

## Effects of Climatic Change on Demand and Pricing of Livestock Insurance in Ethiopia

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### 1. Introduction

Rural households' risk exposure in poor countries has been widely studied (Dercon, Ed., 2004). It is at times considered as a cause (Fafchamps, 1999) or as a consequence of households' poverty and of their risk aversion (Mosley, 2001). Climatic change is one of the main causes of risk exposure, which proved to be relevant in many areas of the world in different periods. Anderson and Hazell (Eds., 1989) find particular sensitivity to this factor in African countries and more recent literature confirms this view. Studies on Sub-Saharan Africa show how climatic change risk and the related environmental risks affect, at times, single individuals but, more often, the whole population, as they are covariant and hardly diversifiable at a local level (Morduch, 2004). In this case, and even more so in case of a combination of covariant risks (Yaron, 2004), self-protection through diversification, provisioning, or the access to local informal financial markets may not be effective.

Risk management strategies adopted by farmers and rural households' in general are explored, among others, by Mosley (2001), Skees et al. (2002), Skees (2003), Hoogeveen et al., (2004). Strategies include risk externalization through formal and informal insurance. Life, health or casualty insurance may indeed represent an attraction provided that basic condition for implementation are met. Brown (2001) highlights at least the need of verifying the actual demand for insurance as a complementary risk management strategy, the suitability of the services provided and the farmers' willingness to pay for them. The literature on the willingness to pay for insurance is in fact quite rich (among others, Hill and Robles, 2011; Fuchs and Wolff, 2011, Patt et al., 2009; Clarke and Kalani, 2011; Sarris, 2013) .

Informal insurance is offered through arrangements among individuals or as a group solution, in more or less structured forms of mutual insurance (Churcill and Matul, 2012). These kinds of agreements are widespread in rural areas of several countries and Ethiopia represents a significant example (see section 2). Given the restricted area of operation, informal insurers are highly exposed to co-variant risk.

Covariance of risks is less stringent for formal (regulated) insurance, depending on the size of the intermediary, its operational area (which depends, among other things, on the country's characteristics and size), and on accessibility to re-insurance markets. While this is an advantage on informal insurance, formal

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insurance is seldom able to operate in rural areas, where its contribution would potentially be relevant. Several reasons explain this gap. Attractiveness of rural areas for formal insurers is often limited by the size of the single transaction, by the difficulty and costs of monitoring the customers and the contract, by the mismatch between contractual conditions offered and demanded, by the lack of transparency of the supply or of understanding of the demand side, and by basis risk (Castellani, Tamre, Viganò, 2014). Some of the mentioned problems could be softened by a more extensive insurance network which, in turn, may not be an issue when the potential market is not deemed sufficient to justify the costs. The soft penetration of insurance in Africa is still evident. KPMG (2014) reports an estimation by Swiss-Re, NKC Research, of the depth of the insurance market in Africa as compared to the rest of the world. While in terms of penetration ratio (the gross value of insurance premiums as a percentage of GDP) Africa is below the global average of 6,5% but not at the bottom of the list, the insurance density (premiums per capita) show the lowest value for this continent (66.4 USD), with South Africa, Namibia, Mauritius and Botswana sensibly pushing upwards this average.

Microinsurance can be considered as a hybrid case as it is offered by microfinance intermediaries which are more or less formal. While microfinance intermediaries are intended to achieve a larger outreach than traditional formal intermediaries, an estimate of Matul et al. (2010) states that the target African population is minimally reached by microinsurance products (2,6% in number, and 1% in value of premiums). Life insurance predominates while health insurance only covers 0.3% of the market. Even smaller percentages represent the coverage of property and agriculture insurance. As in the case of formal insurance, one main explanation for low take-ups is the difficulty in understanding the product and the felt inability to pay the premium. On the supply side, although in microinsurance size is a less relevant limiting factor, lack of information technology and high administration costs, together with insufficient appreciation of the demand potential, discourage from developing suitable products.

