingness to pay. The determinants of willingness to pay are denoted by the matrix $X$. 
4. RESULT AND DISCUSSION

This chapter consists of both descriptive and econometric results of the study. Specific to econometric part, results were discussed by comparing and contrasting with other research findings done before elsewhere in the world.

4.1 Descriptive Analysis

The Households were asked their willingness to pay for the weather index insurance for different monthly premium levels and households answered which monthly premium offer they are willing to pay. As shown in figure 1 the willingness to pay of the most respondents is in between 12.5 to 17.5 Ethiopian Birr. And the willingness to pay of about 13% of the respondents is 15 Ethiopian Birr.

Figure 1: Willingness to pay

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3 As it was explained on the data source section of this paper respondents were asked if they would be willing to buy this insurance for a monthly premium that was randomly selected to lie (in increments of ETB 5) between ETB 10 and ETB 40.
Table 3: Description of household risk perception

<table>
<thead>
<tr>
<th>Code</th>
<th>Now imagine that you are going to the market to sell a bag of maize. Would you prefer:</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To be certain you will receive 250 Birr for one bag</td>
<td>306</td>
<td>19.47</td>
<td>19.47</td>
</tr>
<tr>
<td>2</td>
<td>Have an equal chance that you will be paid 200 Birr or 400 Birr</td>
<td>249</td>
<td>15.84</td>
<td>35.31</td>
</tr>
<tr>
<td>3</td>
<td>Have an equal chance that you will be paid 150 Birr or 550 Birr</td>
<td>354</td>
<td>22.52</td>
<td>57.82</td>
</tr>
<tr>
<td>4</td>
<td>Have an equal chance that you will be paid 100 Birr or 700 Birr</td>
<td>229</td>
<td>14.57</td>
<td>72.39</td>
</tr>
<tr>
<td>5</td>
<td>Have an equal chance that you will be paid nothing or 1000 Birr</td>
<td>434</td>
<td>27.61</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1,572</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Respondents are asked some hypothetical questions to know their risk perception. They are asked which amount of money they would prefer to receive under different probabilities by imagining that they are going to the market to sell a bag of maize. Table 3 prevailed that those who prefer to receive 250 Birr for one bag certainly are 19.47%. These respondents are treated as risk-averse households. And those who prefer an equal chance of being paid nothing or 1000 Birr are 27.61%. These respondents are treated as less risk-averse households.

Table 4: Summery of dummy variables used in the analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>EQQUB</td>
<td>212</td>
<td>1,363</td>
</tr>
<tr>
<td>OTHER EDUCATION</td>
<td>334</td>
<td>1,189</td>
</tr>
<tr>
<td>WATER HARVESTING</td>
<td>173</td>
<td>1,397</td>
</tr>
</tbody>
</table>
This study used both continuous and dummy variables to explain the variation of willingness to pay for weather index insurance. The summary of dummy variables used in the analysis (table 4) shows that majority of the respondents are not involved in any of the financial market. Only 13.46% of respondents are members of eqqub. The respondents who are involved in any of the water harvesting technologies are 11.02%. A lot of households in rural parts of Ethiopia are learned through informal education system such us adult literacy program, church/mosque schools and other literacy program. Respondents who get their education through this way learning are found to be 21.93%.

Table 5: Summary of other continuous variables used in the analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF FARM INCOME</td>
<td>1042</td>
<td>300.1929</td>
<td>2022.406</td>
<td>0</td>
<td>60000</td>
</tr>
<tr>
<td>LIVESTOCK VALUE</td>
<td>1042</td>
<td>8217.019</td>
<td>11170.59</td>
<td>0</td>
<td>82700</td>
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<td>873.8906</td>
<td>1.5</td>
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<td>100</td>
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<td>1.719246</td>
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<td>3.804201</td>
<td>21.85971</td>
<td>.002</td>
<td>601.75</td>
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</table>

According to table 5, 39.06% of the respondents are with female head and 60.94% are with male head households. The respondents are from age 16 to 100 with mean age of 52. Most Households in the rural areas of Ethiopia are involved in agriculture. Their main source of income is from farm activities. But there are also some households who get additional income from off-farm activities. 74.81% of the respondents have no off-farm income. The mean off-farm income of the respondents in the last four months is 300 Birr with a maximum off-farm income up to 60,000. Another very important variable that is expected to affect the level of willingness to pay of the households is the value of livestock owned by the households. The mean value of livestock owned by the households is 8217 Birr with a maximum livestock value 82700. Time preference of the household indicates for the patience level of households. Here, respondents are asked how much they would have to be given in one month for them to choose to wait instead of being given a gift of 100 Birr today. The mean answer is 569 Birr with a minimum amount of 1.5 birr and maximum amount of 10001 Birr. The mean land holding of the households is 3.8 hectare with a minimum amount of 0.002 hectare and maximum land size of
601.75 hectare. Another very important variable is the education level of the respondents with a range from zero level of education up to 14 years of schooling. The mean schooling of the respondents is 1.7 years.

