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Evaluation of Risk Reductions Associated with Multi-Peril Crop Insurance Products

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Abstract

This study evaluates the impacts on gross revenue distributions of the use of alternative crop insurance products across different coverage levels and across locations with differing yield risks. Results are presented in terms of net costs, values-at-risk, and certainty equivalent returns associated with five types of multi-peril crop insurance across different coverage levels. Findings include that the group policies often result in average payments exceeding their premium costs. Individual revenue products reduce risk in the tails more than group policies but result in greater reductions in mean revenues. Rankings based on certainty equivalent returns and low frequency VaRs generally favor revenue products. As expected, crop insurance is associated with greater relative risk reduction in locations with greater underlying yield variability

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Evaluation of Risk Reductions Associated with Multi-Peril Crop Insurance Products

Since the early 1990s, there has been a rapid expansion in the availability of crop insurance alternatives available to farmers. New revenue products have been developed to complement traditional yield products, available coverage levels have been expanded, unit and practice options have been expanded, and new crops have been covered. During the same time, Federal subsidies to crop insurance products have increased, thereby lowering premiums that farmers pay for insurance products. These changes were made with the goal of improving the attractiveness of crop insurance to farmers. While reasonably high current participation rates provide an often cited measure of success, it is less clear how well the various crop insurance products have met the stated goal of improving crop revenue risk management by farmers.

Little direct evidence exists concerning the effects that crop insurance use has on crop revenue risk, and still less work examines the relative performance across alternative insurance products (e.g., types and coverage levels) and across different yield risk conditions. In response, this research evaluates the risk implications of a wide range of crop insurance products in actual farm contexts. Risk implications are analyzed by comparing gross revenue distributions without crop insurance to gross revenue distributions that result from the inclusion of different crop insurance products. The insurance products examined include both group and individual yield and revenue insurance products. Results are developed for each county in Illinois for a case farm raising corn. Extensive farm-level data from the Illinois Farm Business Farm Management (FBFM) record keeping system are used in conjunction with NASS county-level data to develop the case farms. Illinois counties differ substantially in terms of average and variability of yields. Therefore, this research design permits an assessment of how risk reductions differ by insurance product, coverage level, and underlying yield variability.

Past research has examined issues related to the use of farm-level versus county-level insurance products (Wang et al.), changes in marketing programs that result because of crop insurance use (Coble et al.), and the impacts of different risk criteria on crop insurance choice (Gloy and Baker). This study extends the literature by evaluating the impacts of crop insurance across the full set of existing products, thereby providing more comprehensive evidence of the risk impacts of crop insurance use.

Gross Revenue Distributions and Insurance Products

In order to compare the risk effects, gross revenue distributions that represent each crop insurance product at different coverage levels are needed. Gross revenue is composed of crop revenue, r_c, loan deficiency payments, r_{ldp}, crop insurance indemnity payments, $r_{i,j}$, and crop insurance premium costs, $c_{i,j}$, and can be expressed as:

$$g_{i,j} = r_c + r_{ldp} + r_{i,j} - c_{i,j} \quad (1)$$

where $g_{i,j}$ is gross revenue for the crop with insurance product i and coverage level j. Crop revenue, r_c, at harvest in turn is simply equal to cash price, p, times yield, y, or:

$$r_c = p \cdot y. \quad (2)$$

The cash price in each location at harvest is equal to the futures price at harvest less the local cash basis, or (f - b). Futures prices and yields are random variables. Local cash basis values vary across counties in the state, but are assumed to be known at the time crop insurance decisions are made.

The Loan Deficiency and Marketing Loan programs make payments when prices are below loan rates, thereby providing an important source of price stabilization, and potentially substituting for risk protection provided by crop insurance products. The impacts of these programs are incorporated into revenue distributions by including loan deficiency payments (LDPs) equal to the loan rate, p_{rate}, minus the cash price whenever the cash price is below the loan rate.[1] When they occur, LDP payments are received on all bushels produced. Hence, LDP revenue, r_{ldp}, equals:

$$r_{ldp} = y \cdot max(0, p_{rate} - p). \qquad (3)$$

Gross revenue distributions are evaluated for all five types of multi-peril insurance products available in Illinois. Three of these are farm-level products that make payments based on yields from a farm or unit. These products are 1) yield insurance (i.e. Actual Production History), 2) revenue insurance without a guarantee increase (Revenue Assurance with a base price option) and 3) revenue insurance with a guarantee increase (Crop Revenue Coverage). Alternative forms of the farm-level revenue insurance products exist (i.e., Income Protection can substitute for Revenue Assurance with the base price option and Revenue Assurance with the harvest price option can substitute for Crop Revenue Coverage). In each case, the product with the highest sales in 2000 and 2001 is evaluated.[2] In addition to the farm-level products, two county-level products with indemnification based on county yields are evaluated. The county-level, or group, products are: 1) yield insurance (Group Risk Plan) and 2) revenue insurance without a guarantee increase (Group Risk Income Plan). Each of these products and their associated indemnity functions are described more completely below.