The preceding data show that the type of risk protection potentially demanded may also be a limit. In fact, life insurance has been developing quite extensively in recent years (on Africa see, among others, the cases of Ghana described in Churchill and Matul, 2012) because this risk is better appreciated, assessed, and managed by insurers, statistics of life expectancy are increasingly reliable, the contract can easily be attached to other contracts offered by financial intermediaries (namely loans). On the contrary, casualty insurance still represents a challenge in most instances, especially when the risk is related to weather conditions.

As a matter of fact, crop insurance is not new in rural areas of many poor countries but, being essentially based on revenue protection, minimum guaranteed crop yield and estimated crop losses, experiences proved that moral hazard prevails, especially when the programs are offered by public insurance schemes, with political or welfare goals prevailing on technical analysis (Viganò, 2002; Brown, 2001; Hessel et al., 2002).

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To face this problem, in recent years, attempts to immunize the indemnity mechanism from the policy holders' behaviour are pursued by the introduction of index-based systems. Losses are estimated according to parameters beyond the control of the policy holders, through the use of indexes, such as rainfall or temperature measures which have a statistical correlation with crop yields. While these contracts limit moral hazard issues, they increase basis risk (Skees, 2003; Castellani, submitted). The most common type of index-based contract is linked to weather indicators (rain, wind, or temperature) but area yield and livestock contracts are used as well. In the two latter cases, average (crop or livestock) losses in a given area are estimated; compensations are offered to policy holders when the average loss or mortality rate is beyond a given threshold, proportional to the protection purchased which normally depends on the size of the activity of the policy holder (land extension or number of animals). Area based insurance can be very effective if area yields can be adequately measured (Skees et al., 2002); in the case of livestock, mortality rates must be computed (FAO, 2001). Weather index-based insurance uses historical data gathered from weather stations to compute the correlation between the weather indicator and farmers' yield. The calculation of correlation, the index threshold setting beyond which payment is due, the estimation of the suitable indemnity to be offered, and price setting are critical for the success of the product (Hess, 2003). Such type of protection may be offered through an insurance contract or a simple weather derivative (or a combination of weather derivatives), the choice depending on several factors among which the frequency and harshness of events, delivery channels and the clientele's preferences and understanding of the contract. (Berg, Schmitz, Starp, Trenkel, 2004). Interesting successful examples are increasing worldwide (Sandmark et al., 2013; Greatrex et al., 2015). Among the emerging cases, livestock index-based insurance is still at a pilot stage. A first well known example is implemented in Mongolia (FAO, 2001; Greatrex et al., 2015) while, as concerns, Africa, an interesting reference case is represented by Kenya (Chantarat et al., 2013).

The choice to focus on livestock insurance was driven by the lack of experiences and literature, the relevance of livestock for farmers and the higher income-generating power of this kind of protection. In fact, opposite to agriculture crop insurance which is a zero-sum game because it protects against an income risk, livestock insurance is meant to safeguard the value of assets, at the base of future income generation (Chantarat et al., 2013).

The remaining part of the paper is organized as follows: section 2 presents an overview of the offer of insurance in Ethiopia, with a specific interest in the opportunities for livestock insurance, section 3 focuses on a review of the methodologies applied to date to deal with livestock insurance, and section 4 presents our original work. Section 5 concludes.

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### **2. The Insurance Market in Ethiopia and the Case for Livestock Insurance**

According to the National Bank of Ethiopia (NBE) data, in Ethiopia 17 insurance companies operate with 332 branches, with a sensible recent expansion: 59 branches between 2013 and 2014, 13 of them by the state owned company (Ethiopian Insurance Corporation – EIC). Despite this increase in EIC, the bulk of branches (81%) and of capital (79%) belong to the private sector. 55% of branches are located in the capital town (NBE, 2014). The public and private insurance sector in Ethiopia have only in the last two decades started offering insurance contracts in rural areas, sometimes in co-operation with international development agencies on experimental cases (see, for example, McIntosh, 2013 or Nahu, 2011). Awareness of the potential demand for insurance expressed by small and micro-scale farmers and of their risk exposure to several risks was recorded in the past decade (Viganò, ed., 2007). However, despite the sensible improvement in the formal insurance network, rural areas are still underserved. Resistance of potential suppliers of insurance relate to the logistical impediment and cost to serve rural areas and to the difficulty of assessing risk and make actuarial analysis; resistance on the demand side derive from difficulties in fully understand financially complex products, from the awareness of existing multiple perils, and high cost expectations sometimes coupled with basis risk (Volpi, 2005; Castellani, submitted).

