The Impact of a Supplemental Disaster Assistance Program on the Relative Demands for Individual and Area Plans of Insurance

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National Crop Insurance Services

Background

- Various proposals have emerged as replacements of direct payments, which are likely to be eliminated or reduced in the 2012 Farm Bill.
- Proposals to date have included:
  - variations on the role of revenue protection in farm programs and overhauling SURE and ACRE.
  - both area-based revenue plans and individual revenue plans for a crop on the farm.
- The proposed programs would operate in combination with crop insurance, which offers both individual and area plans.

Objective

- Our interest is in the demand for individual crop insurance and supplemental area plans (offered either free as a farm program or fairly priced as a crop insurance product) in the presence of a supplemental disaster program (SDAP).
- An coherent understanding of the interaction of these various programs and how they address the risk management needs of producers and affect their participation decisions is essential for an informed public policy discussion.
- Literature developing the optimal area insurance did not include multiple insurance and farm program alternatives, and disaster programs in their analytical modeling.

The Insurance Decision of the Farmer

- Derive the producer's preference for coverage among the various area and individual plans of revenue protection by using an economic model of producer choice with separate area and individual plans that may be held either alone or simultaneously (Bulut, Collins, and Zacharias, 2011).
- Within that framework, introduce SDAP in which a farmer is automatically enrolled with the purchase of crop insurance.

Modeling Framework:

- As in Duncan and Myers (2000; *AJAE*), a producer faces a possibility of loss for the amount (l) with probability (p_l) and no loss with probability $(1-p_l)$.
- Introduce a possibility of area loss for the amount (L) with probability p_L.
- Use correlation modeling (adopted from Bulut and Moschini, 2006; *Economics Letters*).

	Area with a loss	Area without a loss
Farmer with a loss	p_{lL}	p_{lN}
Farmer without a loss	p_{nL}	p_{nN}

Parameterization of Joint Probabilities

$$p_{lL} = p_l p_L + \rho r_l r_L$$

$$p_{lN} = p_l(1-p_L) - \rho r_l r_L$$

$$p_{nL} = (1-p_l)p_L - \rho r_l r_L$$

$$p_{nN} = (1-p_l)(1-p_L) + \rho r_l r_L$$

r_l; r_L standard deviations

$$r_l = \sqrt{p_l(1-p_l)} \qquad r_L = \sqrt{p_L(1-p_L)}$$

ρ: correlation coefficient $\quad 0 < \rho < 1$

$\rho r_l r_L$: Covariance

Modeling SDAP Options

- The probability that a disaster is declared without an area loss is zero. Once the area loss happens, the conditional probability that a disaster will be declared can be specified as $p_{d|L} = 1 - e^{-\tau L}$.
- The unconditional probability that a disaster is declared equals the joint probability that area has a loss and a disaster is declared .

$$p_d = p_{d \cap L} = p_{d|L} \times p_L < p_L \quad \text{if} \quad p_{d|L} < 1.$$

- Define SDAP1 as independent of insurance coverage.
  - Expected payment: $p_d \alpha l = p_L p_{d|L} \alpha l = p_L z$
- Define SDAP2 as tied to individual plan coverage .
  - Expected payment: $p_d \alpha x l = p_L p_{d|L} \alpha l x = p_L z x$

Farmer's Problem under SDAP2

$$\underset{x\geq 0,\, y\geq 0}{Max}\ \hat{\hat{U}}_i = M - \pi_x x - \pi_y y - \hat{\hat{l}}_i - 0.5\lambda \hat{\hat{\sigma}}^2_{l_i}$$

$\hat{\hat{U}}_i$: utility or satisfaction level; M : initial income

x : coverage level choice with individual insurance

y : coverage level choice with area insurance

π_x : premium rate for per unit of coverage x

π_y : premium rate for per unit of coverage y

$\hat{\hat{l}}_i$: expected loss with x, y and SDAP2

λ : degree of risk (absolute) aversion

$\hat{\hat{\sigma}}^2_{l_i}$: variance of the loss with x, y and SDAP2

Key Derivations

- Derive the expected loss and variance of the loss with x and y and SDAP2 .

$$\hat{\hat{l}}_i = p_{lL}(l - xl - zx - yL) + p_{lN}(l - xl) + p_{nL}(-zx - yL) + p_{nN}0$$

$$= p_l l - (\underbrace{p_l l x + p_L L y}_{=\hat{R}_i} + p_L z x) = p_l l - (\hat{R}_i + p_L z x) = \hat{l}_i - p_L z x$$

$$\hat{\hat{\sigma}}^2_{l_i} = p_{lL}(l - xl - zx - yL)^2 + p_{lN}(l - xl)^2 + p_{nL}(-zx - yL)^2 + p_{nN}0 - (\hat{l}_i - p_L z x)^2$$

$$= \sigma_l^2 + \underbrace{(x^2 - 2x)\sigma_l^2 + y^2\sigma_L^2 - 2\rho(1-x)y\sigma_l\sigma_L}_{=\hat{s}}$$

$$-2\rho(1-x)\sigma_l\sigma_L\frac{zx}{L} + 2y\frac{zx}{L}\sigma_L^2 + \frac{(zx)^2}{L^2}\sigma_L^2$$

- Plug the expressions for $\hat{\hat{l}}_i$ and $\hat{\hat{\sigma}}^2_{l_i}$ back in the objective function.

Separate Area and Individual Plans with SDAP2

- Max the objective function and obtain the demand functions:

$$\hat{\hat{x}} = 1 + \frac{\sigma_L^2}{\lambda\sigma_l^2\sigma_L^2(1-\rho^2)}(\bar{l} + p_L z - \pi_x) - \frac{(\rho\sigma_l\sigma_L + \frac{z}{L}\sigma_L^2)}{\lambda\sigma_l^2\sigma_L^2(1-\rho^2)}(\bar{L} - \pi_y)$$

$$\hat{\hat{y}} = -\frac{z}{L} + \frac{(\sigma_l^2 + 2\rho\sigma_l\sigma_L\frac{z}{L} + \frac{z^2}{L^2}\sigma_L^2)}{\lambda\sigma_l^2\sigma_L^2(1-\rho^2)}(\bar{L} - \pi_y)$$

$$- \frac{(\rho\sigma_l\sigma_L + \frac{z}{L}\sigma_L^2)}{\lambda\sigma_l^2\sigma_L^2(1-\rho^2)}(\bar{l} + p_L z - \pi_x)$$

Coverage Demands for Individual and Area Insurance

Disaster Plan	Individual Crop Insurance	Area Plan	
	Fair Rate	Free	Fair Rate
(1) No SDAP	Full		None
(2) No SDAP	< Full	Some	
(3) SDAP 1	< Full		None
(4) SDAP1	< Full, =(2)	Some, < (2)	
(5) SDAP2, free	Possibly > Full at low risk aversion.		None
(6) SDAP2, free	< Full, =(2)	Some, > (2) at low risk aversion.	

Conclusion

- The substitutability of individual and area plans of insurance increases in the presence of a SDAP that is tied to individual crop insurance coverage.
- A free disaster plan tied to crop insurance coverage stimulates individual crop insurance demand, provided the area plan is a crop insurance product sold at fair rates. If the area plan is a free farm program, demand for individual crop insurance is not increased.
- Future work:
  - Study of deductibles, coinsurance, or externally imposed limits to coverage levels
  - Empirical application
  - Integrated plans with a SDAP

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