Does Risk Aversion Matter for Shallow Loss Crop Insurance?

Thomas Sproul and David Zilberman

Presented at the 2013 AAEA Symposium on
Crop Insurance and the Farm Bill:
A New Paradigm for U.S. Agricultural Policy

October 8, 2013

Motivation

- New interest in shallow-loss policies in proposed versions of the Farm Bill.
- Proposed ARC policy is deductible-style, relative to coinsurance-style mechanism we had under SURE.
- We ask: do risk management specifics matter when comparing shallow-loss policies?
- Short answer: No. Only expected payments.

Key Findings

- When two shallow-loss policies have the same actuarially fair value...
  - **Differences** in risk premiums are economically insignificant.
  - Farmers will be approximately risk neutral towards the **difference** in residual risks, if they are risk-neutral enough to farm.
- Policymakers can choose among shallow-loss policies only on the basis of expected cost.
  - Equity considerations remain if certain crops or constituencies are favored.

Methodology

- Define simplified, idealized shallow-loss policies.
  - Actual policy specifics do not generalize well.
  - Why deductible vs. coinsurance?
- Econometrically estimate revenue distributions.
  - Variety of crops and counties to address risk vs. productivity tradeoffs.
- Find deductible and coinsurance policies of equal actuarially fair value, and compare risk premiums.
  - Across a number of risk preference specifications.
  - Across the range of buy-up coverage levels.

Comparing Policies

- Comparison of actual policies is difficult
  - Rating differences, coverage options
  - Whole farm vs. single crop
  - SURE's disaster trigger
- For apples-to-apples comparison:
  - Deductible vs. coinsurance, both "free" add-ons
  - Assume underlying buy-up coverage at same level
  - All coverage is revenue insurance, at farm-level
  - Mono-crop environment, no disaster trigger

A Basic Model of Crop Insurance

- Per-Acre Revenues, $Y \sim F$. Underlying buy-up coverage has guarantee, T_B, and pays:

  $B = \max(0, T_B - Y)$. So, $Y_B = Y + B$

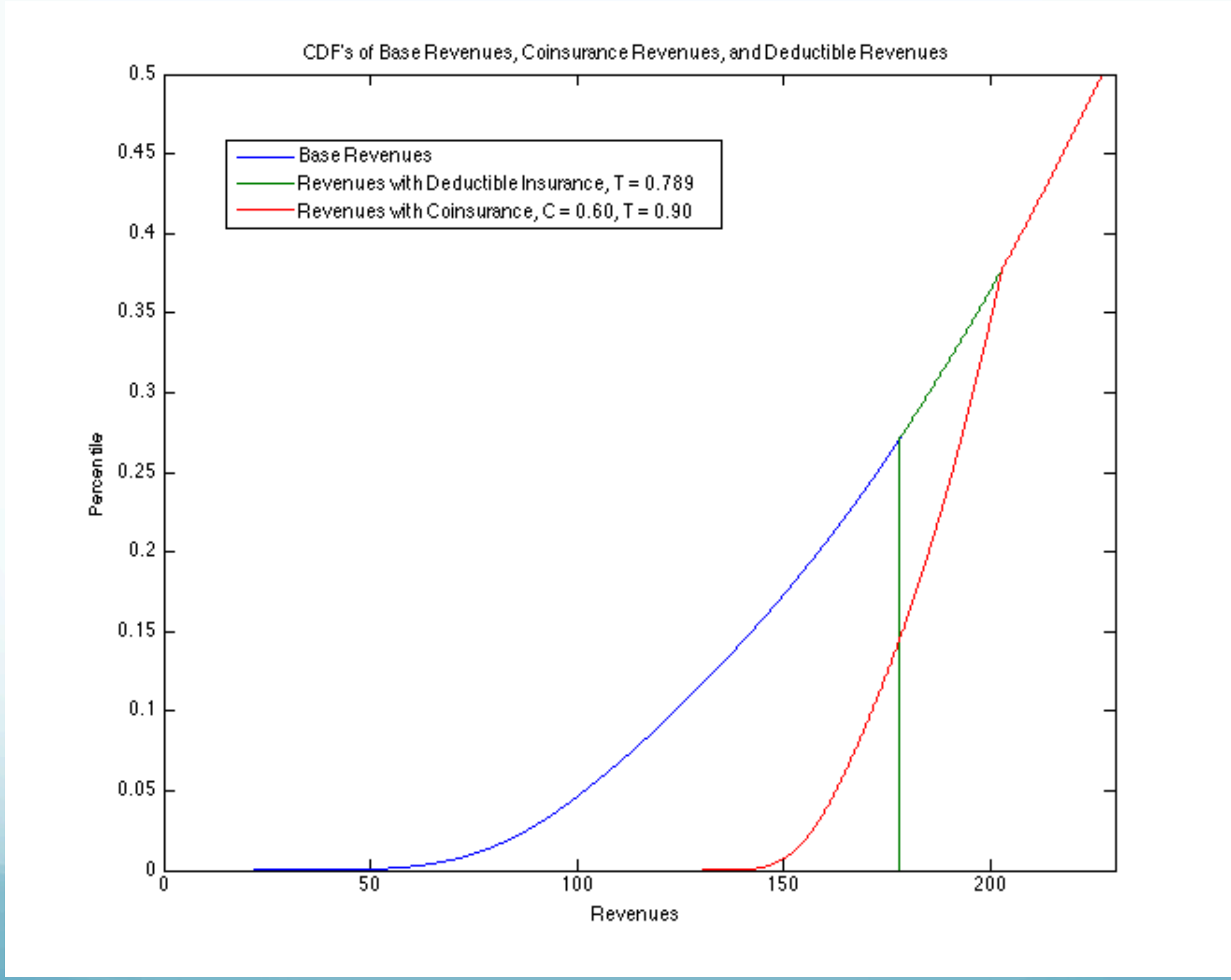
- Deductible shallow-loss policy has guarantee, T_D, and pays $D = \max(0, T_D - Y_B)$

