SELECTING AN OPTIMAL CROP INSURANCE STRATEGY UNDER CLIMATE VARIABILITY: CONTRASTING INSURER AND FARMER INTERESTS

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Abstract

This study analyzes the potential synergies and conflicts of interest between farmers and insurers in the selection of an optimal crop insurance contract. Special attention is given to how climate information influences this decision-making process. To do so, we consider a representative 40 hectares, rainfed, cotton-peanut farm located in Jackson County in Florida. Our results show that year-to-year ENSO-based climate variability affects farmers' income and insurers' gains according to crop insurance contracts. Additionally, introduction of ENSO-based climate forecasts presents a significant impact on the selection of a particular contract. We conclude that insurers and farmers can bridge their divergent interests by improving their understanding of the effect of climate conditions on the development of sustainable business plans.

Data

Jackson Co., FL (30.774N, 85.226W) farm

40 ha, non-irrigated, 50% peanut, 50% cotton

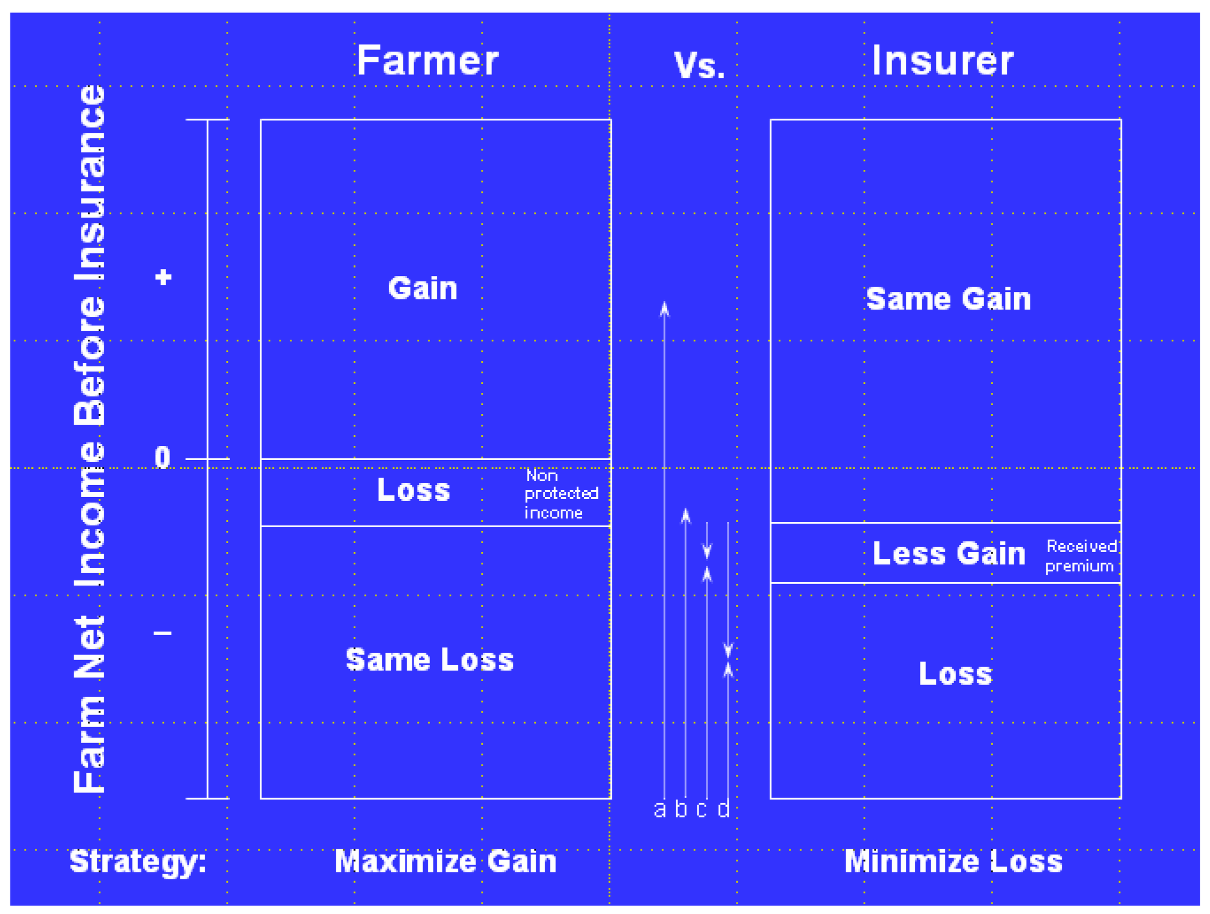
Dothan Loamy Sand soil type

65 (1939-2003) ENSO phases

Most popular crop insurance contracts

Premium subsidies included for insurer

Framework



Methodology

A stochastic non-linear whole-farm model was implemented to select optimal crop insurance combinations according to ENSO phases and risk aversion levels. However, the implemented model differed between farmer and insurer to account for their own specific business goals. The farmer's case was evaluated by maximizing a constant relative risk aversion utility function; whereas, the insurer's optimal choices were computed using a minimization of losses framework constrained by a conditional value-at-risk model (CVaR).