Insurance Product Indemnity Functions

Actual Production History (APH) insurance. APH yield insurance makes payments when a farm yield falls below a guaranteed level. The guaranteed level equals a farmer-selected coverage level times the APH yield (usually based on a yield history from the farm unit). When yield falls below the guaranteed level, APH makes a payment equal to the yield shortfall times an indemnity price. Algebraically, indemnity payment from APH at coverage level j equals:

$$r_{aph,j} = p_{aph} \cdot max(0, y_{aph} \cdot c_{aph,j} - y) \qquad (4)$$

where p_{aph} equals the indemnity price, y_{aph} is the APH yield, and $c_{aph,j}$ identifies the coverage level. By increasing the coverage level, the range of yields over which the APH product makes payments expands, the amount of indemnity payment increases, and the product's premium cost increases.

Revenue Assurance with the base price option (RA-BP) insurance. RA-BP makes payments when indemnified crop revenue falls below a guaranteed level. The guaranteed level equals the farmer-selected coverage level times the APH yield times the RA base price. For corn, the base price is set equal to the average of the settlement prices of the December corn contract traded on the Chicago Board of Trade during the month of February. RA-BP makes payments when the yield times a harvest price falls below the guaranteed revenue. The harvest price is determined by the average of the settlement prices of the December CBOT corn contract during the month of November. For the simulations, the harvest price is assumed to be equal to the futures price at harvest, f. Indemnity payments from RA-BP therefore can be expressed as:

$$r_{ra,j} = max(0, p_b \cdot y_{aph} \cdot c_{ra,j} - f \cdot y) \quad (5)$$

where p_b is the base price and $c_{ra,j}$ identifies the coverage level. Increasing the coverage level under RA-BP is intended to improve risk reduction, but also increases premium costs.

Crop Revenue Coverage (CRC) insurance. CRC makes payments when indemnified crop revenue falls below a guaranteed revenue that depends on the relationship between the base price and harvest price.[3] The base price is used as the indemnification price when the harvest price is below the base price, the harvest price is used when the harvest price is above the base price but below an upper limit ($p_b + l$, where l is limit increase), and the upper limit is used when the harvest price is above the upper limit.[4] Algebraically, CRC's guaranteed revenue equals

$max(p_b, min(f, p_b + l)) \cdot y_{aph} \cdot c_{crc,j}$ and CRC's indemnity payment equals:

$$r_{crc,j} = max(0, max(p_b, min(f, p_b + l)) \cdot y_{aph} \cdot c_{crc,j} - f \cdot y \quad (6)$$

where $c_{crc,j}$ identifies the coverage level. The guarantee increase associated with CRC causes payments from CRC to differ from RA-BP when the harvest price is above the base price. CRC and RA-BP have the same indemnity payments when the base price is below the harvest price.

Group Risk Plan (GRP) insurance. GRP makes payments when county yield falls below a guaranteed yield that equals a farmer-selected coverage level times the expected county yield.[5] The indemnity payment for GRP equals:

$$r_{grp,j} = max(0, w_{grp} \cdot (y_{ec} \cdot c_{grp,j} - y_c) / (y_{ec} \cdot c_{grp,j})) \quad (7)$$

where w_{grp} is the dollar protection level, y_{ec} equals expected county yield, $c_{grp,j}$ identifies the coverage level, and y_c is the random county yield. The protection level is chosen by the farmer from a range allowed under the insurance contract. The expression $(y_{ec} \cdot c_{grp,j} - y_c) / (y_{ec} \cdot c_{grp,j})$ equals the percentage yield shortfall from the guarantee and is used to establish the indemnity payment.

GRP avoids many of the moral hazard and adverse selection problems associated with farm level products (Miranda). Avoiding these factors reduces GRP's costs relative to farm-level products. However, GRP may not result in as much risk reduction as APH because of the imperfect correlation between county yields and farm yields.

Group Risk Income Plan (GRIP) insurance. GRIP makes payments when county revenue falls below a guaranteed revenue equal to the coverage level times the base price (similar to that for RA-BP and CRC) times the expected county yield.[6] When county revenue is below the revenue guarantee, GRIP makes an indemnity payment, $r_{grip,j}$, equal to:

$$r_{grip,j} = max(0, w_{grip} \cdot (p_b \cdot y_{ec} \cdot c_{grip,j} - f \cdot y_c) / (p_b \cdot y_{ec} \cdot c_{grip,j})) \quad (8)$$

where w_{grip} is the protection level and $c_{grip,j}$ indicates the coverage level.

