Agricultural Index Insurance: An Optimization Approach

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The Problem of Agricultural Risk

- Farmers face a lot of risk, and the lack of risk management tools forces them to use coping strategies that hurt their long term welfare.
- Traditional insurance is prohibitively costly in most developing countries due to lack of data and high verification costs.
- Moral hazard, adverse selection, and the presence of large covariate shocks make the problem of agricultural insurance especially hard.

A Proposed Solution: Index Insurance

- In index insurance, an index (or statistic) is created using easily observable quantities (e.g. rainfall), and it is used to determine whether the insured party suffered an adverse event.
- If the index falls below a pre-determined threshold, the insurance company automatically issues out payments to the insured.
- This allows the insurance company to reduce verification costs.

Index Insurance in Practice

- Since it was first proposed, index insurance programs have been implemented in many countries including India, Mexico, Tanzania, Malawi, Kenya, and many others (Jensen and Barrett 2017).
- Today, tens of millions of farmers worldwide are covered by index insurance programs (Greatrex et al. 2015).
- However, in most of these cases, the insurance has to be heavily subsidized by governments due to high cost and low demand (Greatrex et al. 2015).

Project Overview

- Traditionally, the contract for each insured zone is designed independently of all other zones.
- The goal of this project is to make insurance less costly by improving the design of the insurance contracts.
- Our method simultaneously determines the contract parameters for different areas, while taking into account the correlation between the areas.

Model Overview

- We conducted interviews with researchers and practitioners that had implemented index insurance programs in several countries (Malawi, Kenya, Senegal, Thailand, among others) to learn more about the context.
- **Objective:** minimize risk faced by farmers
- **Constraints:** Budget constraints and price constraints
- **Cost to insurer:** sum of payouts plus cost of required capital: $C(\theta_z) = \sum_z P_z(\theta_z) + c_k K$

Evaluation Method

- **Baseline Method:** We compare our method to the method developed in Chantarat et al. 2013. This is the method that was used to design Kenya's index insurance program, and is what is most commonly used in academic publications (see Flatnes, Carter, and Mercovich 2018; Jensen, Stoeffler, et al. 2019).

- **Kenya Household Survey Data:** We used a household survey of Kenyan pastoralists. This survey tracked monthly livestock levels and losses for 900 households between 2010-2013.

Evaluation Procedure

1. Split data into training and test sets
2. Use training set to design insurance contracts using both methods
3. Apply insurance contracts designed by the two methods to farmers in the tests set and compare outcomes.

Performance Metrics: Conditional Value at Risk ($CVaR$), Value at Risk (VaR), semi-variance.

Results

The insurance contracts developed by our method are 20% less costly than the baseline with this dataset, while offering comparable coverage.

Model	Max CVaR	Max VaR	Max SemiVar	Average Cost
Baseline	0.69	0.52	0.22	**5263.64**
Opt	0.65	0.53	0.22	**3794.80**

Table: Results using Kenya household data

Summary of Results

- Our method offers comparable coverage to the status quo as measured by $CVaR$, VaR, and semi-variance
- Contracts designed by our method are over 15% less costly on average.
- Our method reduces costs associated with required capital.
- Our method is more robust to misspecification of prediction model.

Summary

- We make index insurance more cost effective by improving the design of the insurance contracts.
- Our method simultaneously designs the contracts for all insured zones, taking into account correlation between zones.
- Our method is able to outperform baseline because it is better at managing risk and because it is more robust to errors in the prediction model.

References

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