Tackling Price and Yield Risk Using an Optimal Combination of RP and ARC

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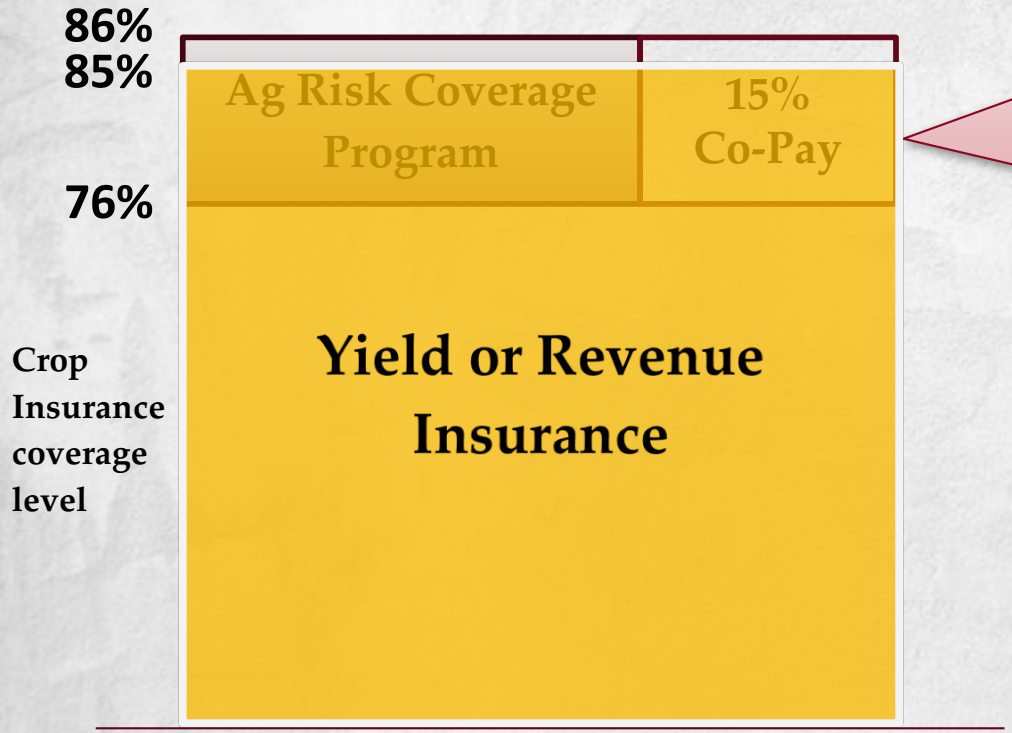
If shallow loss ARC is great risk protection why overlap it with crop insurance?



$2.2 billion of 2017 corn & soybean insurance liability overlapping with ARC & costing producers over $1 billion

- County yield may be less than perfectly correlated with farm yield
- Farmer may think ARC won't cover them

RP Subsidy Schedule

Coverage Level	Basic and Optional Subsidy %	Producer Paid Premium
50%	67%	33%
55%	64%	36%
60%	64%	36%
65%	59%	41%
70%	59%	41%
75%	55%	45%
80%	48%	52%
85%	38%	62%

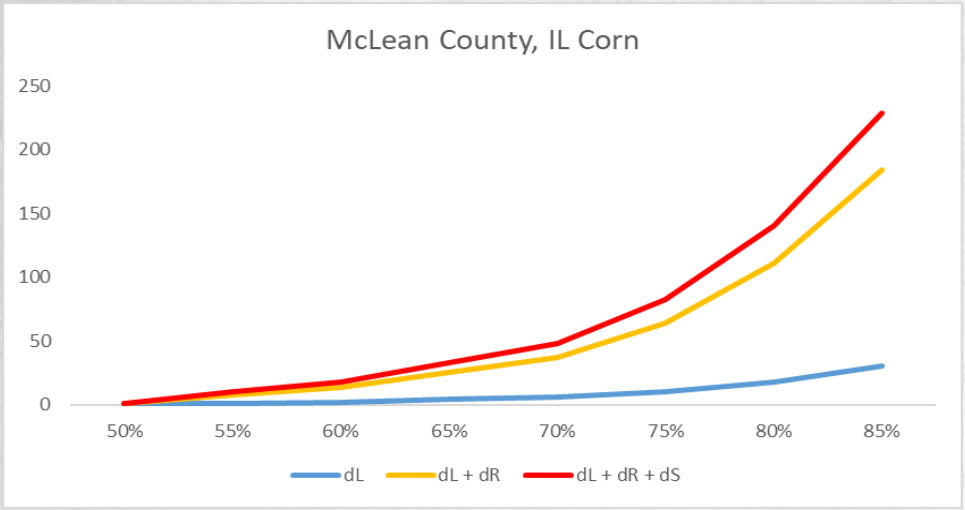
Comparative Statics

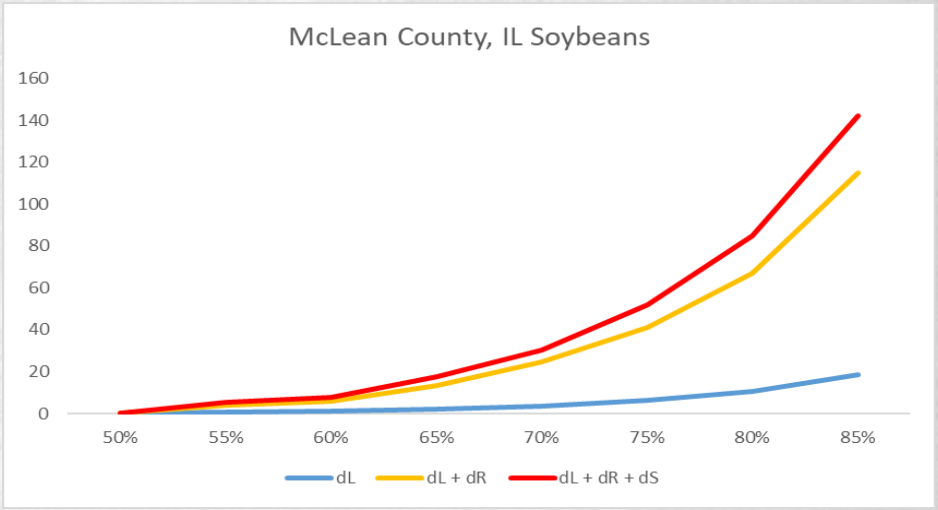
$$PPP = \left[CL \times E(V) \right] R(CL)\left(1 - S(CL)\right)$$

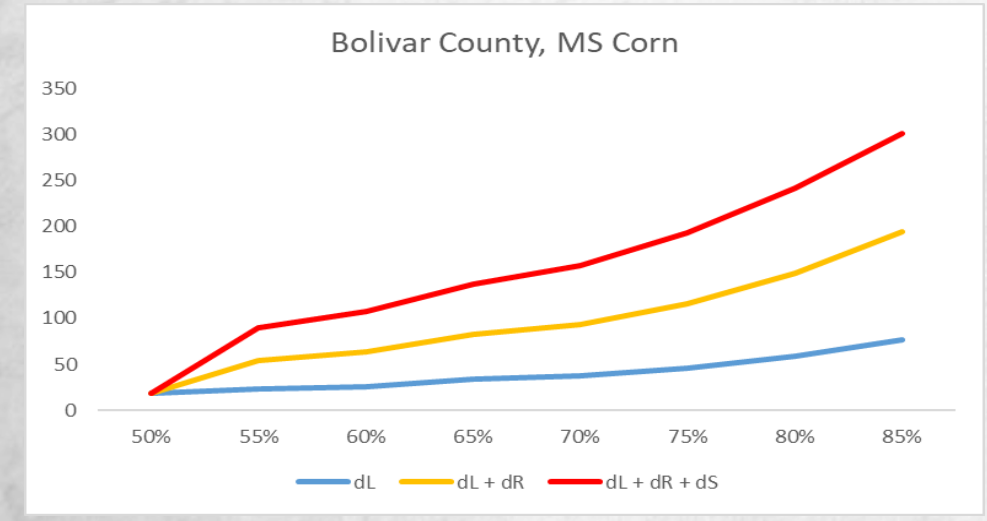
$$\frac{\partial PPP}{\partial CL} = \underbrace{E(V) \times R(CL) \times \left(1 - S(CL)\right)}_{\Delta L} + \underbrace{CL \times E(V) \frac{\partial R}{\partial CL}\left(1 - S(CL)\right)}_{\Delta R} + \underbrace{CL \times E(V) R(CL) - \frac{\partial S}{\partial CL}}_{\Delta S}$$