- Coinsurance shallow-loss policy has guarantee, T_C, and reimbursement rate, c, and pays:

  $C = \max(0, c*(T_C - Y_B))$

- We constrain T_D, c, T_C, such that $E[D] = E[C]$

Comparing the CDFs, Deductibles vs. Coinsurance



Taylor Results

- Using familiar Taylor approximations, the certainty equivalent of a gamble is roughly:

$$CE \approx \mu + \frac{u''}{u'} \cdot \frac{\sigma^2}{2}$$

- As a result, the **difference** in risk premiums between two gambles with equal fair value is:

$$\Delta\pi \approx \frac{u''}{u'} \cdot \frac{\Delta\sigma^2}{2}$$

Taylor Results in Context

Table: Comparing Revenue **Variance** under Different Scenarios

Crop/ County	Raw Revenue	Buy-up at 75%	Shallow-Loss Coinsurance	Shallow-Loss Deductible	Shallow-Loss ∆Variance
Corn/ DeKalb, IL	$92.57**K**	$68.87**K**	$60.27**K**	$60.24**K**	$37.47
Cotton/ Hoke, NC	$133.0**K**	$85.61**K**	$75.78**K**	$75.76**K**	$17.46
Soybeans/ Logan, IL	$39.34**K**	$29.86**K**	$25.88**K**	$25.86**K**	$17.41
W. Wheat/ Logan, KY	$61.85**K**	$39.57**K**	$35.84**K**	$35.84**K**	$5.52

Generating Revenue CDF

- USDA/NASS Yield Data, 1975-2011.
- Selected counties and crops.
- Expected and Realized Prices from grain futures.
- Joint distribution of county-level yields and prices estimated for 2012 crop year (Cooper, Delbecq, and Davis, 2012) .
  - Kernel density (Gaussian) estimated for yields.
  - Pearson and Spearman rank correlations imposed between county, state and national yields, and prices, via copula.
- Blown-up to farm-level with scaled white noise (Coble and Dismukes, 2008).

Deductible vs. Coinsurance

- Comparing as if free add-on coverage.
- Buy-up coverage levels, T_B = 55-85% (5% increments)
- Coinsurance parameters chosen according to SURE formula: $c = 0.60$, $T_C = \min(1.15 * T_B, 0.90)$.
- Corresponding deductible level chosen so $E[C] = E[D]$.

Risk Specifications

- CARA expected utility: E[U(Y)] = E[– exp(– a*Y)].
  - Test across range of reasonable R_A coefficients (Babcock, Choi, and Feinerman, 1993).
- Results are robust to CRRA specification as well, e.g. U(Y) = log(Y) and scaling up acres.
- Results also robust to Prospect Theory spec:
  - All certainty equivalents are losses
  - Delta risk premium ≤ \$0.03/acre

$$v(x) = \begin{cases} (x-r)^{\alpha} & x \geq r \\ -\lambda \cdot (r-x)^{\alpha} & x < r \end{cases}$$

$$\textit{where } \alpha = 0.88, \lambda = 2.25$$

Coverage Thresholds

- $R_A = 0.001$
- Corn/DeKalb, IL
- Mean Revenues = $974.44, SD = $304.25

Buy-Up (Percent of Mean)	T_B	T_C	T_D	E[C] = E[D]	$\Delta\pi$
60.00%	$584.66	$672.36	$642.96	$16.36	$0.006
70.00%	$682.11	$784.52	$749.55	$34.69	$0.017
80.00%	$779.55	$876.99	$842.72	$60.80	$0.028

EV and Delta Risk Premium

- $R_A = 0.001$
- Winter Wheat
- Hyde County, SD
- Mean = $225.34
- SD = $74.48

Buy-Up (Percent of Mean)	E[C] = E[D]	$\Delta\pi$
70.00%	$10.84	$0.0007
75.00%	$14.24	$0.0009
80.00%	$17.23	$0.0007
85.00%	$18.59	$0.0001

Max Δπ by Crop/County

County	Crop	Mean	Std. Dev.	Max Δπ
DeKalb, IL	Corn	$974.44	$304.25	$0.19
McLean, IL	Corn	$1,009.80	$202.87	$0.17
Howard, NE	Corn	$905.61	$449.42	$0.13
Beadle, SD	Corn	$619.02	$319.81	$0.06
Montgomery, MS	Cotton	$942.76	$512.72	$0.13
Hoke, NC	Cotton	$850.92	$364.65	$0.12
Howard, TX	Cotton	$373.59	$373.89	$0.01
Logan, IL	Soy	$697.53	$198.33	$0.11
Sumner, KS	Soy	$395.42	$306.86	$0.02
Sanilac, MI	Soy	$570.16	$256.83	$0.06
Logan, KY	Winter Wheat	$470.77	$248.70	$0.04
Marion, OH	Winter Wheat	$449.92	$165.73	$0.04
Hyde, SD	Winter Wheat	$225.34	$74.48	$0.03

What Did We Learn?

- Shallow-loss risk premiums are often low; these policies bite near the peak of the distribution.
- **Differences** in shallow-loss risk premiums are even lower for the same reason.
- Findings approximated in theory are confirmed empirically, and robust to a variety of risk preference specifications.
- Shallow-loss policies can and should be compared as if risk-neutral (i.e., by expected cost).

Questions?