# Optimal Index Insurance Contract Design

José I. Velarde Morales and Linwei Xin

University of Chicago - Booth School of Business

December 6, 2022

Uninsured risk limits agricultural productivity and growth in developing countries. Since nearly two thirds of the world's poor are employed in agriculture, addressing this problem could have significant welfare implications. Agricultural insurance is, even in the best circumstances, a hard problem. Many of the features one would want (independent units, uncorrelated risk, etc) are missing in this context. When considering insurance in developing countries, the problem becomes even harder because of verification costs. Traditionally, whenever an adverse event happens, the insured party contacts the insurer, and the insurer verifies the claim and issues a payout. However, agriculture in developing countries is often characterized by many small farmers spread out over hard to reach regions. This makes verification prohibitively costly. Additionally, the presence of correlated risks makes insurance more expensive because it makes large payouts more likely. Intuitively, if one farmer is affected by a drought, it is likely that other farmers were also affected. If large payouts are more likely, the insurer must have larger reserves in order to maintain solvency.

Researchers developed index insurance as a less costly way to offer insurance in developing countries. In index insurance, an index (or statistic) is created using easily observable quantities, and it is used to determine whether the insured party suffered an adverse event. In the past, indices have been constructed using rainfall, weather, and satellite images. If the index falls below a predetermined threshold, the insurance company automatically issues out payments to the insured. This allows the insurance company to circumvent the issue of verification, moral hazard, and adverse selection, since the actions of individual farmers cannot affect the index. Even though index insurance has proved to be a less costly way of providing insurance for small farmers, it has been difficult to scale up. There are several problems with index insurance. One of the main problems is low take up: farmers are often unwilling to purchase the insurance at market prices. Another problem, as previously mentioned, is the cost. The goal of this project is to make insurance more cost effective by improving the design of the contracts.

We conducted interviews with researchers and practitioners to learn more about the context. Based on these interviews we formulated the problem of designing insurance contracts as an optimization program. The objective in our program was to minimize the risk faced by farmers subject to a constraint on the price of the product. Our method simultaneously designs the contracts for all insured zones, taking into account the correlations between the zones. We compare our method to the method developed in Chantarat et al. (2013), which is what's most commonly used in the academic literature and what is used in Kenya's Index Insurance program. We compare the two methods using both real and synthetic data, and find that our method is able to provide better coverage at the same cost as the baseline method.