As a substitute for the lacking formal insurance, Ethiopia is well known for its large and widespread informal insurance network. Spontaneous financial intermediation historically rooted in Ethiopia is well known: Iqqub, a kind of ROSCA (Rotating Savings and Credit Association – Dejene, 2004a) varying in size, gender orientation, and with specific local variations, is widespread all over the country among almost all social classes; even more widespread among all classes is the Iddir, a local insurance mechanism (Dejene, 1993, 2004a, 2004b). Members of Iddirs are villagers in general (for community Iddirs) or specific category of people (like women or a given ethnic group) who contribute to a common pool on a regular basis (in cash and, less commonly, in kind). The constituted fund is used to support members who are in need for different circumstances such as the death of a household member, or a casualty. The rules for intervention and the indemnities are set in advance orally or through written bylaws. Among the several options given in the literature, Iddir can be defined as a mutual insurance system (Dejene, 2003a; Mauri, 1987) even if Iddir can also provide support to establish a new enterprise, or to community development, or credit. While the most common purposes are life insurance and funeral expenses coverage, there are several other risks which can be covered like medical insurance, fire, or livestock death (oxen insurance; Dejene 2003a). Since some iddirs only concentrate on one insurance products, people tend to participate in more than one Iddir. Even Iqqub may have an insurance component as some specific measures (like loans) in favour of members in emergency situations can be foreseen (Dejene 1993 and 2004b; Besley, 1995).

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Another indirect form of insurance common in Ethiopia is the use of labour exchange arrangements, or working parties, established in order to perform indivisible activities which are necessary, urgent and intensively request manpower in a limited time span, like plowing the field at the right time in the season, or construct a house. They can be organized as reciprocal agreements, where the same service is returned to the member offering his/her help first, or be non reciprocal (Dejene, 2003b). Most often, all members together work on each member's field on a rotating basis. Labour sharing may be human or performed by oxen. These agreements are often very relevant to help people to face urgent need of help.

While informal agreements have various advantages, limits are also evident and related to their reduced choices in product offer (Dejene, 2003a and b), or to the lack of flexibility and, more important, to their exposure to both idiosyncratic and covariant risks.

Also in the case of Ethiopia, the microfinance sector is quite developed, with 31 Microfinance Intermediaries (MFIs) operating as of 2014, with increasing capital base and total assets, deposit mobilization and credit granted (NBE 2014). While their branching network allows a better positioning to reach rural customers, MFIs' intervention in the insurance product provision is still meager and basically limited to life insurance. Field studies in the Country, among which the one we conducted described hereafter, prove that several other risks affect rural households, some of them suitable to be protected by casualty insurance adapted to the specific conditions of rural areas. They may be provided by traditional or microfinance intermediaries and made attractive both for the potential policyholders and the financial intermediary offering it.

This study aims to study the determinants of the demand of oxen insurance for smallholder farmers in Ethiopia. The empirical analysis relies on the data collected in the frame of the MicroRiMI (Microfinance, Risk Management and Innovation) project of the Findev Group-Research Center on International Co-operation of the University of Bergamo. MicroRiMI entailed six infra-annual data collection rounds from March 2011 to November 2013. The surveyed area consists of three Ethiopian villages in the Wolayta Region in Southern Ethiopia. The villages are representative of three different agro-ecological areas (high, medium and low lands). The sample is made up of 360 randomly selected households (around 120 households per village).