Simulation Parameters

Gross revenue distributions are simulated for each insurance product at different coverage levels. For APH, RA-BP, and CRC, coverage levels between 65 percent and 85 percent in five percentage increments are examined. For GRP and GRIP, distributions are generated for coverage levels from 70 percent to 90 percent in five percent increments. In addition, a gross revenue distribution is generated for the case with no crop insurance. Hence, a total of 26 gross revenue distributions are generated for each case farm – five distributions for each product and one distribution for the no-insurance case.

Random variables in the simulation model (futures prices, county yields, and farm yields), as well as other model parameters, represent Illinois conditions in 2002. Farm yield distributions and crop insurance premiums for each county's case farm represent a typical acre of corn for that county.

Prices. In keeping with previous research, the futures price distribution is parameterized as a lognormal distribution whose parameters are recovered using options market data. Futures and options data from the last trading day in February 2002 for the Chicago Board of Trade December corn futures contracts were used to estimate the parameters of the futures price distribution. Black-Scholes type procedures, generalized to use information from multiple options, were used to recover lognormal parameters. Specifically, parameters were found that minimized the summed squared errors between observed option prices and option prices implied by the fitted distribution. All put and call options that traded on February 28, 2002 with a volume greater than 10 were used. In total, options across 11 strikes with underlying volume of 4,979 were used in recovering the implied distribution (see Sherrick, Garcia, and Tiruppatur; or Fackler and King for more detail on the performance of the methods used).[7] The resulting distribution has an expected value of $2.32 per bushel and a standard deviation of $0.43 per bushel.

Local basis values were calculated using data provided by the Illinois Agricultural Marketing Service (AMS). AMS collects cash prices for each Thursday from elevators across Illinois and reports average cash prices for seven regions in Illinois. Closing futures prices on respective Thursdays for the December CBOT corn were subtracted from the cash prices to arrive at a local basis. An average basis for each of the seven regions was calculated using data during the month of November for 1999 through 2001. Local cash basis values across the counties vary from $0.28 per bushel to $0.34 per bushel.

Actual marketing loan rates for each county in Illinois as of February 28, 2002 were used. The loan rates range from $1.87 per bushel to $2.06 per bushel in Illinois counties, with an average of $1.94 per bushel.

Yield distributions. Previous research has identified numerous plausible parameterizations of farm-level crop yields including the beta (Nelson and Preckel), Weibull (Zanini, Pichon), gamma, lognormal, and numerous nonparametric models (Ker and Goodwin). Using farm-level data from over 1,700 farms with 20 or more years of data, Pichon conducts goodness-of-fit tests comparing the Weibull, gamma, beta, logistic, lognormal, and normal and concludes that the Weibull and conditional beta perform best. Likewise, using data from same-site observations over 20 or more years across 26 University of Illinois Trust Farms, Zanini concludes that the Weibull performs well relative to other alternatives. Hence, the Weibull distribution was selected to represent county and farm-level yield distributions.

Data for county-level corn yields from 1972-2002 were obtained from the National Agricultural Statistical Service (NASS). Each county's yield series was detrended using a linear model and stated in terms of 2002 yields for purposes of representing current conditions. The Weibull distributions were fit to the detrended series using method-of-moments estimation. The resulting expected values of the fitted county distributions range from a low of 97 bushels per acre to 167 bushels. Lower yields are concentrated in Southern Illinois, while Northern and

Central Illinois generally display higher yields. Yield variability also varies across the state, with standard deviations ranging from 15 bu. per acre to 26 bu. per acre.

The expected yield of each case farm was set equal to the expected yield of its county distribution. However, use of county-level yield distributions will understate the farm-level variability on individual farms. Thus, empirical evidence from 4,417 farms in the FBFM record keeping system with at least 12 years of data was used to rescale county yield standard deviations to reflect farm yields. To do so, each farm series in the FBFM database was detrended and fitted to a Weibull distribution. Then, for each farm, the ratio of farm standard deviation to county standard deviation was computed. An average ratio was calculated for each county. Counties with less than 10 farms were assigned the overall average ratio for the state. To recover the final parameters of the yield distribution for the case farm for each county, method of moments estimation was used subject to the constraint that their standard deviations equaled the county standard deviation times the average ratio of farm to county standard deviations.[8]

Correlations among random variables. Farm to county yield correlations were calculated using the same set of farm data as used to calibrate the farm yield distributions. The correlations were calculated between the detrended county and farm-level data series for all Illinois counties with at least 10 farms. The average correlation between farm and county level yield is 0.74 with a range from 0.52 to 0.85. The correlation between the futures price at harvest and yield also is calculated using prices at harvest by county and both county average yield and each set of farmer yield series. The correlations range from -0.36 to -0.69 across counties in Illinois. Higher correlations are congregated in central Illinois while lower correlations tend to occur in southern Illinois.