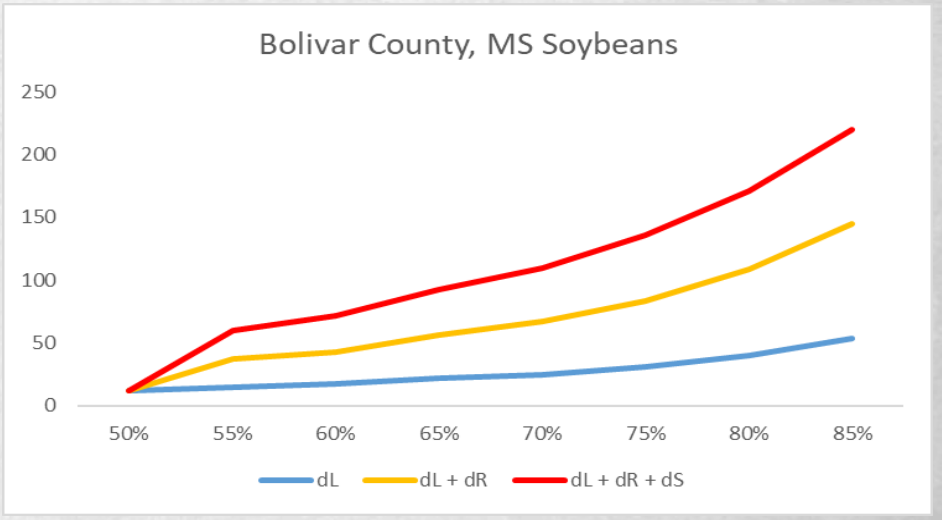
$$\frac{\partial PPP}{\partial CL} = \underbrace{\Delta L}_{(+)} + \underbrace{\Delta R}_{(+)} + \underbrace{\Delta S}_{(+)}$$

Breaking Down PPP

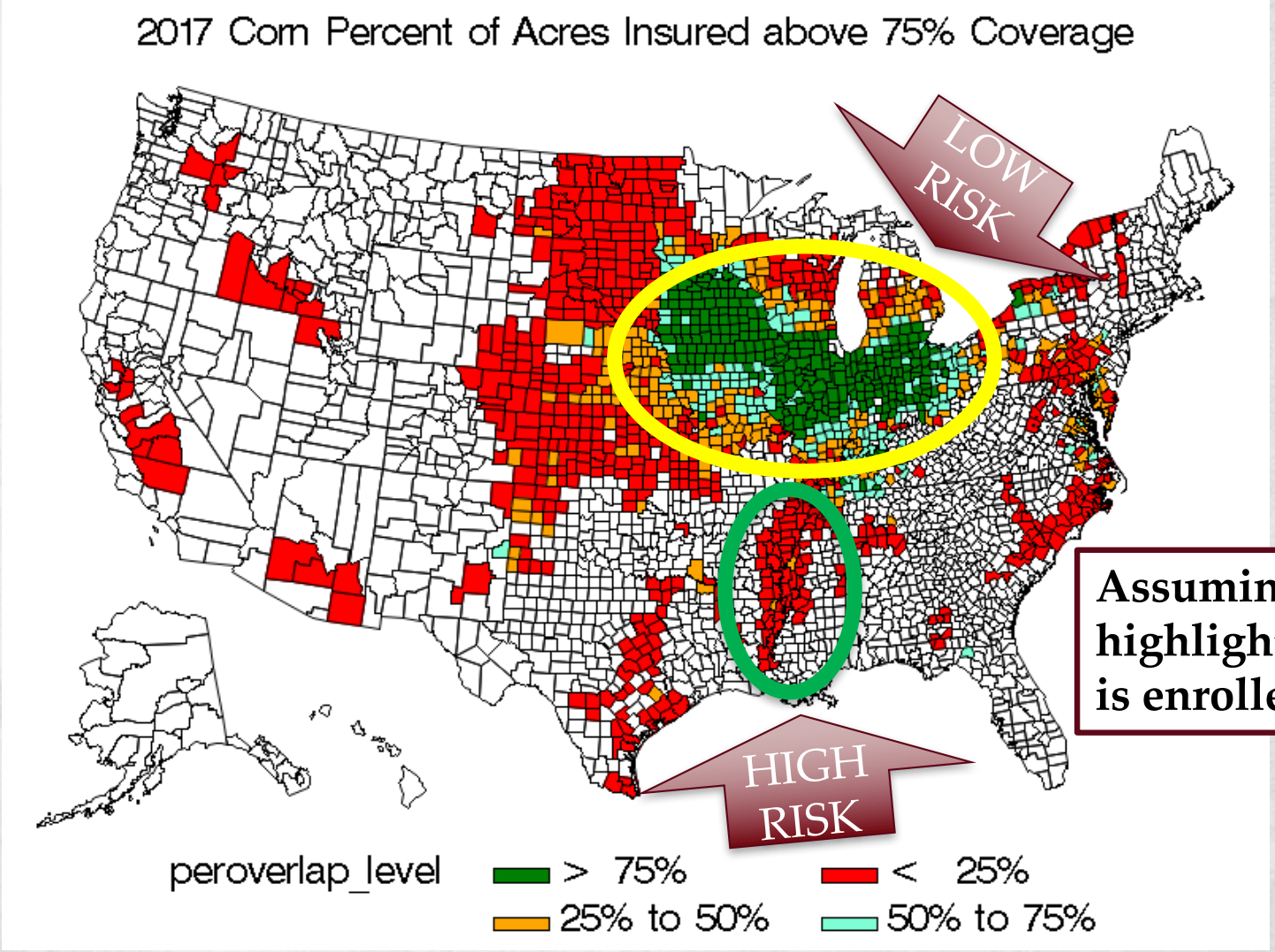








Regional Differences



Assuming every highlighted county is enrolled in ARC

Hypothesis

- Assuming actuarially fair base premium rates, a fully-informed, expected utility and prospect maximizing producer will be willing to pay the most for 75% RP crop insurance paired with ARC.

- ARC decision has already been made.