Farmer's case

$$\max E[U(W_f)] = \sum_{n=1}^{N} U(W_0 + \Pi_{i,n}) / N, \qquad \text{for } i = 1, 2, 3, 4 \qquad (1)$$

where

$$U(W_f) = \frac{W_f^{1-R_r}}{1-R_r}, \qquad \text{for } R_r = 0, 0.5, 1, 2, 3, 4 \qquad (2)$$

$$\Pi_{i,n} = \sum_{j=1}^{2} Y_j P_j X_j + IY_j PB_j X_j - C_j X_j - Pr_j X_j, \qquad \text{for } n = 1 \text{ to N}; i = 1, 2, 3, 4 \qquad (3)$$

subject to

$$\sum_{m=1}^{9} X_{m,j} = 0.5, \sum_{m=10}^{13} X_{m,j} = 0.5, X_m \geq 0 \qquad \text{for } j = 1; \text{ for } j = 2 \qquad (4)$$

where: i = ENSO phase (1 = El Niño, 2 = Neutral, 3 = La Niña, 4 = all years); j = crop (1 = peanut, 2 = cotton); m = planting date in Table 1 (1 to 9 for peanut, and 10 to 13 for cotton); n = years for each optimization (1 to 990 for El Niño, 991 to 1980 for neutral, 1981 to 2970 for La Niña, and 1 to 2970 for all years); R_r = constant risk aversion coefficient; Π = income; W_0 = initial wealth; W_f = final wealth; Y = crop yield; IY = indemnity yield for insurance purposes (i.e., the compensation a farmer receives to cover losses below insured yield levels); P = crop price; PB = price base for insurance purposes; C = production cost; Pr = insurance premium; and, X = land allocation for every crop planting date.

Insurer's case

$$\min_x E[L] = \sum_{n=1}^{N} \sum_{j=1}^{2} X_{m,i,j} IY_{i,j} PB_{i,j} - X_{m,i,j} Pr_{i,j} / N, \qquad \text{for } i=1 \text{ to } 4; m=1 \text{ to } 13 \qquad (5)$$

subject to

$$\sum_{m=1}^{9} X_{m,j} = 0.5, \sum_{m=10}^{13} X_{m,j} = 0.5, X_m \geq 0 \qquad \text{for } j=1; \text{ for } j=2 \qquad (6)$$

$$CVaR_\alpha[L(\vec{x}, \vec{\xi})] \leq v \qquad (7)$$

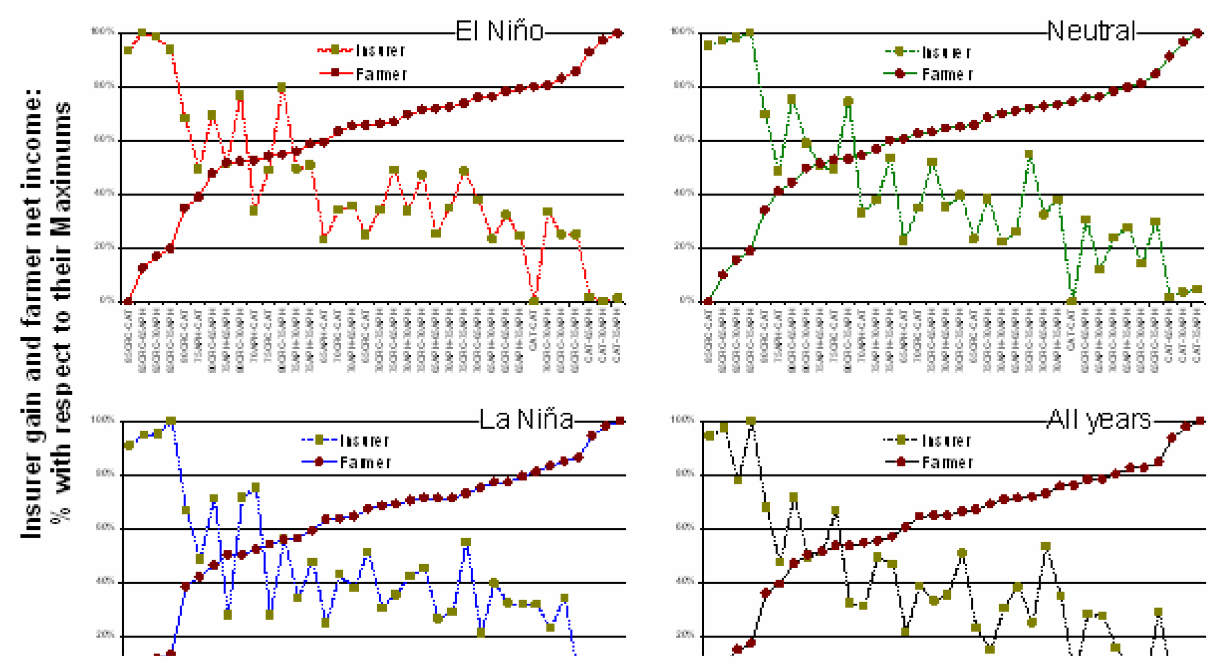
where: $\vec{x} = \{X_m, \lambda_j\}$ is the decision vector,

