Yield Aggregation Impacts on a "Deep Loss" Systemic Risk Protection Program

Yang Wang, Barry J. Barnett, Keith H. Coble and Ardian Harri

Department of Agricultural Economics, Mississippi State University
Corresponding Author: Barry J. Barnett barnett@agecon.msstate.edu

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association Annual Meeting, Seattle, WA, August 12-14, 2012

Yield Aggregation Impacts on a "Deep Loss" Systemic Risk Protection Program

U.S. agricultural commodity programs have their roots in the New Deal era (Schertz and Doering, 1999; Paarlberg and Paarlberg, 1999). While these programs have changed considerably over time they have always been, until recently, focused exclusively on compensating agricultural producers for low market prices. The Federal Crop Insurance Program (FCIP), also a product of the New Deal era, existed to help protect agricultural producers from yield risks (Barnett, 2000). Thus, two separate federal programs (administered by different federal agencies) existed to protect agricultural producers against two different types of risk.

This changed in 1996 when the early versions of what is now called the Revenue Protection crop insurance product were first offered. For the first time, the FCIP was protecting against revenue (the product of yield and price) risk; not just yield risk. By 2011, more than 80% of insured corn, soybean, and wheat acres were covered by revenue insurance rather than yield insurance. For cotton, 68% of insured acres were covered by revenue insurance.

In the 2008 farm bill, an area revenue triggered agricultural commodity program called the Average Crop Revenue Election (ACRE) program was introduced (Barnett and Coble, 2011; Shields and Schnepf, 2011). Despite the fact that farmers displayed only lukewarm interest in ACRE, the move toward revenue triggered commodity programs seems likely to continue. The various "shallow loss" programs contained in the committee version of the Senate 2012 farm bill legislation – Ag. Risk Coverage (ARC), Stacked Income Protection Plan (STAX), and Supplemental Coverage Option (SCO) – are all revenue triggered.

As a result of these changes, the historical distinction between agricultural commodity programs focused on price risk and federal crop insurance focused on yield risk no longer exists.

Federal crop insurance is now primarily revenue triggered and once the 2012 farm bill is adopted agricultural commodity programs are also likely to be primarily revenue triggered. This raises obvious questions about whether the risk protection provided by these programs is complementary or redundant.

Another important question is whether commodity programs should protect against shallow revenue losses and federal crop insurance protect against deep revenue losses (as in the committee version of the Senate 2012 farm bill legislation) or *vice versa* as proposed by the American Farm Bureau Federation (AFBF). The logic behind shallow loss programs is that agricultural producers can purchase federal crop insurance to protect against deep losses but need commodity programs to protect against shallow losses that would fall within the deductible on federal crop insurance policies.

The AFBF's 2012 farm bill proposal, originally called the Systemic Risk Reduction Program (SRRP) but more recently referred to simply as a "Deep Loss" program (Bennett, 2012), essentially turns shallow loss proposals upside down. Instead of protecting against shallow losses, it focuses on protecting against deep losses. More specifically, the proposal would trigger payments whenever large losses occur in county revenue measures. Similar to the Group Risk Income Protection (GRIP) area revenue insurance policies currently offered under the FCIP, the deep loss proposal would make payments to producers whenever the realized county revenue is less than some specified percentage of the expected county revenue. For example, if the expected county revenue was $500 per acre and the coverage level was set at 70%, then producers in that area would receive a payment whenever the realized area revenue was less than the trigger revenue of $350 per acre; irrespective of the realized revenue on an insured producer's farm. Furthermore, unlike shallow loss program proposals, the payments would not be limited to a specified layer of revenue shortfall. Instead, payments would be made for losses of any magnitude relative to the trigger level. The AFBF "deep loss" proposal would differ from GRIP however by using historical average prices instead of planting-time futures market prices to establish the expected county revenue.

Agricultural producers could "wrap" a farm-level federal crop insurance policy around the county-level deep loss program. Depending on relative farm-level and county-level revenue outcomes, a producer might receive a payment on the federal crop insurance policy but not the deep loss policy, or *vice versa*. If the producer received a payment on both the wrapped crop insurance policy and the deep loss program, the crop insurance payment would be reduced by the amount the producer received from the deep loss program. If the payment from the deep loss program exceeded the payment from the crop insurance policy, no payment would be made on the crop insurance policy. In this way, the county-based deep loss program would protect against deep systemic risks (e.g., a major drought) while the wrapped farm-level crop insurance policy would protect against idiosyncratic risks. In principal, this would reduce the premium cost of farm-level federal crop insurance policies because the deep loss program would provide protection against widespread deep losses.

County yield data generated by the U.S. Department of Agriculture's National Agricultural Statistical Service (NASS) are currently used to establish both the expected yields and realized yields for area-based federal crop insurance policies such as GRIP. These data would also be required for the proposed area-based farm bill proposals (either shallow loss or deep loss). Recently, however, NASS has reduced the number of counties for which they report county yield data though yield data continue to be reported at the crop reporting district (CRD), state, and national levels. This manuscript utilizes a unique data set of farm-level yields to investigate how different levels of yield aggregation (e.g., county and CRD) impact the effectiveness of the proposed area revenue triggered deep loss commodity program.