The Pre-Subsidy Wedge

- Black and Hu (2002)
- Difference between what the farmer and RMA think the actuarially fair base premium rate (AFR) is
- Issue with what the "true" AFR is
  - Farmer v. RMA Perception

Simulation Method

- Phoon, Quek, and Huang (2004)
- Mixed marginal distributions
- Yields follow Beta distribution
- Prices follow Lognormal distribution

Conceptual Model - EUT

- Objective function: (Base = Planted)

$$E(U) = \underset{CL}{MAX}\, U\left[R + RP + ARC - C\right] f(P, Y)$$

- Certainty equivalents ($\alpha = 2$):

$$CE = \left[(1-\alpha)E(U)\right]^{\frac{1}{1-\alpha}}$$

Conceptual Model - CPT

- Cumulative value function:

$$V = \sum_{i=-m}^{n} v(x_i)\pi(p_i)$$

- Value function:

$$v(x) = \begin{cases} x^a & \text{if } x \geq 0 \\ -\lambda(-x)^a & \text{if } x < 0 \end{cases}$$

- Certainty Equivalent Returns (CER):

$$x(v) = \begin{cases} v^{1/a} & \text{if } v \geq 0 \\ -\left(-\frac{v}{\lambda}\right)^{1/a} & \text{if } v \geq 0 \end{cases}$$

Curvature and Loss Aversion parameters (Babcock 2015): $a = 0.88 \quad \lambda = 2.25$

Reference Points

$$R_1 = E(R);\ \ x_i = P_i y_i + I_i - R_1$$

$$R_2 = E(R) + p(\alpha)\left(1 - s(\alpha)\right);\ \ x_i = P_i y_i + I_i - R_2$$

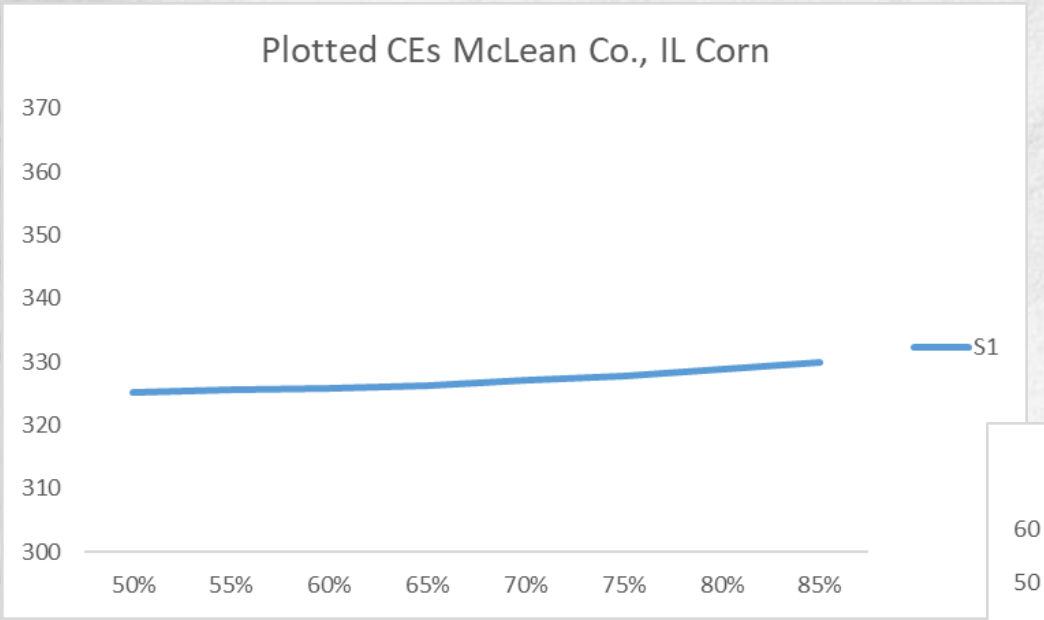
$$R_3 = p(\alpha)\left(1 - s(\alpha)\right);\ \ x_i = I_i - R_3$$

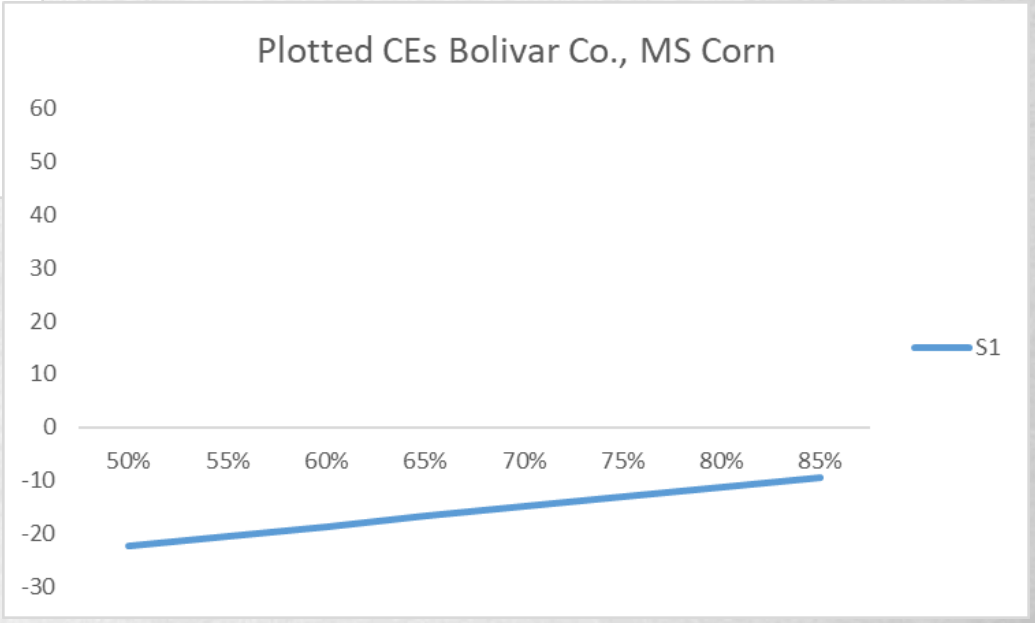
Results

- FIRST: Four different scenarios under **EUT**; analysis of corn then soybeans

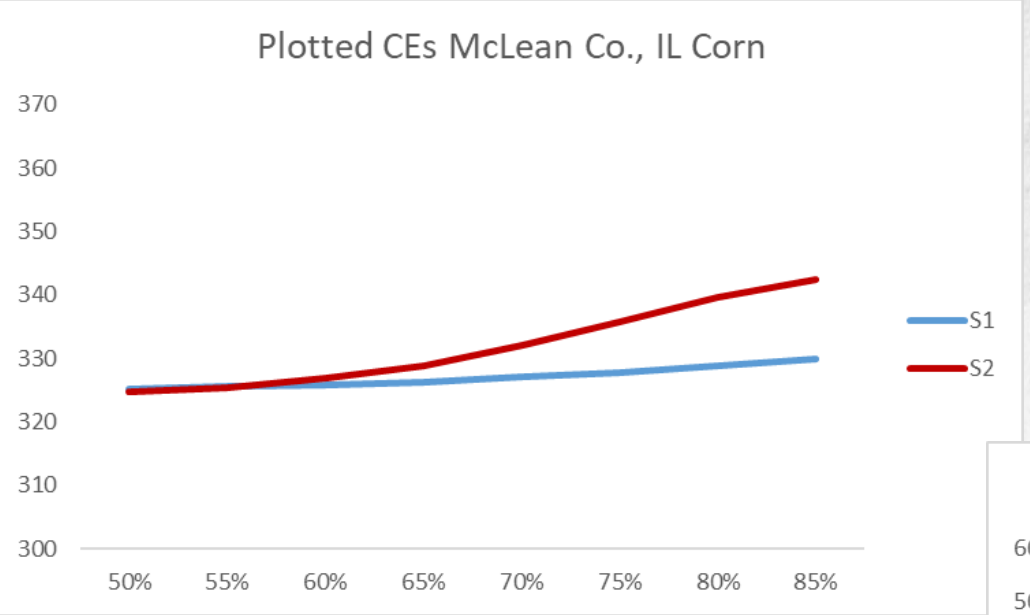
- SECOND: Three different reference points under **CPT**; analysis of corn and soybeans

