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The Potential for Moral Hazard Behavior in Irrigation Decisions Under Crop Insurance

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BACKGROUND

- The Federal Crop Insurance program (FCIC) has been one of the most adopted risk mitigation tools used by crop producers across the U.S.
- Irrigation plays a vital role for high-productivity agriculture, and water conservation is considered a critical social goal
- Since irrigation has a large impact on yield distribution, crop insurance has a potential to produce incentives for farmers to change their irrigation behavior to alter revenue distribution or downside risk

OBJECTIVES

- Examine the potential impact of crop insurance on irrigation behavior
- Compare outcomes due to different components of the crop insurance program
 - Yield Substitution
 - Trend Adjustment
 - Sufficient irrigation requirement

CROP INSURANCE AND APH

- Revenue Protection (*RP*) plan is the most commonly used crop insurance plan
- Rate yield (*RY*) is a simple average of historical yield and Approved APH yield (*AY*) is an adjusted version of *RY*
- A change in *RY* would affect base premium rate, and a change in *AY* would affect add-on premium rate, probability of indemnity payments being triggered, and liability calculation
- *AY* adjustment devices:
 - Yield Substitution (*YS*): Replace yield with 60% of county's T-yield (*TY*)
 - Trend Adjustment (*TA*): Adjust historical yield by Trend Adjustment Factors
 - Yield floor: Prevents *AY* from falling below 80% of *TY*

THEORITICAL MODEL

Let x denotes farmer's input of interest and $f(y|x)$ denotes distribution on yield conditional on x . The expected utility for a single production season on input use is

$$E[U(\tau, x)] = \int [\pi(\tau, x) - w \cdot x] f(y|x) dy$$

where

$$\pi(\tau, x) = mp \cdot y + \phi(y, hp, pp, \tau, AY) - \eta(AY, RY, \tau, \lambda, \theta) - \gamma$$

mp, hp, pp are market, harvest, and projected price. τ is a coverage level, λ is a subsidy level, γ is the production cost, $\phi(\cdot)$ is the indemnity payment and $\eta(\cdot)$ is the premium payment.

Farmers solve the following optimization problem

$$\begin{aligned} \max_{\{x_1, \dots, x_T, \tau_1, \dots, \tau_T\}} & \sum_{t=0}^T \rho^{t-1} E[U(x_t, \tau_t)] \\ \text{s. t. } AY_{t+1} &= \max(0.8 \cdot TY, \sum_{i=0}^{K-1} \max(y_{t-i}, \varepsilon \cdot TY_{t-i}) / K \\ RY_{t+1} &= \sum_{i=0}^{K-1} y_{t-i} / K \end{aligned}$$

ρ is the future discount factor, K is the number of years used to calculate *AY* and *RY*, and ε is the proportion of T-yield (*TY*) permitted for yield substitution

NUMERICAL MODEL

- Actuary parameters from Chase County, Nebraska for 2017 growing season maintained by USDA RMA
- Simulate crop-water production function using AquacropOS, where yield is a function of soil moisture target (SMT)
- Solve dynamic optimization problems under various levels of irrigation cost and various level of *YS*
- A farmer chooses SMT and coverage level to maximize expected utility

Results

Figure 2: An example irrigation path over time at the steady state at the irrigation cost of \$15/acre-inch

- When *AY* become high enough, farmers choose zero-irrigation strategy to take advantage of indemnity payments. Then the farmer continue to irrigate again to rebuild *AY* until *AY* hits the threshold again
- When the cost of irrigation is low (\$6 - \$12/acre-inch), farmers do not have an incentive to change their irrigation water use under crop insurance. However, as the irrigation cost rise, it become more economically appealing to not use water.
- When irrigation cost is high, *YS* has a large negative impact on irrigation.
- Without *TA*, farmer could be irrigating more under insurance than they would without insurance
- If sufficient irrigation rule is enforced, farmers have no incentive to shirk on irrigation (Enforcement of the rule is crucial)

CONCLUSION

- Results suggest that moral hazard could affect irrigation practice when irrigation costs are high
- Insurance impacts need to be considered when evaluating price-based policies such as a water tax
- Enforcement of the sufficient irrigation requirement rule in regions with a high depth to water table may reduce unnecessary indemnity payments

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