Background

As with the GRIP insurance policy, area-based commodity programs (either shallow loss or deep loss) leave farmers exposed to basis risk. In this context, "basis risk" refers to the lack of perfect correlation between realized farm-level revenue and the area-level revenue on which the commodity program or insurance policy will trigger payments (Skees, Black, and Barnett, 1997). With any area-level commodity program or insurance policy it is possible that the farm may experience a significant revenue shortfall when the area does not, so the farm receives no payment from the area-level commodity program or insurance policy to compensate for the loss. Of course, the opposite is also true. The farm may not experience a revenue shortfall when the area does, and thus the farm receives a payment even though it has experienced no loss. Since price variability tends to be systemic, basis risk is generally the result of low correlation between the farm yield and area yield.

Various studies have examined how basis risk affects the risk reduction effectiveness of area-based crop insurance products (Deng, Barnett and Vedenov, 2007; Barnett, et al., 2005; Wang, et al., 1998; Miranda, 1991). A common finding across all of these studies is that basis risk is higher for more heterogeneous production regions.

Miranda and Glauber (1991) proposed replacing the price triggered deficiency payment program that was in place at the time with a county revenue triggered deficiency payment program. They analyzed the effectiveness of such a program for corn production in the United States and found that it would substantially reduce county-level revenue variability. Furthermore, they found that a county revenue triggered program provided better farm level revenue risk protection than a price triggered program, even when the latter was offered together with FCIP farm-level yield insurance. These findings were attributed, in part, to the fact that yield and price are negatively correlated in major corn production regions and price triggered programs undermine this "natural revenue stabilization mechanism" (p. 1238). Revenue triggered programs, on the other hand, would not.

In separate analyses that were published in different journals during the same month, Paulson and Babcock (2008) and Coble and Barnett (2008) revisited the issue of county revenue triggered programs. Paulson and Babcock estimated the cost to the federal government of a county revenue triggered commodity program for corn and soybean farmers in Iowa, Illinois, and Indiana. They argued that such a program could be delivered by the Farm Service Agency (FSA) at much lower marginal cost than the administrative and operating costs associated with the GRIP FCIP policy. Coble and Barnett examined the residual risk that would remain if a farm-level FCIP product (either yield or revenue insurance) was wrapped around an area-based revenue triggered commodity program at either the county, state, or national level. The analysis was conducted for 10 representative farms in each county in the United States where NASS yield data were available for corn, soybeans, wheat, or cotton. Not surprisingly, the residual risk on the wrapped farm-level insurance product was higher when the revenue triggered commodity program was at a higher level of aggregation. However important crop and regional differences were observed in the extent to which an area revenue triggered commodity program reduced farm-level risk exposure.

Conceptual Framework

Consider a producer *i* who farms a particular crop in county *c* and experiences a yield in year *t* equal to $\tilde{y}_{it}$, where the tilde represents a stochastic variable. The price per unit of the crop

$\tilde{p}_t$ is stochastic but assumed perfectly spatially correlated.[1] Finally, define $\mu_i = E(\tilde{y}_{it})$, $\mu_c = E(\tilde{y}_{ct})$, and $\mu_p = E(\tilde{p}_t)$ where $E(\cdot)$ is the expectations operator.

A county-level deep loss commodity program triggers payments whenever the realized county revenue is less than a stated percentage (the coverage level) of the expected county revenue. The higher the coverage level, the higher the federal cost of the deep loss commodity program. For the analysis presented here, the coverage level is assumed equal to 70%. The expected county revenue per acre is equal to $\mu_c \times \mu_p$ and a payment is triggered whenever the realized county revenue per acre $\tilde{R}_{ct} = \tilde{y}_{ct} \times \tilde{p}_t$ is less than the critical revenue R_c^* where

(1) $$R_c^* = \mu_c \times \mu_p \times 70\%.$$

The payment for the deep loss commodity program $\tilde{n}_{ct}$ (denominated in dollars per acre), is calculated as

(2) $$\tilde{n}_{ct} = max\left[\left(R_c^* - \tilde{R}_{ct}\right), 0\right].$$

Further assume that farmers can purchase farm-level revenue insurance at 85% coverage that wraps around the deep loss program. The critical revenue for the revenue insurance is,

(3) $$R_i^* = \mu_i \times \mu_p \times 85\%$$

and the payment $\tilde{n}_{it}$ is calculated as

(4) $$\tilde{n}_{it} = max\left[\left(R_i^* - \tilde{R}_{it}\right), 0\right].$$

Because the revenue insurance is wrapped around the deep loss commodity program, the insured farmer receives a payment $\tilde{n}_{wt}$ (where the subscript *w* indicates "wrapped") equal to the higher of the payment for the revenue insurance policy and the payment for the deep loss commodity program. That is,

(5) $$\tilde{n}_{wt} = max[\tilde{n}_{it}, \tilde{n}_{ct}].$$

[1] This simplifying assumption was adopted because the primary cause of basis risk in area-level revenue triggered programs is spatial differences in yields, not prices.