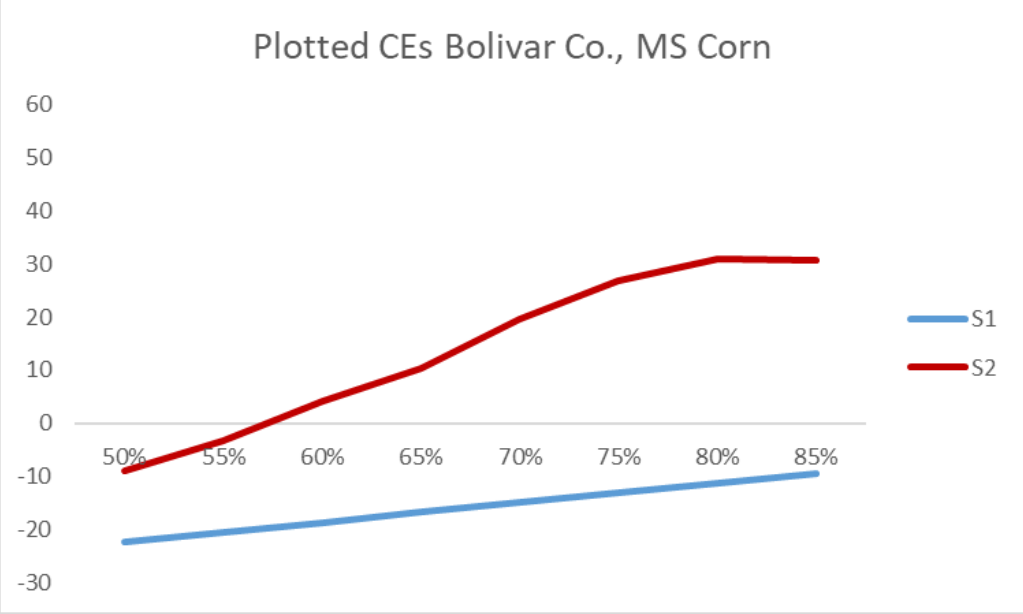
Scenario 1 – Base Case



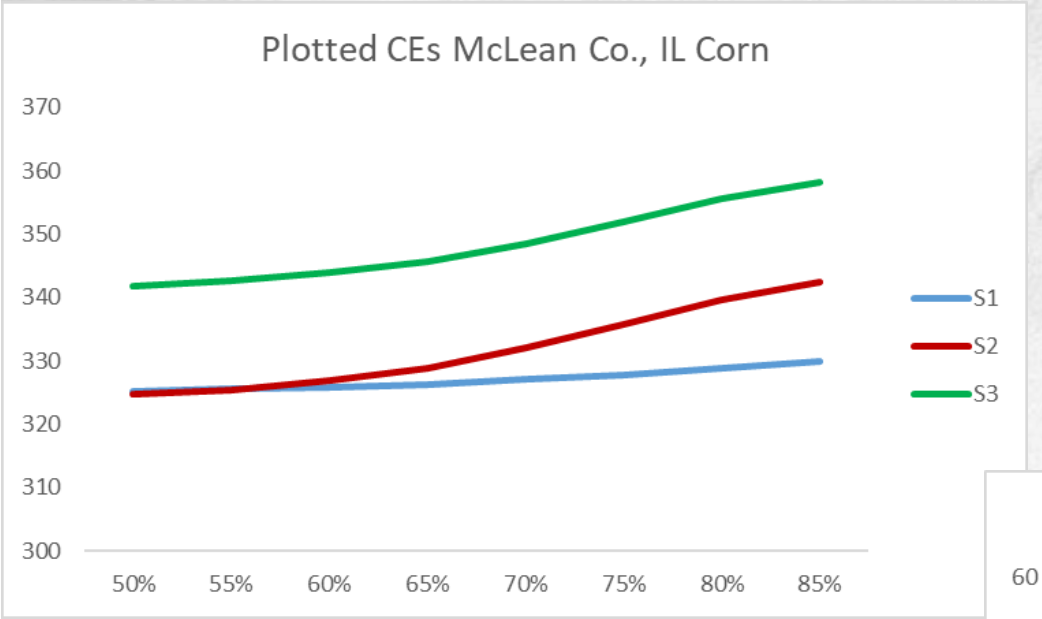


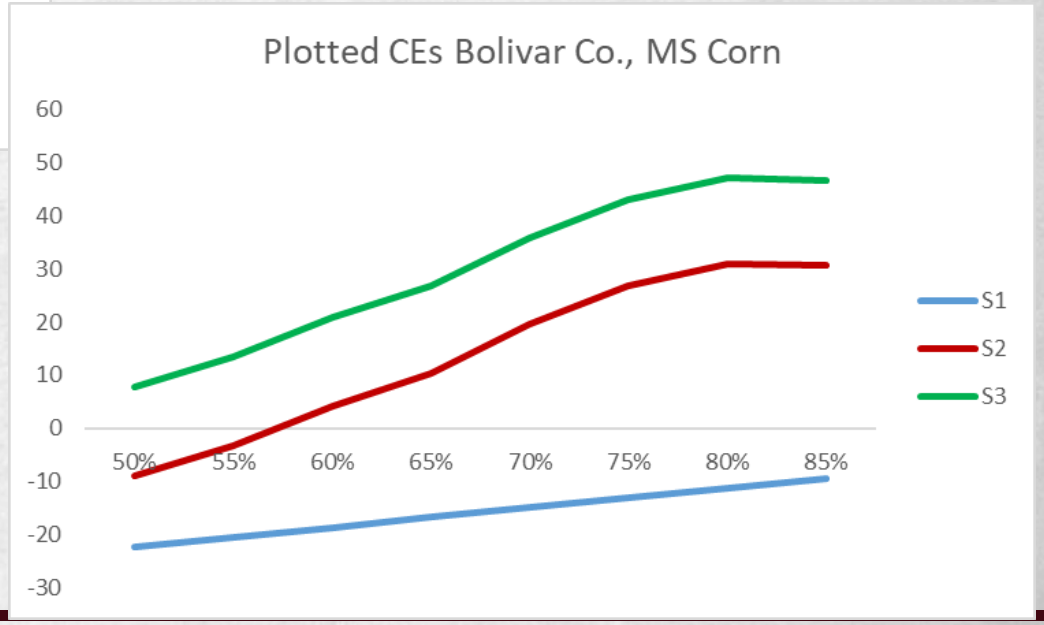
Scenario 2 – RP Subsidy



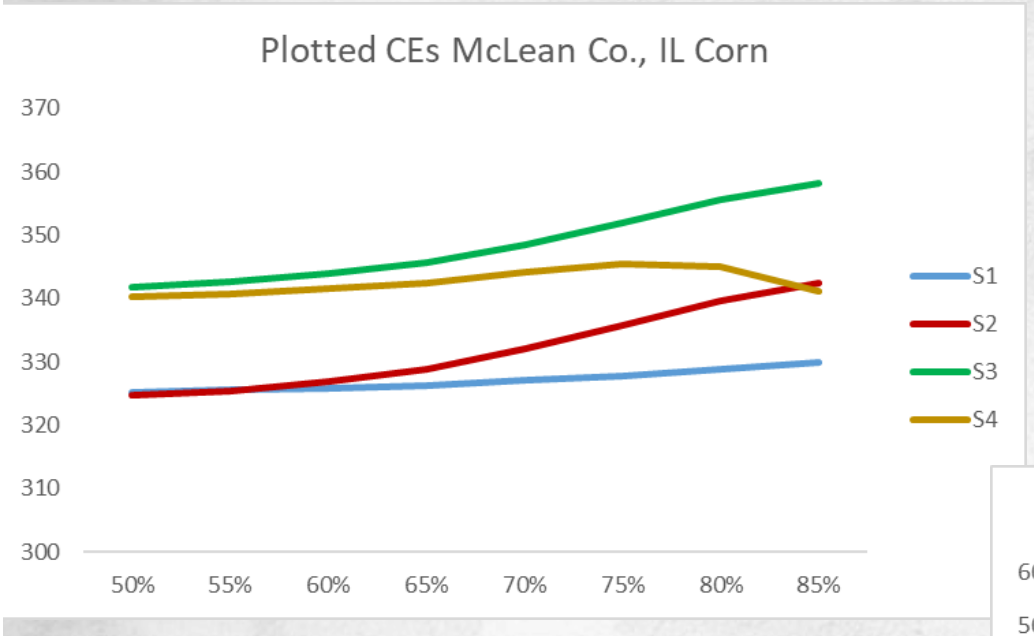


Scenario 3 – Sub and ARC Payment



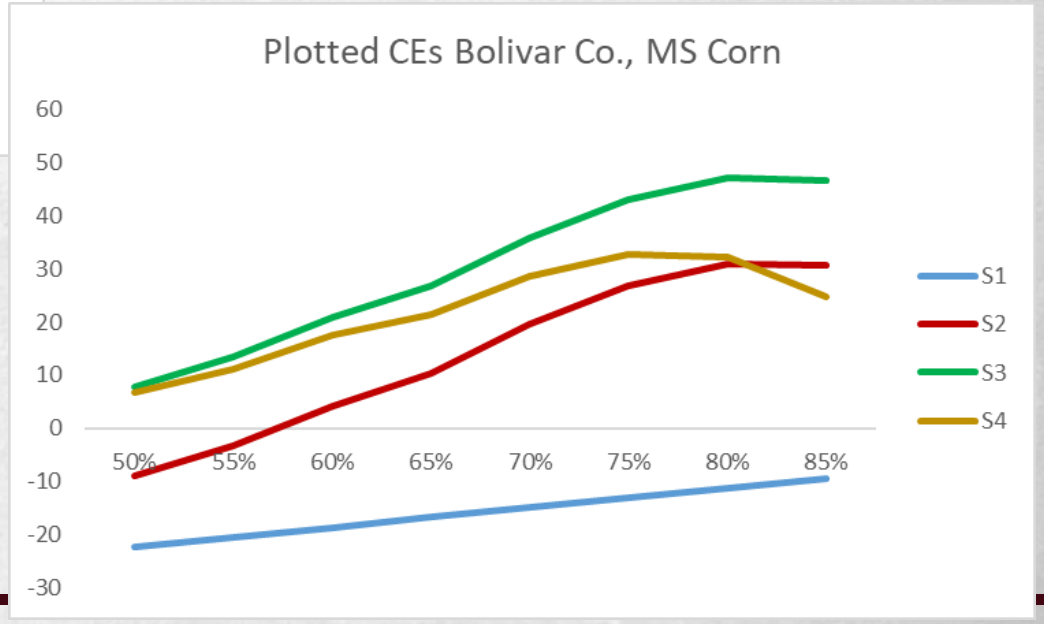


