

Crop Insurance: Lecture XXXX

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Valuing Crop Yield Insurance

- The general concept of insurance is the construction of an instrument or gamble that pays the purchaser in the event of some adverse occurrence.
- Frequently purchased insurance contracts include life insurance that pays in the event of the holders death, car insurance that pays in the case of an accident, catastrophic health insurance that pays in the event of a major medical event such as cancer, etc.
- Under commercial insurance arrangements the premium charged for the insurance is generally considered to be actuarially sound. Specifically, the expected indemnity payments are exactly equal to premiums charged.

- Each of these contracts specifies a payable event, an indemnity (the amount to be paid on the event), and a premium (the amount paid for insurance contract).
 - If the premiums exceeded the expected indemnity payments then insurance firms would earn abnormal profits. These abnormal profits would be bid out of the market by new firms entering the insurance arena.
 - If premiums fell short of the expected indemnity, the insurance firm would lose money and ultimately exit the industry.

- The actuarial value of an insurance contract can then be written as

$$V = \int_0^{y^*} P y f(y) dy \quad (1)$$

- V is the value of crop yield insurance.
- P is the price of the crop.
- y is the variable of integration.
- $f(y)$ is the probability density function for crop yields.
- y^* is the minimum insured yield (trigger yield in crop insurance).

Current Debates in Crop Insurance

- Estimation of the probability density function for yields $f(y)$.
 - Most common statistical applications assume that the probability density function is normal or asymptotically normal.
 - This assumption may have serious shortcomings in the valuation of crop insurance.
 - From an agronomic perspective, yields are bounded by zero on the downside and limiting nutrients such as nitrogen on the up side.
 - Hence, at the least the $x \in (-\infty, \infty)$ of the normal would appear to be violated.
 - However, the truncated normal distribution may be appropriate for crop yields.

- Continued

- The debate of potential normality of crop yields typically revolves around skewness and kurtosis.
 - Skewness is a measure of nonsymmetry of the distribution.
 - The normal distribution is symmetric and, hence, yields zero skewness.
 - A significant portion of the literature supports skewness in yields, but as pointed out by Just and Weninger, it does not reach a consensus on the direction of skewness.
 - Kurtosis measures the relationship between the area in the tails and the area around the means.

- The second area of debate in the area of crop insurance is the moral hazard/incentive compatibility dimension of crop insurance.
 - A basic problem in any insurance contract is the determination of the insurable event and the amount of damages.
 - A second problem is the difficulty of self-selection. Specifically, as in health insurance contracts, riskier farmers will be willing to pay more money for insurance than safer farmers.
- Using the data from Ramirez, Moss and Boggess, we derive the parameters of the normal distribution function for corn as $\mu = 173.03$, $\sigma = 8.71$.

$$V = \int_0^{y^*} P_y \frac{1}{8.71\sqrt{2\pi}} \exp \left[-\frac{(y - 173.03)^2}{151.88} \right] \quad (2)$$

Table : Insurance and Coverage

Level of Insurance	Cost of Premium
0.90×173.03	10.73
0.85×173.03	0.63
0.80×173.03	0.01

- Integrating Price Insurance

- In order to integrate price risk the actuarial premium becomes

$$V = \int_0^{p^*} \int_0^{y^*} pyf(y, p) dydp \quad (3)$$

- The joint distribution is specified using the futures price as an efficient estimate of the price at harvest time.
 - The price at harvest time can be estimated as a function of the futures price at planting

$$p_t^h = \alpha_0 + \alpha_1 f_{t-1}^h + \epsilon_t \quad (4)$$

- Given traditional assumptions, α_0 is the anticipated basis and α_1 is equal to one. The distribution of price is then a function of the distribution of ϵ_t .