The insurer only pays for that portion of $\tilde{n}_{wt}$ that is not covered by $\tilde{n}_{ct}$ (i.e., when $\tilde{n}_{it} > \tilde{n}_{ct}$). Thus, the actuarially fair premium for the wrapped revenue insurance product π_w is

(6) $$\pi_w = E(max[\tilde{n}_{it} - \tilde{n}_{ct}], 0).$$

A CRD-level deep loss commodity program can also be modeled using the equations above simply by using CRD-level expected and realized yields in the calculations rather than county-level yields.

Data and Methods

Farm-level yield data were obtained from the Risk Management Agency (RMA). These data are the 10-year yield histories from 1999 to 2008 that were used to establish actual production history (APH) yields for 2009 purchasers of yield and revenue insurance policies that trigger based on farm-level losses. Both CRD and county-level yield data that span from 1971-2010 were obtained from NASS.

To reflect diversity across crops and production regions, this study focuses on four crops produced in five different CRDs. Specifically, analyses were conducted for corn and soybeans produced in Iowa CRD 10, cotton and soybeans produced in Mississippi CRD 40, corn and soybeans produced in Ohio CRD 10, wheat produced in Kansas CRD 30, and cotton produced in Georgia CRD 70. These specific CRDs were selected because they had significant production of the specified crop, a complete time series of NASS data for 1971-2010, and sufficient farm-level yield data. For each crop and CRD combination, counties were eliminated that did not have at least twenty-five different farms with 10 years of historical yield data. This resulted in eight counties being eliminated for Georgia CRD 70 cotton, one county being eliminated for Iowa CRD 10 corn, one county being eliminated for Mississippi CRD 40 soybeans, and two counties being eliminated for Mississippi CRD 40 cotton. Also, counties without a complete NASS county yield series from 1999 to 2008 were eliminated resulting in one county being eliminated for Ohio CRD 10 corn and two counties being eliminated for Kansas CRD 30 wheat. No counties were eliminated from the analysis for Iowa CRD 10 soybeans or Ohio CRD 10 soybeans.

Futures price data from 1971 through 2010 were obtained from the Commodity Research Bureau. For each year, planting time and harvest time prices (for the harvest futures contract) were calculated exactly as they are calculated for the existing FCIP revenue insurance products. The percentage change between the planting time and harvest time prices was calculated for each year and fit to a lognormal distribution.

Miranda (1991) models farm-level yield $\tilde{y}_{it}$ as

(7) $$\tilde{y}_{it} = \mu_i + \beta_i(\tilde{y}_{ct} - \mu_c) + \tilde{\varepsilon}_{it}$$

where

(8) $$\beta_i = \frac{Cov(y_{it}, y_{ct})}{Var(y_{ct})}$$

(9) $$E(\tilde{\varepsilon}_{it}) = 0 \;\; Var(\tilde{\varepsilon}_{it}) = \sigma^2_{\varepsilon_{it}} \;\; Cov(\tilde{y}_{ct}, \tilde{\varepsilon}_{it}) = 0$$

and all other variables are as previously defined. Equation (7) decomposes farm yield deviations from expectation into two components: a systemic component $\beta_i(\tilde{y}_{ct} - \mu_c)$ that is associated with county yield deviations from expectation and a non-systemic component $\tilde{\varepsilon}_{it}$ that reflects idiosyncratic deviations in farm yields that are not associated with the deviations in the county yield. The coefficient β_i measures the sensitivity of the farm yield deviations from expectation to area yield deviations from expectation.

Extending the logic of equation (7)

(10) $$\tilde{y}_{ct} = \mu_c + \beta_c(\tilde{y}_{dt} - \mu_d) + \tilde{\varepsilon}_{ct}$$

where the subscript *d* indicates the crop reporting district in which county *c* is located.

The parameter β_c in equation 10 was estimated using ordinary least squares (OLS). Due to the potential for contemporaneous correlation in the error terms, equations (7) and (10) were then simultaneously estimated using seemingly unrelated regression (SUR) with β_c restricted to be equal to the value estimated using OLS. The parameters β_c and β_i were captured for use in simulation analysis along with $Var(\tilde{\varepsilon}_{ct})$ and $Var(\tilde{\varepsilon}_{it})$.

Following Ubilava et al. (2011) and Anderson, Coble, and Miller (2007), the Phoon Quek, and Huang (2004) procedure was used to simulate from mixed marginal distributions. This procedure uses an empirically determined correlation matrix to simulate correlated probabilities that are used in an inverse transformation of the relevant marginal distributions to generate simulated correlated variables (Anderson, Harri, and Coble, 2009).

After detrending, the historical CRD yield data were fit to a beta distribution. A simulated CRD yield $\hat{y}_{dt}$ (where *t* is now a counter variable for iterations and the hat indicates a simulated value) is drawn randomly from the beta distribution of CRD yields along with a correlated draw from the log-normal distribution of percentage price changes. Planting time price is set at \$7.00 per bushel for corn, \$11.00 per bushel for soybeans, \$0.90 per pound for cotton, and \$7.00 per bushel for wheat. The simulated harvest time price $\hat{p}_t$ is calculated as the product of the planting time price and one plus the randomly drawn percentage change from the lognormal distribution.