Scenario 4 – Sub, ARC, Wedge



Wedge = 1.70

Wedge = 1.35



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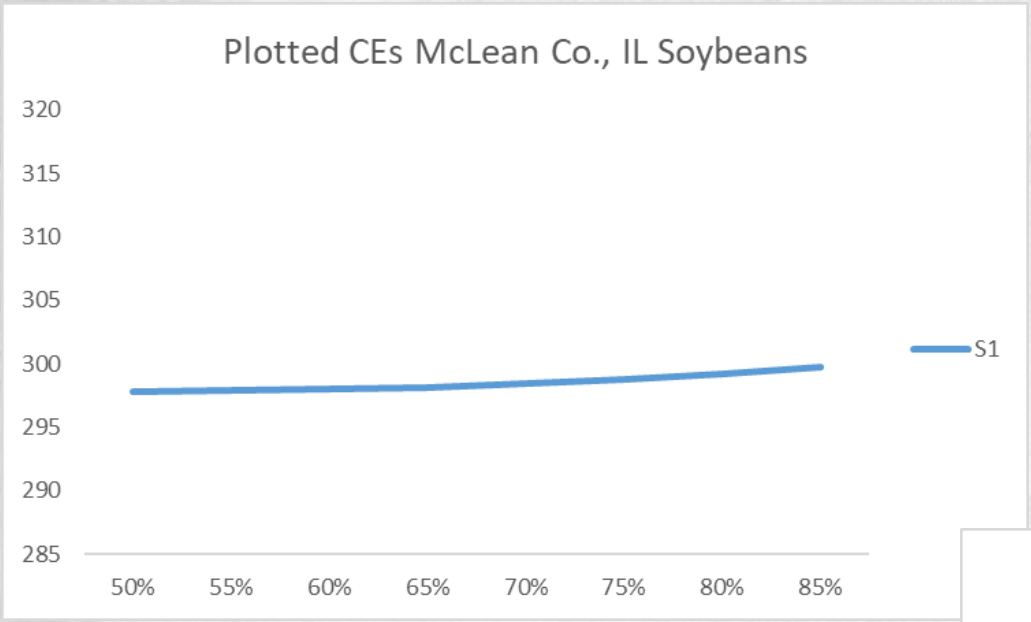
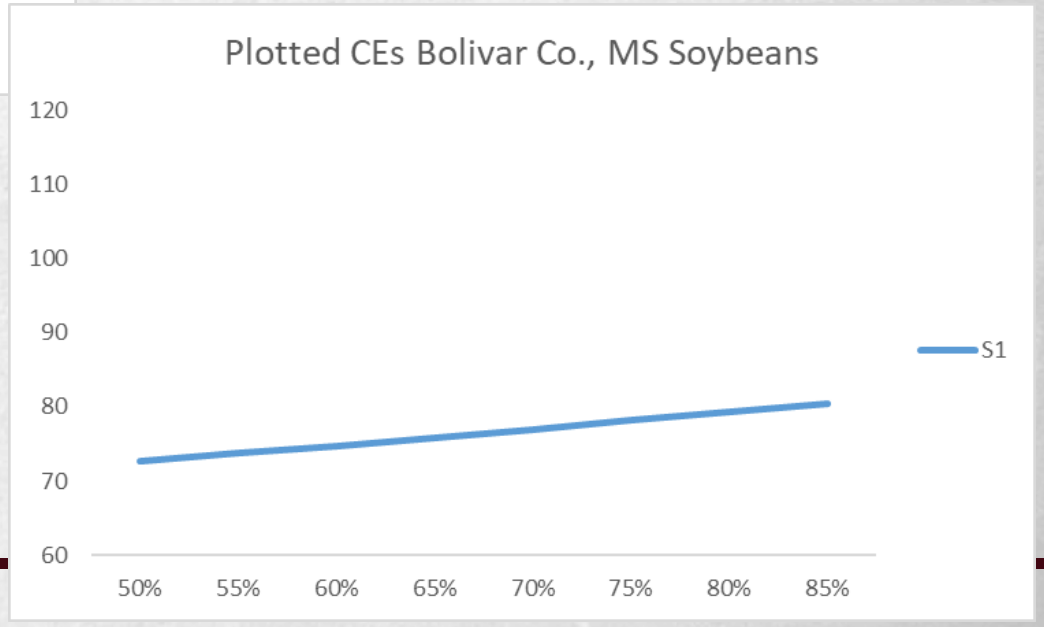
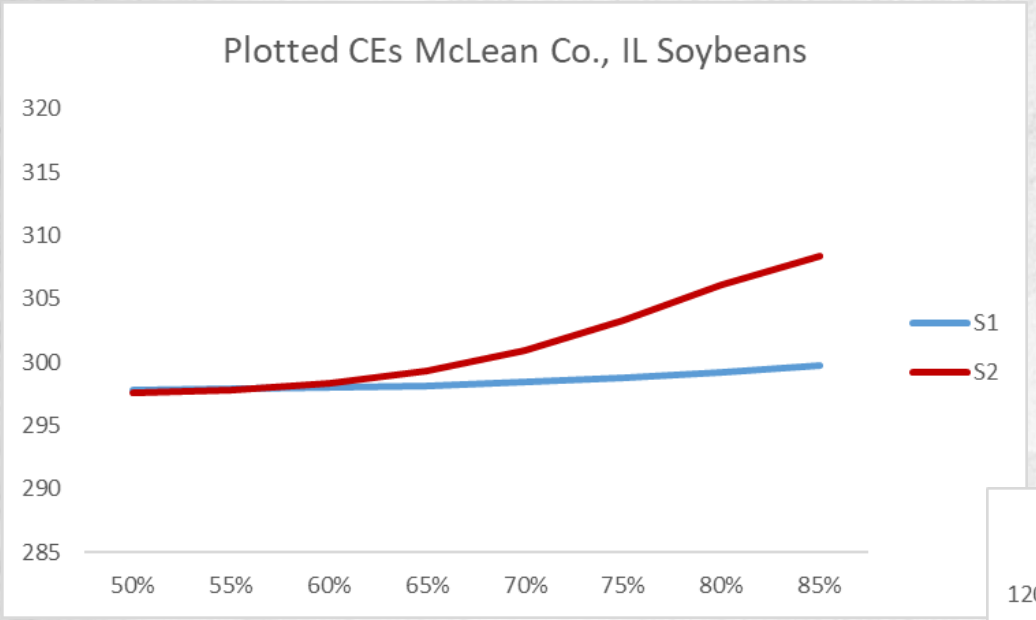
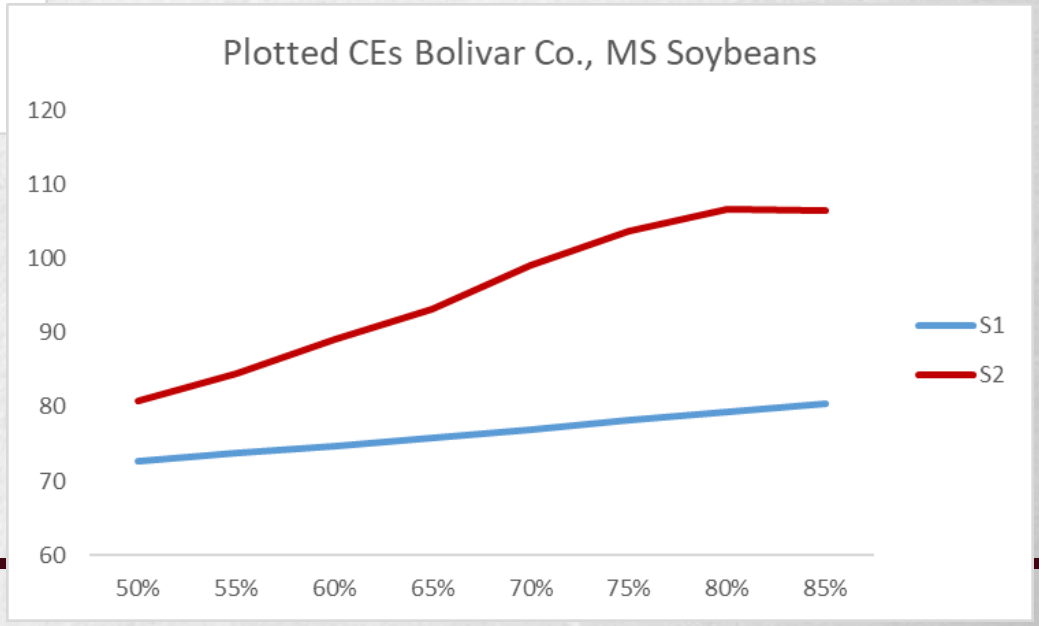