### 4.2 Econometric Results

The risk perception was driven from the hypothetical market game. From Figure 2 below we can see that the median of the willingness to pay for weather index insurance of the less risk-averse households is higher than the risk-averse households. The corresponding minimum and maximum willingness to pay of the less risk-averse households are also higher than the risk-averse households. The range of the willingness to pay is higher on the risk-averse households. But the degree of difference is not consistent across all categories of risk.

**Figure 2: Box plot of willingness to pay over Risk**

![Box plot of willingness to pay over Risk](image)

*Note:* The categorical variable risk takes five values (1 = To be certain you will receive 250 Birr for one bag, 2 = Have an equal chance that you will be paid 200 Birr or 400 Birr, 3 = Have an equal chance that you will be paid 150 Birr or 550 Birr, 4 = Have an equal chance that you will be paid 100 Birr or 700 Birr, 5 = Have an equal chance that you will be paid nothing or 1000 Birr). The graph shows the distribution of the willingness to pay for each risk category.
As it is shown in table 6 below, the willingness to pay of those who chose to get paid 200 Birr or 400 Birr for one bag with equal chance is 2.25 units more than those who chose to get paid 250 Birr certainly for one bag. This is significant at 5% level of significance. The willingness to pay of those who want to get paid 150 Birr or 550 Birr are with equal chance is also more than those who want to receive 250 certainly. But it was with insignificant value. The willingness to pay of those who chose to get paid 100 Birr or 700 Birr for one bag with equal chance is 2.66 units more than those who chose to get paid 250 Birr certainly for one bag. This is significant at 5% level of significance. Those who want to be paid nothing or 1000 Birr has also insignificantly more willingness to pay as compared to those who certainly want to be paid 250 birr for one bag. We can see from this result that risk-averse, those who certainly want to be paid 250 for one bag, households have less willingness to pay for index based insurance. This result is in line with the result found by Hill et al. (2011). They found increased risk aversion reduces the likelihood of selecting this insurance product—but with improved precision. With the caveat that their results were based on willingness to purchase a hypothetical product, the negative relationship between willingness to pay and risk aversion was not consistent with the predictions of their basic model.

As a risk-reducing asset, the willingness to pay for insurance was expected to increase with risk aversion. However, weather index insurance has not been introduced in most part of Ethiopia. And thus, this asset is new for majority of the households. According to Kebede et.al (1990), adoption of agricultural production technologies in developing countries is influenced by a wide range of economic and social factors as well as physical and technical aspects of farming and the risk attitude of farmers. Their study examined that the impact of such factors on the adoption of single-ox, fertilizer and pesticide technologies as part of a post-drought recovery project in Tegulet-Bulga district in Ethiopia. They found, the impact of the degree of risk aversion of farmers is found to be significant and negative for single-ox technology in both areas, and for fertilizer and pesticide technologies in only one area. So, we can hypothesize that the willingness to pay of weather index insurance, as a new technology, is low for risk-averse households.
### Table 6: Determinants of willingness to pay

<table>
<thead>
<tr>
<th>WILLINGNESS TO PAY</th>
<th>Coef.</th>
<th>Std. Err.</th>
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<th>P&gt;t</th>
</tr>
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<td>LIVESTOCK VALUE</td>
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<td>0.000309</td>
<td>5.56</td>
<td>0.000***</td>
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<td>0.065*</td>
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<td>0.76</td>
<td>0.446</td>
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<td>0.214</td>
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<td>2.33</td>
<td>0.020**</td>
</tr>
<tr>
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<td>0.001***</td>
</tr>
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<td>0.0003987</td>
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<td>RISK</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>2.247722</td>
<td>1.023204</td>
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<td>0.028**</td>
</tr>
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<td>4</td>
<td>2.66252</td>
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<td>5</td>
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<td>_cons</td>
<td>18.90777</td>
<td>3.294055</td>
<td>5.74</td>
<td>0.000</td>
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</table>