The simulated county yield $\hat{y}_{ct}$ is calculated by taking a random draw from the equation (10) error term (estimated using SUR) which is distributed $N\left(0, \sigma^2_{\varepsilon_{ct}}\right)$ and substituting into equation (10) along with the simulated CRD yield $\hat{y}_{dt}$ and the known values of β_c, μ_d, and μ_c.

Substituting equation (10) into equation (7) yields

(11) $$\hat{y}_{it} = \mu_i + \beta_i(\beta_c(\hat{y}_{dt} - \mu_d) + \hat{\varepsilon}_{ct}) + \hat{\varepsilon}_{it}.$$

The simulated farm yield $\hat{y}_{it}$ is calculated by taking a random draw from the equation (7) error term (estimated using SUR) which is distributed $N\left(0, \sigma_{\varepsilon_{it}}^2\right)$ and substituting into equation (11) along with $\hat{y}_{dt}$, $\hat{\varepsilon}_{ct}$, and the known values of β_i, β_c, μ_i and μ_d.

Farm *i*'s simulated revenue per acre without purchasing insurance is calculated as

(12) $\hat{R}_{it} = \hat{y}_{it} \times \hat{p}_t$.

If the farm is participating in a county-level deep loss commodity program but not purchasing a wrapped insurance product, the simulated revenue per acre is

(13) $\hat{R}_{it} = (\hat{y}_{it} \times \hat{p}_t) + \hat{n}_{ct}$

where $\hat{n}_{ct}$ is the simulated payment on the deep loss commodity program calculated using the simulated values of $\hat{y}_{ct}$ and $\hat{p}_t$. With a county-level deep loss commodity program and a wrapped farm-level revenue insurance product, the simulated revenue per acre net of the insurance premium is

(14) $\hat{R}_{it} = (\hat{y}_{it} \times \hat{p}_t) + \hat{n}_{wt} - \pi_w$

where $\hat{n}_{wt}$ is the simulated payment on the combination of the deep loss commodity program and a wrapped revenue insurance product calculated using the simulated values of $\hat{y}_{it}$, $\hat{y}_{ct}$, and $\hat{p}_t$. By using CRD expected and simulated yields, equations (13) and (14) can also be calculated for a CRD-level deep loss commodity program.

Each farm is assumed to consist of 1,000 acres of the specified crop with an initial wealth equal to 10% of the CRD-level expected revenue per acre.[2] Ending wealth is calculated as the sum of initial wealth and $\hat{R}_{it}$ under each of three scenarios: 1) no commodity program and no insurance; 2) deep loss commodity program; and, 3) deep loss commodity program with wrapped farm-level revenue insurance. The deep loss commodity program is evaluated at both the county

[2] Since the focus of the analysis is on revenue triggered commodity programs and insurance policies, production costs, other than the insurance premium, are not included in the net revenue calculation. If other production costs are assumed nonstochastic, then not including them in the net revenue calculation essentially increases the assumed initial wealth by a small amount.

and CRD level.

Ending wealth is designated as W_{its} where the subscript *s* indicates one of the scenarios described above. Assuming a constant relative risk aversion (CRRA) utility function, utility was calculated as

(15) $$U(W_{its}) = \frac{(W_{its})^{1-\gamma}}{1-\gamma}$$

where $\gamma \geq 1$ is the measure of relative risk aversion. Expected utility across 10,000 iterations is calculated as

(16) $$E\big(U(W_{its})\big) = \sum_{t=1}^{10000} \frac{U(W_{its})}{10000}.$$

The certainty equivalent for farm *i* under scenario *s* is calculated as

(17) $$CE_{is} = \left[(1-\gamma)E\big(U(W_{its})\big)\right]^{1/1-\gamma}.$$

Results and Implications

Means and variances for the estimated values of β_i and β_c are presented in table 1. The mean values of β_c are close to one except for Georgia cotton. Mean values of β_i vary between 0.68 (Mississippi soybeans) and 1.06 (Iowa Corn). Mississippi CRD 40 soybeans and Georgia CRD 70 cotton exhibit more variability in β_i across farms than the other CRD/crop combinations.

Coefficients of variation (CV) for the simulated farm and county yields are presented in table 2. The lowest relative yield risk occurs for Iowa soybeans. The highest occurs in Kansas wheat. Table 2 also contains the Spearman correlation coefficient between CRD-level yield and price. With high levels of negative yield-price correlation, low (high) yields are partially offset by high (low) prices. This “natural hedge” reduces revenue variability relative to a situation where yield and price are uncorrelated. For the study CRDs and crops, the highest levels of negative yield-price correlation occur for Iowa corn and Ohio corn and soybeans. Low levels of negative yield-price correlation occur for Iowa soybeans, Mississippi cotton, and Kansas wheat. Yield and price are essentially uncorrelated for Mississippi soybeans and Georgia cotton.