Scenario 2 – RP Subsidy





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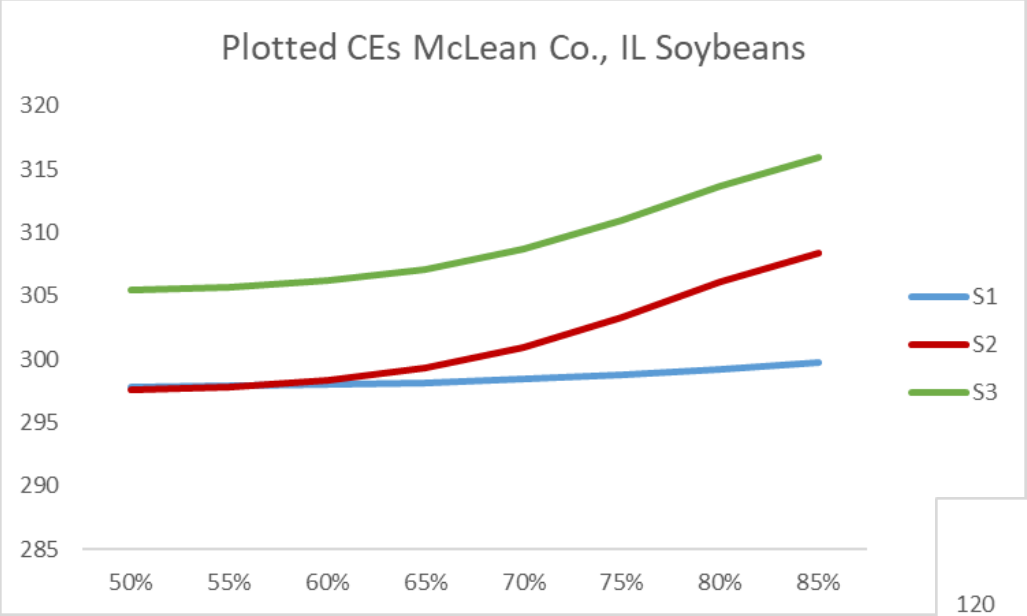