$\vec{\xi} = \{Y_j, P_j\}$ is the random vector,

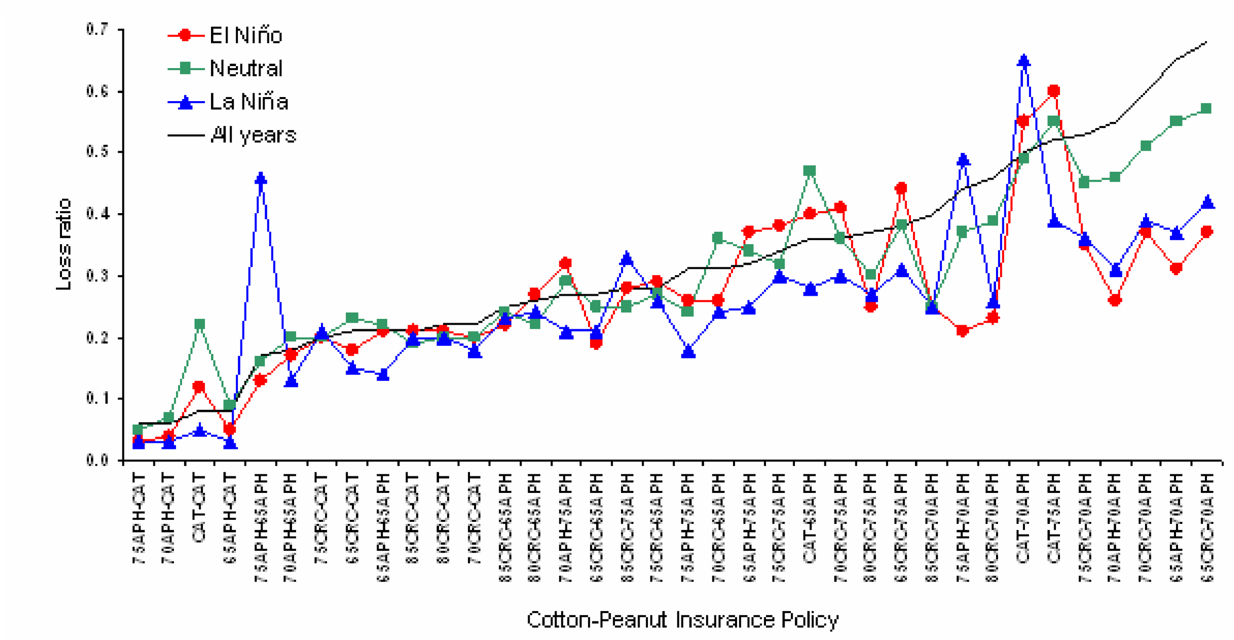
λ_j = selection of insurance policy for crop j.

Main Results

Insurer gain and farmer net income expressed by percentage of their maximums by crop insurance contract and ENSO phase.



Average loss ratio per crop insurance contract and ENSO phase



Implications

ENSO climate variability impacts farmer and insurer crop insurance selection

Conflict of interest exists, but seems workable

Premiums and/or subsidies could be decreased or better assigned

Consistent with previous studies: Crop insurance could be privately promoted

Further study including spatial distribution

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