Certainty equivalents for alternative scenarios of deep loss programs and wrapped revenue insurance were generated for $\gamma = 2$ and $\gamma = 3$. Since there were no qualitative differences in the results generated under the alternative relative risk aversion assumptions, results are presented here only for $\gamma = 3$. Tables 3 through 10 present marginal percentage certainty equivalent effects across alternative scenarios for Iowa CRD 10 corn, Iowa CRD 10 soybeans, Ohio CRD 10 corn, Ohio CRD 10 soybeans, Georgia CRD 70 cotton, Mississippi CRD 40 cotton, Mississippi CRD 40 soybeans, and Kansas CRD 30 wheat, respectively. In each table the first column contains the name of the county and the second column contains the number of farms that were simulated in that county (the number of farms for which at least 10 years of yield data were available). The third and fourth columns indicate the marginal certainty equivalent effect of a deep loss commodity program. More specifically, the third column assumes a county-level deep loss program while the fourth column assumes a CRD-level deep loss program. For each of these columns the average (across farms) certainty equivalent from the deep loss commodity program scenario has been compared to the average certainty equivalent of the scenario with no commodity program and no insurance product. Thus, for example, table 3 indicates that for corn farms in Buena Vista county Iowa a 70% county-level deep loss commodity program increases the average certainty equivalent by 1.89% relative to having no commodity program and no insurance. A 70% CRD-level deep loss commodity program increases the certainty equivalent by 1.61%.

The marginal effects of wrapping an actuarially fair farm-level revenue insurance policy with 85% coverage around the deep loss commodity program are presented in columns 5 (county-level deep loss program) and 6 (CRD-level deep loss program).[3] Continuing the example from table 3 for corn farms in Buena Vista county Iowa, wrapping revenue insurance around a county-level deep loss commodity program increases the average certainty equivalent by 3.76% relative to just having the county-level deep loss commodity program. Similarly, wrapping revenue insurance around a CRD-level deep loss commodity program increases the average certainty equivalent by 3.98% relative to just having the CRD-level deep loss commodity program.

All of the ratios presented in tables 3-10 are greater than one indicating that the marginal effects of the deep loss commodity programs and the wrapped farm-level revenue insurance are always positive. This is not surprising since the deep loss commodity programs are provided by the government at no cost to the farmer and the wrapped farm-level revenue insurance is constructed to be actuarially fair.

Deep Loss Commodity Program Marginal Effects

The marginal certainty equivalent effect of the county-level deep loss commodity program almost always exceeds that of the CRD-level deep loss commodity program. This occurs for two reasons. First, the same coverage level was used for both county-level and CRD-level programs. Since county-level yields are almost always more variable than CRD-level yields the county-level deep loss commodity program generally has a higher expected payment. Second, in most cases, farm-level yields are more highly correlated with county-level yields than with CRD-level yields, so the basis risk for a county-level deep loss program is generally lower than that of a CRD-level program.

[3] The wrapped insurance is constructed to be actuarially fair (rather than subsidized) to isolate the marginal risk reduction impact on certainty equivalents.

The magnitude of the marginal certainty equivalent effects varies across different crops and regions. In general, a deep loss commodity program (at either the county or CRD level) generated higher marginal certainty equivalent effects in Georgia, Kansas, and Mississippi than in Iowa or Ohio. This may seem counterintuitive since the specified CRDs in Iowa and Ohio are likely more homogeneous production regions than the specified CRDs in Georgia and Mississippi. This would suggest that basis risk should be higher in Georgia and Mississippi reducing the relative effectiveness of a deep loss commodity program. However for the specified Georgia, Kansas, and Mississippi crops, yield variability is higher than for corn and soybeans produced in Iowa and Ohio (see table 2). Since a fixed coverage level (70%) was used for all deep loss commodity programs, regions with higher yield variability have higher expected deep loss payments. Furthermore, for corn in Iowa and corn and soybeans in Ohio, area yields and prices exhibit relatively high levels of negative correlation. This further reduces the variability in area-level revenues and thus further reduces expected deep loss commodity program payments. In contrast, the correlation between yields and prices is quite small for Georgia cotton, Kansas wheat, Mississippi cotton, and Mississippi soybeans.

While county-level deep loss commodity programs are almost always preferred to CRD-level deep loss commodity programs, there are noticeable crop and regional differences in the magnitude of this preference. The difference in certainty equivalent marginal effects between county-level and CRD-level deep loss programs is relatively small for Iowa and Ohio compared to Georgia, Kansas, and Mississippi.

Wrapped Insurance Marginal Effects

The marginal certainty equivalent effect of wrapping actuarially fair revenue insurance around a deep loss commodity program (either at the county or CRD level) is generally also higher in Georgia, Kansas, and Mississippi than in Iowa and Ohio. Again, this likely reflects higher levels of yield risk in Georgia, Kansas, and Mississippi and the fact that Georgia and Mississippi are more heterogeneous production regions and thus have higher basis risk associated with the deep loss commodity program (either at the county or CRD level). The marginal effect of wrapping revenue insurance around a CRD-level deep loss program is generally greater than that of wrapping revenue insurance around a county-level deep loss program. This is consistent with a CRD-level deep loss program having higher basis risk than a county-level program.