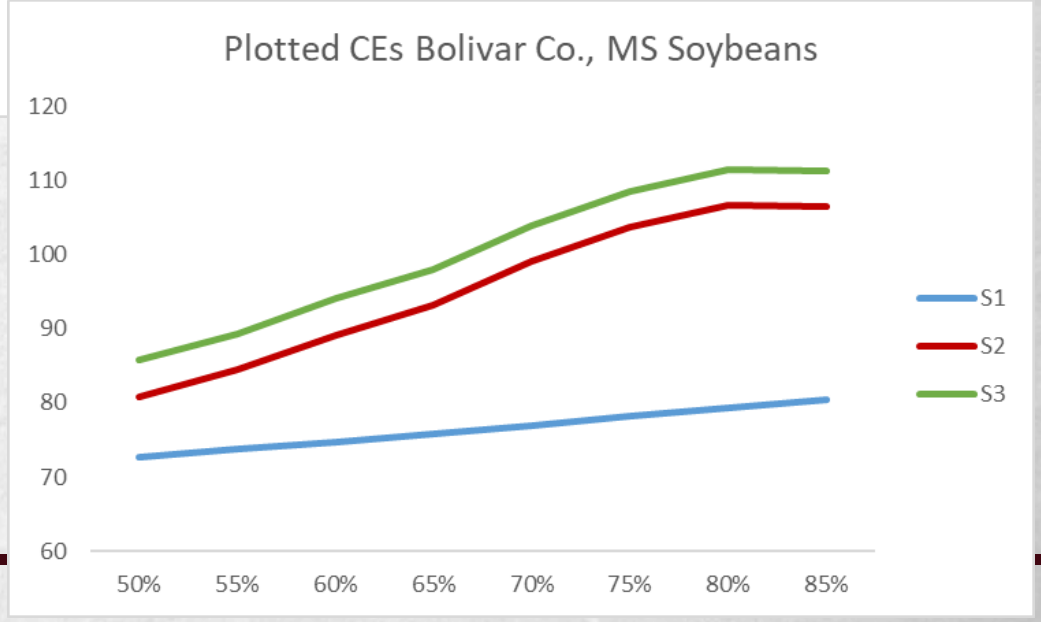

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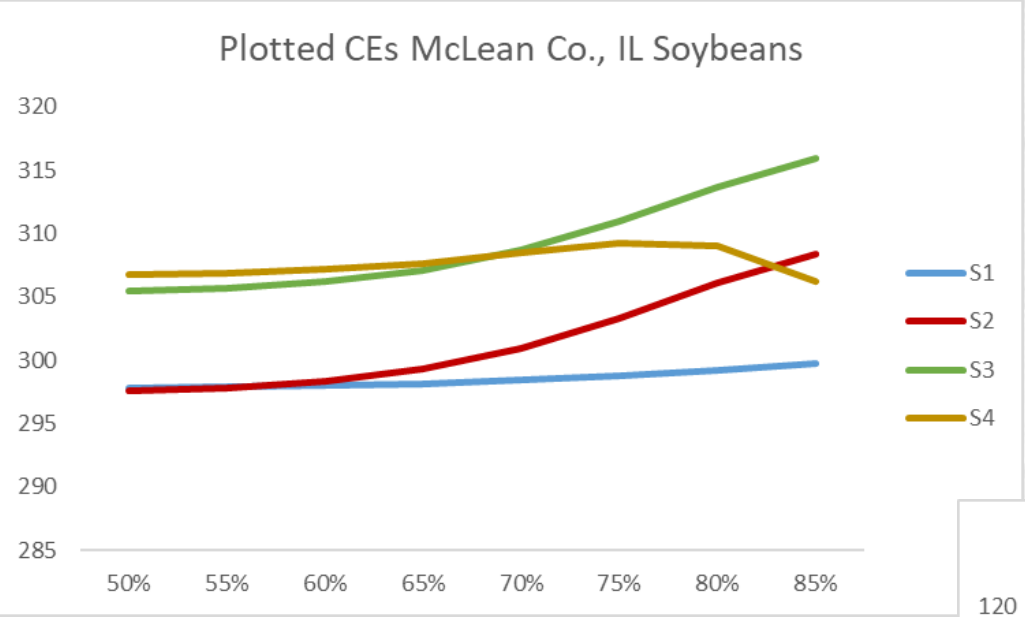
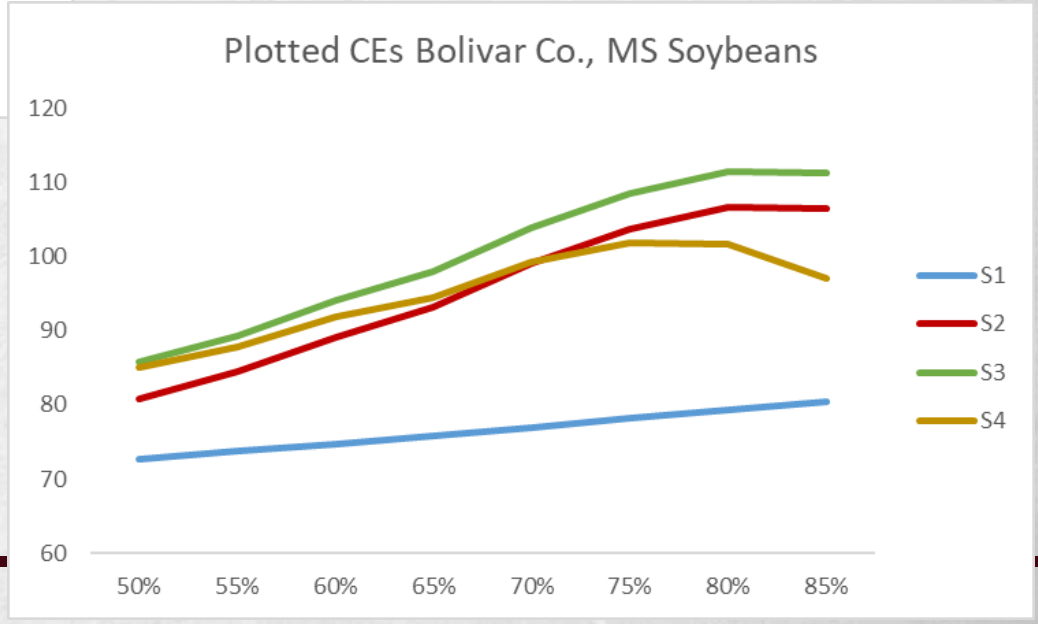
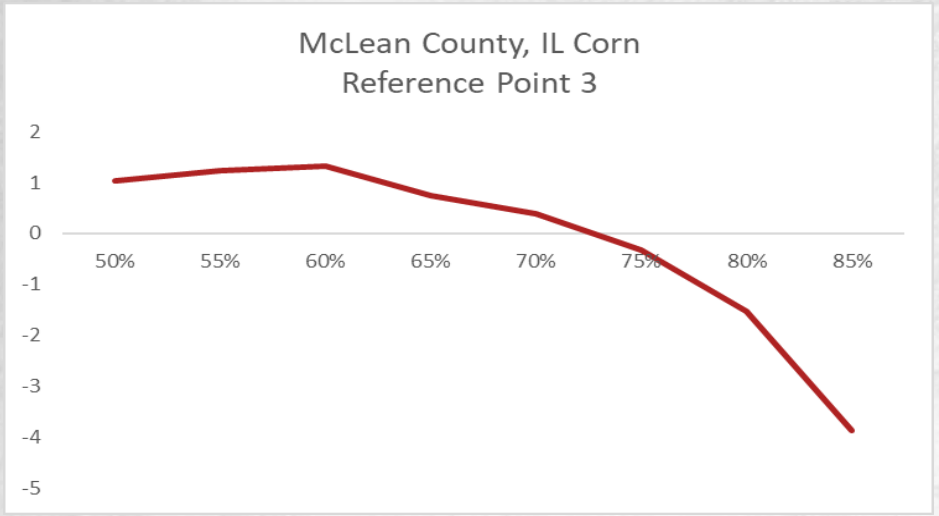