The choice of the product relates to the importance of livestock for rural households in Ethiopia which may make livestock loss risk predominate among others. Recent NBE (2014) statistics show that the percentage contribution of animal farming and hunting to the overall primary sector is around 21% which, in turns, contributes by 22% to the higher than 10% growth in GDP. Despite this, the growth rate of the livestock-related activities decreased at 2,1% in the last year (from 5,4% of 2011/12). Several causes may explain these numbers but a drop in growth can be worrisome to the extent that livestock is important in the life of many Ethiopians, as it also emerges from our field study.

Among the animals raised in Ethiopia, oxen and cows have the greater water needs and so, are the most exposed to drought shocks. Besides, oxen as well as the other animals suffer from recurrent epidemics. A

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pair of oxen is the main draft power for Ethiopian smallholder farmers and the number and size of oxen is also perceived as a measure of household's status<sup>2</sup>. During plowing periods, farmers lend oxen to each other through oxen sharing arrangements, as explained above. These farmers are usually also part of the same labor party. This strategy allows to save time and reduces the risk of crop failure. When a household is very low-income and cannot afford to buy a whole ox, the ox is bought with other households and the ownership is so shared. Oxen are also the main source of meat but, apart from the Meskel feast in September, rural Ethiopian households rarely consume any meat during the rest of the year. In this regard, oxen, and livestock in general, are considered as a risky but common investment of the household's liquidity. This is motivated further by the presence of incomplete and inefficient financial markets. Access to formal financial institutions is indeed still limited and most of households borrow or save with informal actors<sup>3</sup>.

Local livestock markets are also incomplete and inefficient because they are tiny and dispersed. The price of oxen is therefore variable and spurious. When some localized systemic shocks, such as drought or low-rainfall, occur, the price can drastically go down implying remarkable liquidity costs. In fact, the impact of a major drought, given the difficulties to forage, could lead the household to purchase extra food and sell livestock at a low price, which also weakens the possibility to sell or lend the related labour (Viganò, Ed., 2007). Accordingly, agro-pastoralists are particularly vulnerable to failing rainfall, mainly because of their inability to reach sufficient grazing land during droughts (Heady et al. 2014). So, oxen seem a good buffer against idiosyncratic shocks but can barely protect against systemic shocks. A mechanism to transfer the implied systemic shock is though insurance. Viganò (Ed., 2007) reported the awareness of Ethiopian insurance companies about the prevailing need to insure crop and cattle but still at present such contracts are not offered to remote rural areas.

### 3. Relevant Literature on Index-Based Livestock Insurance

This section is still to be written even if the relevant literature has been studied and used in order to develop our own model. Papers which will be reviewed here include (but are not limited to):

Chantarat, S., Mude, A. G., Barrett, C. B. and Carter, M. R. (2013), Designing Index-Based Livestock Insurance for Managing Asset Risk in Northern Kenya. *Journal of Risk and Insurance*, 80: 205–237.

Heady, D., A. Seyoum Taffesse, and L. You. 2014. Diversification and Development in Pastoralist Ethiopia. *World Development* 56 (1): 200-213.

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<sup>2</sup> During the interviews, many farmers stated to be poor because they had no or few oxen.

<sup>3</sup> According to our data, only 15-20% of households is client of a formal financial institution and the drop-out ratio is also high.

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Lybbert, T., C. Barrett, S. Desta, and L. Coppock. 2004. Stochastic Wealth Dynamics and Risk Management among a Poor Population. *Economic Journal* 114 (498): 750:777.

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### 4. The Model and the Empirical Analysis

Our study of oxen insurance is based on a model which considers that changes in the probability of death of oxen are related to variations in market values, considering the increase in oxen size component but also the price volatility.

Our approach is based on the observation that the livestock buyer (owner) discounts the increased probability of death in the price of purchase (sale). In a perfect market, the seller could sell the animal along with an insurance contract on oxen. Therefore, we can consider the reduction in average sale price that is not explained by other factors as a proxy of the premium that the seller would like to pay. The price reduction can be related to his/her willingness-to-pay. On the other hand, being oxen important assets, an increase in their intrinsic value may imply higher willingness to pay for insurance.