Table 11 presents average actuarially fair premium rates for 85% revenue insurance wrapped around both county-level and CRD-level deep loss programs. Not surprisingly, premium rates are lower for wrapping revenue insurance around a county-level deep loss program than around a CRD-level program. Again, this is because the basis risk is lower for the county-level program so there is less residual idiosyncratic risk to be covered by the wrapped revenue insurance policy. Consistent with earlier findings, the actuarially fair premium rates are lower for Iowa and Ohio corn and soybeans because these region and crop combinations have lower yield risk and/or lower basis risk on the deep loss policy.

Implications

These results have several important implications for policymakers who are developing area-level commodity programs (either deep loss or shallow loss). First, a common coverage level for area-level commodity programs *does not* imply similar levels of benefits for all farmers. Those who produce riskier crops and those who produce in riskier regions will receive higher payments. Likewise, those who produce in regions where area yields and prices are largely uncorrelated will also receive higher payments.

Second, the results presented here suggest that while farmers would certainly prefer a county-level deep loss commodity program to a CRD-level program, a CRD-level program may be feasible given that NASS is reducing the regions for which it reports county-level yields. However, the impacts of moving from county-level to CRD-level programs are not the same for all producers. Moving from county-level to CRD-level programs will hurt those who farm in relatively heterogeneous production regions more than those who farm in relatively homogeneous regions. It is also important to note that this research did not include some of the western states that have very large counties and crop reporting districts. Those areas may also be hurt more by moving from county-level to CRD-level programs.

Finally, most farmers would benefit from wrapping farm-level actuarially fair revenue insurance around either a county-level or CRD-level deep loss commodity program. However, this is especially so for crops and regions with higher levels of yield risk and/or more heterogeneous production regions or when the underlying deep loss commodity program is at the CRD level.

Conclusion

This study compared the marginal certainty equivalent effects of revenue triggered deep loss commodity programs at the county and CRD levels for several crops and regions. In addition, the study investigated the marginal certainty equivalent effects of wrapping actuarially fair farm level revenue insurance around a county or CRD level deep loss commodity program. While both the deep loss commodity program (at either the county or CRD level) and the wrapped revenue insurance product had positive marginal certainty equivalent effects, the results reveal important crop and regional differences in the magnitudes of the marginal certainty equivalent effects caused by differences in yield variability, the correlation between area yields and prices, and spatial basis risk.

Future extensions of this work could analyze proposed shallow loss commodity programs in addition to deep loss programs. Furthermore, as farm policy becomes increasingly focused on area-based commodity programs (either deep loss or shallow loss) it will be important to analyze differences in the impacts of these programs across additional crops and regions.

References

Anderson, J., A. Harri, and K. Coble. "Techniques for Multivariate Simulation from Mixed Marginal Distributions with Application to Whole-Farm Revenue Simulation." *Journal of Agricultural and Resource Economics* 34(2009):53-67.

Anderson, J. D., K.H. Coble, and J.C. Miller. "Hedging a Government Entitlement: The Case of Counter-cyclical Payments." *Journal of Agricultural and Applied Economics* 39(2007):507-522.

Barnett, B.J. "The U.S. Federal Crop Insurance Program." *Canadian Journal of Agricultural Economics* 48(2000):539–551.

Barnett, B.J., J.R. Black, Y. Hu, and J.R. Skees. "Is Area-Yield Insurance Competitive with Farm-Yield Insurance?" *Journal of Agricultural and Resource Economics* 30(2005):285-301.

Barnett, B.J., and K.H. Coble. 2011. "Understanding Regional Differences In Farm Policy Preferneces." *American Journal of Agricultural Economics* 94(2011):528-534.

Coble, K.H. and B.J. Barnett. "Implications of Integrated Commodity Programs and Crop Insurance." *Journal of Agricultural and Applied Economics* 40(2008):431-442.

Deng, X., B.J. Barnett, and D. Vedenov. "Is there a Viable Market for Area-based Crop Insurance?" *American Journal of Agricultural Economics* 89(2007):508-519.

Miranda, M.J. "Area-Yield Crop Insurance Reconsidered." *American Journal of Agricultural Economics* 73(1991):233-242.

Miranda, M.J. and J.W. Glauber. "Providing Crop Disaster Assistance through a Modified Deficiency Payment Program." *American Journal of Agricultural Economics* 73(1991):1233-1242.

Paulson, N.D. and B.A. Babcock. “Get a GRIP: Should Area Revenue Coverage Be Offered Through the Farm Bill or as a Crop Insurance Program?” *Journal of Agricultural and Resource Economics* 33(2008):137-153.

Paarlberg, R. and D. Paarlberg. “Agricultural Policy in Twentieth Century.” Presentation at the Eightieth Anniversary Symposium of the Agricultural Historical Society, at Mississippi State University, Starkville, Mississippi, June 1999.