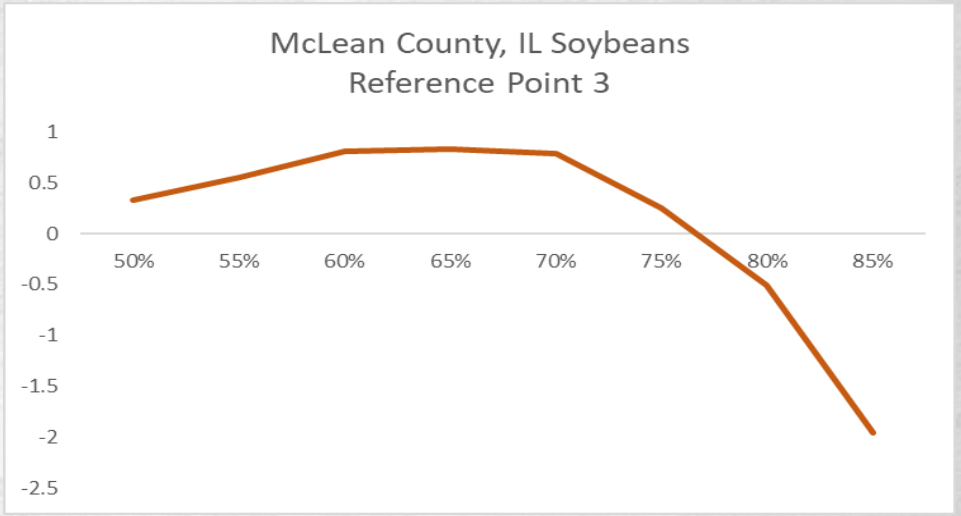
Wedge = 1.75

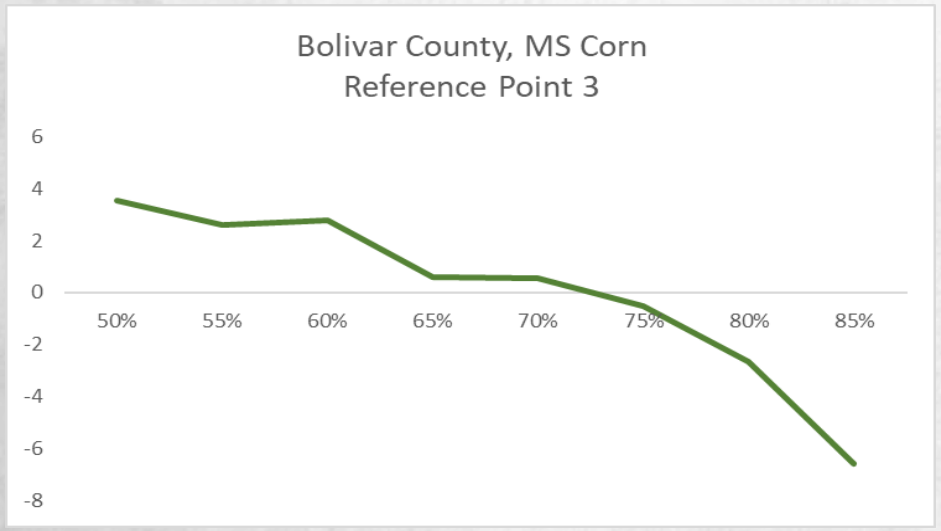
Wedge = 1.35

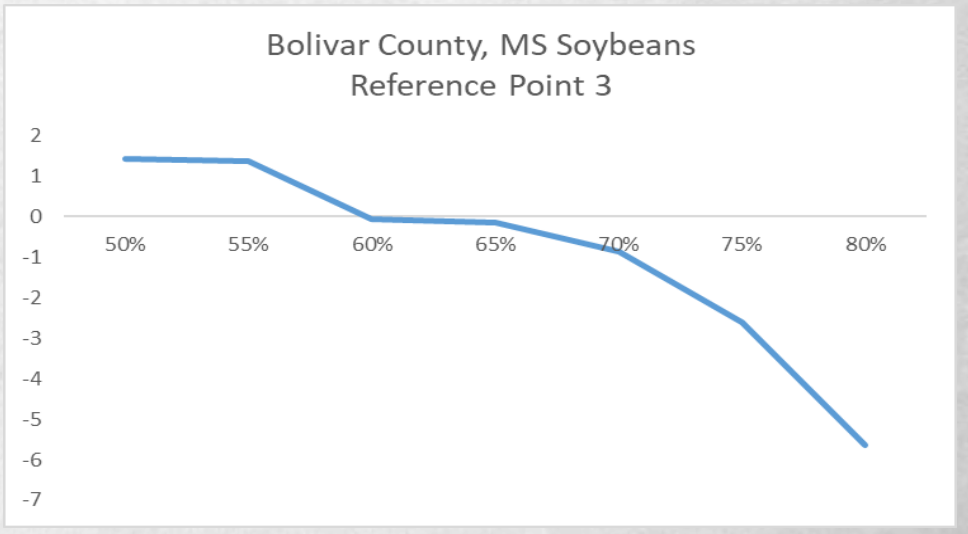


CPT Results


McLean County, IL Corn
Reference Point 3
2
1
0
-1
-2
-3
-4
-5
50%
55%
60%
65%
70%
75%
80%
85%


McLean County, IL Soybeans
Reference Point 3
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
50%
55%
60%
65%
70%
75%
80%
85%


Bolivar County, MS Corn
Reference Point 3
6
4
2
0
-2
-4
-6
-8
50%
55%
60%
65%
70%
75%
80%
85%


Bolivar County, MS Soybeans
Reference Point 3
2
1
0
-1
-2
-3
-4
-5
-6
-7
50%
55%
60%
65%
70%
75%
80%

Conclusion

Results are contrary – but interesting!

- Is the farmer acting suboptimal?
- Wedge – appropriate rates
- Farmer's trust in ARC
- Indemnities "too low"?
- Insurance too expensive?

Extensions?

1. Risk aversion – sensitivity analysis
2. County-Farm yield correlation
3. RMA's rating calculation
4. EUT v. CPT
   - Different probability distributions for revenue

Thank you!

Questions?

2008 Farm Bill	2014 Farm Bill	Pre-Subsidy Wedge
Interaction of ACRE and SURE [Bulut et al. (2012)]	**STAX** [Bulut and Collins (2014); Yehouenou (2018)]	**Wedge:** A percentage that indicates how much lower or higher a premium rate is perceived by the farmer [Black and Hu (2002)]
Types of overlap: revenue stream/income supplement and assistance beyond intended levels [O'Donoghue (2011)]	**Interaction of ARC and RP** [Cooper, Hungerford, and O'Donoghue (2015)]	Further exploration: Wang et al. (2003) Barnett et al. (2005) and Deng et al. (2007)

Yield Data

- 25 years of RMA county yield data
- Detrended county yields, where trend was found using:

$$Y_c = \beta_0 + \beta_1 t + \varepsilon$$

- Individual farm yield follows:

$$Y_{it} = Y_c + \beta_1 (2018 - t) + \gamma_i$$

Price Data

- 25 years of NASS state cash prices received and marketing year average (MYA) prices
- 2017 DEC Corn futures prices from the Commodity Research Bureau

Conceptual Framework

- Objective function, choice variable is RP coverage level:

$$E(U) = \underset{L}{MAX} \int_{\tilde{P}_c} \int_{\tilde{P}_M} \int_{\tilde{F}_f} \int_{\tilde{Y}_f} \int_{\tilde{Y}_C} U\left[A_p\left(\tilde{R} + I - M\right) + ARC\right] f\left(\tilde{P}_c, \tilde{P}_M, \tilde{F}_f, \tilde{Y}_f, \tilde{Y}_C\right) d\tilde{P}_c d\tilde{P}_M d\tilde{F}_f d\tilde{Y}_f d\tilde{Y}_C$$

- Wedge is nested in premium equation (M)
- Certainty equivalents are found by:

$$CE = \left[(1-\alpha) E(U)\right]^{\frac{1}{1-\alpha}}$$

Correlation Matrix

Table 1. Rank Correlation Matrix Used in Revenue Protection Insurance Premium for McLean Co., IL

	Y_c	Y_f	P_c	F_f	P_M
Y_c	1	0.65	-0.38	0.49	0.51
Y_f		1	-0.23	0.22	0.25
P_c			1	-0.11	0.05
F_f				1	0.98
P_M					1

Correlation Matrix

Table 2. Rank Correlation Matrix Used in Revenue Protection Insurance Premium for Bolivar Co., MS

	Y_c	Y_f	P_c	F_f	P_M
Y_c	1	0.29	0.06	0.22	0.36
Y_f		1	0.03	0.04	0.14
P_c			1	-0.41	0.00
F_f				1	0.49
P_M					1