Among the most common causes of increase in the probability of livestock death there are weather conditions, in particular draught. To identify the casual effect of climate on these outcomes, the literature has generally relied on either climate normals (i.e., long averages of observed weather in a cross-sectional setting) or day-to-day (or year-to-year) fluctuations in observed weather as explanatory variables across time and space. The econometrician's choice of a weather versus a climate measure as an explanatory variable critically affects the interpretation of the estimated coefficients in the econometric model; that is, whether the outcome is a true climate response or a short-run weather elasticity. Drought is a phenomenon of (at least) abnormally high temperatures that cause unusually high evaporation, combined with abnormally low or failing rainfall. Drought is also influenced by various other factors including vegetation, soil characteristics, surface water availability, and wind.

Bearing in mind the limits and effects just reported, we used data on rainfall patterns provided by the Ethiopian National Meteorological Agency and are referred to the three weather stations of Soddo, Areka, and Humbo, the nearest ones to the three villages where data on households were collected.

Our idea is to see whether rain patterns affect the value of livestock, oxen in particular. Subsequently, we tested if the value of oxen affects the willingness to pay. We have chosen to compute the sum of excess rain with respect to long-term average, from April of year  $t-1$  until March of year  $t$ , around one month before the beginning of the big rainy season. The three years considered are 2011, 2012 and 2013.

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As concerns the value of oxen, since we did not have many data on prices, we have taken the average value declared by our sample households in November of each considered year. Willingness to pay is measured through the declared premium that households are ready to pay if an insurance contract would be available. We used a two-stage least squares regression. In the first, we estimated the effects of excess rain on oxen prices while in the second we used the predicted oxen price as an input variable, together with other subjective characteristics, to estimate the households' willingness to pay for insurance.

Subjective variables are chosen given their influence on the evaluation capacity or preferences. We expect that:

- Literacy level affects the ability to assess risk and insurance products
- Gender affects evaluation as usually women in Ethiopia are less involved in livestock transaction and, therefore, normally less informed
- Age may also affect perception of values, given the different degree of experience and risk attitude

We used data on all 360 interviewed households referring to the questions on oxen owned in November of each year. Therefore, only oxen owners are actually used in the regression.

The results of the regression are as follows:

Regression	Two stage	
	First	Second <sup>b</sup>
Dep. Var.	Ox price	Premium (log)
Cumulative precipitation anomaly	207.0917***(31.7789)	-
Illiterate (0/1)	-	-0.0005*** (0.0001)
Age	-	-0.2454 (0.1510)
Gender (0/1)	-	-0.0168*** (0.0053)
Ox price	-	0.7187*** (0.1680)
Constant	3922.203*** (67.9525)	6.0191*** (0.5978)
Observations	969	969
Adj R-squared	6,4	-
RMSE	-	1,9275

Note: \*\*\*Significant at 1% confidence level; <sup>b</sup>bostrapped standard errors

The results show that all values are significant but age, which does not seem to affect willingness to pay. The most interesting outcome is that the excess rain as a significant impact on oxen values: expected higher rain means more forage, increase in oxen weight and strength, and higher value. Concerning the second

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regression, the coefficient of oxen price is important and significant. The more the oxen value the higher the willingness to pay. In this respect, it seems that the effect of the value of the assets prevails over the reduction in the perceived risk of death. In fact, higher values of oxen would imply an estimate of lower probability of death but, on the other side, a good and healthy oxen may become an important source of revenue whose value preservation becomes very important. The two subjective characteristics which affect the willingness to pay are the level of literacy (as expected, the more is the respondent literate the less he/she is willing to pay for insurance) and gender (also in this case, expectations are met and women are less willing than men to pay for insurance).

These are just preliminary outcomes, which will be refined by including, among other things:

- Possible transformation of the rainfall variable to better capture extreme events, in particular the occurrence of drought
- A more accurate analysis of missing values
- Possible inclusion of other individual characteristics.

We are confident that the refinement will also allow to focus on product characteristics of oxen insurance contracts which better fit potential customers' expectations.

## 5. Conclusions

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