**Notes:** The categorical variable risk has four dummy variables (2= Have an equal chance that you will be paid 200 Birr or 400 Birr, 3= Have an equal chance that you will be paid 150 Birr or 550 Birr, 4= Have an equal chance that you will be paid 100 Birr or 700 Birr, 5= Have an equal chance that you will be paid nothing or 1000 Birr) explained relative to 1= To be certain you will receive 250 Birr for one bag. *, **, *** indicate significance at 10, 5, and 1 percent levels, respectively.
Another important variable that affects the willingness to pay for weather index insurance is the time preference of the households. They could choose to receive the gift of ETB 100 today or could instead choose to receive a gift of ETB 100 + X one month from now, where X was increased from ETB 25 to the point at which the household chose to wait. The result shows that a unit increase in the amount of money that they would have to be given to wait for a month increases willingness to pay to weather index insurance by small amount that’s by 0.0002 times. This is significant at 10% level of significance. Figure 3 below shows the bivariate relationship of willingness to pay and time preference. This bivariate relationship is also in line with the result in table 6. It shows that increase in the amount of money that they would have to be given to wait for a month increases willingness to pay. This is hypothesized due to the fact that poor households are believed to be unable to insure themselves. Those households who ask to be given more money to choose to wait are impatient and unable to insure themselves. The more households are impatient and unable to insure themselves the more they are willing to pay for insurance.

**Figure 3: The effect of time preference on willingness to pay**

As it is presented in table 6, the willingness to pay of those households who are involved in any of the water harvesting technologies is found 3.21 units more than those who are not involved in water harvesting technologies. This is significant at 1% level of significance. Besides, as it is depicted willingness to pay of those households who are involved in water harvesting in the figure 4 below, the corresponding median, minimum and maximum values of the technologies is higher than those who are not involved.
This may be because water harvesting technologies are introduced in Ethiopia recently and these technologies are easily adopted by those who are less risk-averse households. As Haile and Merga (2002) explained, the economy of Ethiopia is agrarian, and mainly relying on household labor. Agriculture production is aimed at self-subsistence and dependent on forces of nature. As such, success in production in the lowland agro-ecology is severely affected by climatic variability. The total annual rainfall is inadequate for crop production; since often the rainfall distribution is erratic. The most common shock to which mainly the lowland inhabitants are exposed is insufficient agricultural production resulting from moisture stress. Techniques to improve soil moisture retention or water harvesting is not known to most farmers or not commonly practiced. As presented before, those who are less risk-averse households have higher willingness to pay.

Another reason for why those who are involved in different water technologies have more willingness to pay than those who are not involved is hypothesized to be because those who easily adopt Water harvesting technologies are those who are relatively rich; because constructions of water harvesting technologies require some expenditure. Thus, those who are able to construct that water harvesting technology are also expected to be able to buy the weather index insurance.
Another variable that is important in explaining insurance is Eqqub which refers to access to local financial institutions. As we can see from table 6, those who are member of Eqqub have 2.16 unites more willingness to pay than those who are not member of Eqqub. This is significant at 5% level of significance.

**Figure 5: Box plot of willingness to pay over Eqqub**

As it is depicted in figure 5 above, the corresponding median, minimum and maximum values of the willingness to pay of those households who are members of Eqqub is higher than those who are not members. This may be because those households who are member of Eqqub are familiar with financial products and thus they are able to finance insurance purchases.

Education is also another very important variable that affects the willingness to pay of weather index insurance. We can see from table 6 that a unit increases in years of schooling increases willingness to pay for the weather index insurance of the households by approximately 0.24 times. This is significant at 10% level of significance. Those households who are educated through informal education system (stated as other education) such us adult literacy program, church/mosque schools and other literacy program have also 0.62 unites more willingness to pay than those who did not complete any education. But it is statistically insignificant.

Livestock is a very important asset of households. Those who have more livestock value may be able to insure themselves during weather shock and thus they will have less willingness to pay. But, on this study it is found that a unit increase in livestock value increases willingness
to pay for the weather index insurance by small amount that is 0.0002 times. This is significant at 1% level of significance. The bivariate relationship of willingness to pay and livestock value is also portrayed in figure 6 below. This figure in line with the result found in table 6. It shows increase in livestock value increases willingness to pay of households. The reason may be due to those households with higher livestock value are more likely to be able to pay more for insurance.