Phoon, K., S.T. Quek, and H.Huang. “Simulation of Non-Gaussian Processes Using Fractile Correlation.” *Probabilistic Engineering Mechanics* 19(2004):287-292.

Ubilava D., B.J. Barnett, K.H. Coble, and A. Harri. “The SURE Program and Its Interaction with Other Federal Farm Programs.” *Journal of Agricultural and Resource Economics* 36(2011):620-648.

Schertz, L. P., and O. C. Doering. *The Making of the 1996 Farm Act*. Ames, IA: Iowa State University Press, 1999.

Shields D.A., and R. Schnepf. “Farm Safety Net Proposals for the 2012 Farm Bill.” CRS Report for Congress 7-5700, R42040, November 10, 2011.

Skees J.R., J.R. Black, B.J. Barnett. “Designing and Rating an Area Yield Crop Insurance Contract.” *American Journal of Agricultural Economics* 79(1997):430-438.

Wang, H.H., S.D. Hanson, R.J. Myers, and J.R. Black. “The Effects of Crop Yield Insurance Designs on Farmer Participation and Welfare.” *American Journal of Agricultural Economics* 80(1998):806-820.

Table 1: Mean and Variance of $\boldsymbol{\beta_i}$ and $\boldsymbol{\beta_c}$

CRD/Crop	Mean of β_i	$Var(\beta_i)$	Mean of β_c	$Var(\beta_c)$	Mean of $\beta_i \times \beta_c$
Iowa CRD 10 Corn	1.06	0.212	1.01	0.009	1.07
Iowa CRD 10 Soybeans	0.91	0.162	0.99	0.033	0.91
Ohio CRD 10 Corn	0.89	0.137	1.05	0.023	0.93
Ohio CRD 10 Soybeans	0.97	0.186	1.06	0.015	1.03
Mississippi CRD 40 Cotton	0.83	0.238	1.00	0.009	0.83
Mississippi CRD 40 Soybeans	0.68	0.346	0.98	0.008	0.67
Georgia CRD 70 Cotton	0.82	0.338	0.85	0.066	0.70
Kansas CRD 30 Wheat	1.03	0.163	0.99	0.007	1.02

Table 2: Yield Coefficients of Variation and Correlation between Yield and Price

CRD/Crop	CV of Simulated Farm Yield $\hat{y}_{it}$	CV of Simulated County Yield $\hat{y}_{ct}$	Spearman Correlation between CRD Yield and Price
Iowa CRD 10 Corn	0.19	0.15	-0.36
Iowa CRD 10 Soybeans	0.16	0.11	-0.13
Ohio CRD 10 Corn	0.20	0.15	-0.42
Ohio CRD 10 Soybeans	0.23	0.15	-0.26
Mississippi CRD 40 Cotton	0.24	0.18	-0.10
Mississippi CRD 40 Soybeans	0.25	0.20	-0.03
Georgia CRD 70 Cotton	0.30	0.25	-0.01
Kansas CRD 30 Wheat	0.40	0.30	-0.11

Table 3: County Average of Marginal Percentage Certainty Equivalent Effects, Iowa CRD 10 Corn

County	Number of Farms	County Deep Loss	CRD Deep Loss	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Buena Vista	499	1.89%	1.61%	3.76%	3.98%
Cherokee	488	1.52%	1.51%	4.22%	4.24%
Clay	415	2.59%	1.96%	4.58%	5.08%
Dickinson	263	3.99%	2.05%	6.61%	8.30%
Emmet	308	3.88%	2.00%	5.19%	6.75%
Lyon	534	2.45%	1.48%	3.70%	4.35%
O Brien	484	1.60%	1.66%	4.59%	4.91%
Osceola	326	2.64%	1.70%	3.81%	4.51%
Palo Alto	406	2.27%	1.65%	4.25%	4.76%
Pocahontas	620	3.01%	1.75%	4.50%	5.50%
Sioux	567	1.83%	1.36%	3.41%	3.76%

Table 4: County Average of Marginal Percentage Certainty Equivalent Effects, Iowa CRD 10 Soybeans

County	Number of Farms	County Deep Loss	CRD Deep Loss	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Buena Vista	394	2.08%	1.67%	3.61%	3.90%
Cherokee	373	1.32%	1.30%	3.43%	3.47%
Clay	341	2.24%	1.69%	1.91%	5.32%
Dickinson	210	2.84%	1.88%	5.60%	6.39%
Emmet	228	2.84%	1.67%	4.16%	4.98%
Lyon	382	1.87%	1.55%	3.77%	3.99%
O Brien	379	1.59%	1.36%	3.56%	3.74%
Osceola	270	2.36%	1.62%	3.59%	4.11%
Palo Alto	302	2.52%	1.70%	4.88%	5.52%
Pocahontas	499	1.36%	1.24%	4.61%	4.77%
Sioux	417	1.89%	1.56%	3.45%	3.67%

Table 5: County Average of Marginal Percentage Certainty Equivalent Effects, Ohio CRD 10 Corn