**Figure 6: The effect of livestock value on willingness to pay for insurance**

As we can see from table 6, Male-head households have 0.82 unites higher willingness to pay that women-head households; though it is statistically insignificant. A unit increase in off-farm income of households increase willingness to pay of households by 0.000; it is statistically insignificant. This may be due to the fact that those households who have more off-farm income are more likely to be able to pay for insurance. Age and land size of households insignificantly and negatively affects the willingness to pay for insurance. Increase in one year age of household decreases willingness to pay by 0.16 times. A unit increase in land size also decreases willingness to pay by 0.018 times. This is hypostasized due to crop diversification. Households with large land size diversifies their crop production; they may divide their land in to different plots and produce different type of crops to reduce the risk for rainfall shock as different crop types have different crop water requirements.
4.3 Limitation of the study

This study used the 2009 cross sectional data of Ethiopian rural household survey. The willingness to pay for weather index insurance could also be studied by using panel data of households to see the dynamics of willingness to pay over years. As we can see from appendix 1, the value of VIF (variance inflation factor) of each variable is less than 5. The mean VIF is 1.12 which means the true variance is inflated by 1.12 because of Multicollinearity. So, the model has some degree multicollinearity problem, but it is not significant.

Willingness to pay for weather index insurance is unlikely to affect directly to either of the independent variables used in this model; Reverse causality problem is unlikely to have in this model. However, there may be omitted variables which are not included in this model that can affect to the willingness to pay for weather index insurance. Irrigation can be used by most farmers as a supplementary water supply when there is shortage of rainfall or when the rainfall is inconsistent. Having access to irrigation water supply may reduce the risk of insufficient or inconsistent rainfall water supply. There for, access to irrigation can also affect willingness to pay for weather index insurance. Households’ farm Land size is included in this model. But there is no indicator that weather this land is fertile (with good soil quality) or not. Farm land quality affects the output level that can be harvested from the farm land. So, the households’ farm land quality can also affect willingness to pay for weather index insurance.

The effect of time preference of the households included in this model shows that those who are asking more to wait instead of receiving a gift now are impatient and unable to insure themselves. Thus, these households have more willingness to pay for weather index insurance. So, time preference in this model is indirectly (not directly) affecting willingness to pay for weather index insurance.
5. CONCLUSION

In this paper the willingness to pay for weather index insurance in rural parts of Ethiopia has been analyzed. Willingness to pay for weather index insurance can be affected by different socio-economic factors. In this study household demographics, Farmers risk perception, farmer’s impatience, Education, land size, previous knowledge of financial markets, involvement in water harvesting technologies, and household’s off-farm income are taken as determinant factors of willingness to pay for weather index insurance. This study used the 2009 Ethiopian rural household survey data of the International Food Research Policy Institute and Multiple Linear Regression Model (with OLS Estimation) has been applied to see the effects of these determinant factors on willingness to pay for weather index insurance. This study can help to the policy makers and insurance companies to widely interpose the weather insurance product to the rural parts of Ethiopia. It can also help to guide the implementation modalities of provision of the weather insurance product.

Results show that those households who are less risk-averse have more willingness to pay than the risk-averse households. But the result is not consistent across all risk categories. The results also show that a unit increase in the amount of money that they would have to be given to wait for a month instead of receiving a gift of 100 Birr now increases willingness to pay to weather index insurance by small amount that’s by 0.0002 times. This means impatient households who are unable to insure themselves have more willingness to pay for insurance. A unit increase in livestock value owned by the household also increases willingness to pay for weather index insurance by 0.00017 times. A unit increase in years of schooling increase willingness to pay by 0.24 times. Those households who are educated through informal education system (stated as other education) such us adult literacy program, church/mosque schools and other literacy program have also 0.62 unites more willingness to pay than those who did not complete any education. Those households who are familiar to local financial access (those who are members of Eqqub) have 2.16 more willingness to pay for insurance than those who are not members. Moreover, those households who are involved in any of the water harvesting technologies have 3.21 more unites of willingness to pay for insurance than those who are not involved in any water harvesting technology. Besides, the results show that women, old age households and households with large land size have less willingness to pay for insurance. The increase in off-farm income of households also increases willingness to pay for insurance. Results indicate that the effect of households’ risk perception, time preference, education, familiarity with local financial products, involving in water harvesting...
technologies and livestock value on willingness to pay for the weather index insurance are significant. However, the effects of age, sex, land size, and off-farm income on willingness to pay for weather index insurance are found statistically insignificant.
REFERENCES


Research Center on International Cooperation of the University of Bergamo


Appendix 1

Multicollinearity test

```
. estat vif

<table>
<thead>
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</tr>
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</table>

Mean VIF        | 1.12  |
```