County	Number of Farms	County Deep Loss	CRD Deep Loss	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Allen	56	3.38%	1.95%	6.73%	7.97%
Defiance	47	1.53%	0.97%	5.23%	5.62%
Fulton	36	0.88%	0.96%	3.58%	3.54%
Hancock	152	3.31%	1.69%	5.36%	6.63%
Henry	58	0.88%	1.04%	3.21%	3.09%
Paulding	36	1.91%	1.37%	7.68%	8.11%
Putnam	70	2.37%	1.45%	5.15%	5.86%
Van Wert	66	1.39%	1.13%	5.50%	5.70%
Williams	35	1.33%	1.11%	3.73%	3.85%
Wood	132	1.63%	1.22%	4.33%	4.61%

Table 6: County Average of Marginal Percentage Certainty Equivalent Effects, Ohio CRD 10 Soybeans

County	Number of Farms	County Deep Loss	CRD Deep Loss	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Allen	59	2.23%	1.92%	6.60%	6.84%
Defiance	86	3.40%	2.62%	8.35%	9.44%
Fulton	204	3.12%	1.85%	6.01%	6.96%
Hancock	77	1.66%	1.43%	4.52%	4.68%
Henry	102	3.44%	2.25%	9.42%	10.45%
Paulding	130	2.19%	1.91%	7.64%	7.90%
Putnam	109	1.50%	1.41%	5.10%	5.19%
Van Wert	45	1.86%	1.59%	5.96%	6.19%
Williams	191	2.92%	1.88%	6.88%	7.65%
Wood	59	2.23%	1.92%	6.60%	6.84%

Table 7: County Average of Marginal Percentage Certainty Equivalent Effects, Georgia CRD 70 Cotton

County	Number of Farms	County Deep Loss	CRD Deep Loss	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Decatur	24	8.92%	4.82%	5.06%	7.79%
Early	24	10.05%	6.28%	10.21%	13.22%
Grady	30	13.58%	5.79%	8.63%	15.30%
Miller	20	6.10%	4.25%	11.30%	13.16%
Mitchell	41	9.56%	6.24%	8.34%	10.73%
Seminole	16	7.72%	4.75%	7.69%	10.14%
Sumter	13	6.78%	4.53%	10.53%	11.06%
Terrell	16	8.35%	4.68%	11.87%	14.71%
Thomas	33	9.13%	5.72%	7.21%	9.48%

Table 8: County Average of Marginal Percentage Certainty Equivalent Effects, Mississippi CRD 40 Cotton

County	Number of Farms	County Deep Loss	CRD Deep Loss	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Humphreys	13	6.33%	5.87%	10.83%	11.14%
Leflore	32	5.62%	4.85%	5.23%	5.65%
Sharkey	16	6.77%	5.00%	6.87%	8.38%
Washington	13	6.85%	5.84%	8.75%	9.59%
Yazoo	15	5.82%	5.13%	6.60%	7.37%

Table 9: County Average of Marginal Percentage Certainty Equivalent Effects, Mississippi CRD 40 Soybeans

County	Number of Farms	County Deep Loss	CRD Deep Loss	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Humphreys	17	8.52%	5.34%	11.46%	13.82%
Issaquena	19	9.87%	5.83%	10.51%	13.68%
Leflore	31	4.03%	4.43%	10.73%	10.41%
Sharkey	23	7.31%	5.17%	9.34%	10.79%
Sunflower	53	4.38%	4.18%	8.92%	8.97%
Washington	52	4.16%	4.29%	9.37%	9.32%

Table 10: County Average of Marginal Percentage Certainty Equivalent Effects, Kansas CRD 30 Wheat

County	Number of Farms	County Deep Loss	CRD Deep Loss	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Clark	82	11.49%	8.84%	10.85%	13.08%
Finney	297	9.05%	8.63%	11.93%	12.26%
Ford	345	12.02%	9.68%	10.24%	12.16%
Gray	219	10.81%	10.06%	1.087%	11.33%
Hamilton	212	10.45%	7.75%	12.05%	14.29%
Haskell	153	8.78%	6.60%	11.80%	13.77%
Hodgeman	248	11.62%	8.90%	10.72%	13.09%
Kearny	207	8.20%	8.80%	14.20%	13.72%
Meade	125	11.97%	10.49%	10.97%	11.87%
Morton	110	12.55%	7.51%	9.71%	14.00%
Seward	98	11.34%	7.85%	8.72%	11.26%
Stanton	157	12.31%	8.74%	9.85%	12.72%

Table 11: Average Actuarially Fair Premium Rates for Wrapped Revenue Insurance

CRD/Crop	Wrapping Insurance around County Deep Loss	Wrapping Insurance around CRD Deep Loss
Iowa CRD 10 Corn	4.15%	4.33%
Iowa CRD 10 Soybeans	4.24%	4.37%
Ohio CRD 10 Corn	4.61%	4.75%
Ohio CRD 10 Soybeans	5.65%	5.81%
Mississippi CRD 40 Cotton	6.49%	6.69%
Mississippi CRD 40 Soybeans	6.33%	6.63%
Georgia CRD 70 Cotton	7.88%	8.75%
Kansas CRD 30 Wheat	10.09%	10.75%