Insurance specifications. The simulated revenue distributions require 2002 per acre premium costs for each of the insurance products at each coverage level. A basic unit option is used to generate premiums for APH, RA-BP, and CRC products. APH yields used to generate premiums were set equal to the expected value for the farm yield. The resulting premiums were generated using the *iFARM* premium calculator (available at the *farmdoc* website at: www.farmdoc.uiuc.edu/cropins/index.html) and represent premiums farmers pay for insurance products after government subsidies have been subtracted. The calculated premiums agree with quotes from the online premium quote software available at RMA's website (www.rma.usda.gov) as well.

Other simulation input variables include the indemnity price for APH products (p_{aph}), which was set to the 2002 maximum allowable level of \$2.00. The indemnity price for generating revenue guarantees (p_b) equals \$2.32 for 2002, and the protection levels for GRP and GRIP are set at their maximum levels using data from RMA (www.rma.usda.gov).

Simulation Methods and Comparisons of Gross Revenue Distributions

Simulation of the gross revenue distributions for the case farm in each county requires the generation of correlated distributions of farm yields, futures prices, and county yields, where the yields are distributed as Weibull distributions, and the prices as lognormal. Because the distributions are continuous, numerical methods to generate a large number of sample points were used to represent the distributions, with empirical distribution functions of the sample points used to represent the underlying continuous distributions. To generate the set of correlated variables, inverse transformation methods were applied. Specifically, a set of three correlated uniform variates is passed through the inverse distribution functions for the farm yield, county yield, and price to generate sets of observations used in the gross revenue and insurance calculations. The set of correlated uniform variates for each county was generated using *Excel* and *Visual Basic for Applications* code by multiplying a 3 by 5000 matrix of normal variables by the Cholesky factorization of the covariance matrix for that location, and then transforming to the set of uniform variates by passing these now correlated normal variables through the inverse distribution function. The same seeds were used in generating the original normal variates to eliminate any differences across locations due to the simulation methods employed.

The resulting sets of observations were checked against the underlying relationships and found to be highly accurate, with simulated averages differing from their theoretical means by less than .001% on average, simulated standard deviations departing from the underlying theoretical standard deviations by less than .01% on average, and simulated correlations differing from specified values by less than 3% on average. Indemnity payments and gross revenues for each insurance product and each coverage level were generated for each coverage level by applying the gross revenue and indemnification rules describe earlier to each of the 5,000 simulated yield and price sets.

There are several approaches available to summarize and compare gross revenue distributions including use of expected values, values-at-risk (VaRs), probabilities below a benchmark return, Sharpe ratios, and stochastic dominance techniques (Gloy & Baker). In addition to these techniques, other studies have used willingness to pay (Wang et al.) and certainty equivalent returns (Hart and Babcock) to evaluate different risk management strategies. To provide as general a set of results as possible, three measures are used in this paper: 1) a measure of the expected value as stated by net cost, 2) a measure of risk as stated by VaRs, and 3) a measure of risk-return tradeoff as measured by certainty equivalent returns.

The net cost for a crop insurance product equals the expected value of gross revenue under no insurance minus the expected value of gross revenue with crop insurance. This measure gives the change in expected value of the gross revenue distribution from the inclusion of insurance. It also equals insurance premiums paid for the product minus the expected value of the indemnity payments.

More general impacts on the distribution are examined graphically using cumulative probability distributions. Particular attention is paid to the lower tails of the distribution to focus on risk reduction. Risks in the lower tail are quantified using VaRs at 5%, 10%, and 25% levels. The VaR at the 5% level, hereafter denoted as $VaR_{.05}$, is found using the cumulative distribution. It equals the revenue on the cumulative distribution associated with the .05 probability. Intuitively, the $VaR_{.05}$ represents a low probability event that happens, on average, once in twenty years; the $VaR_{.10}$ represents revenue associated with a once in ten year occurrence; and the $VaR_{.25}$ represents low revenues that occur with some regularity of, on average, once in four years.

To summarize the risk impacts of insurance, changes in the VaR values relative to the no-insurance case are provided. For example, the $VaR_{.05}$ change associated with an insurance product equals the $VaR_{.05}$ for that insurance product minus the $VaR_{.05}$ under the no-insurance case. A positive VaR change implies that the insurance product improved revenue at that point in the cumulative revenue distribution while a negative VaR change indicates that the insurance product lowers the VaR at the associated probability level.

Net costs provide a measure of the profitability impacts of crop insurance while VaR changes provide a measure of risk impacts. The choice of crop insurance products may be viewed in a context that evaluates risk-return tradeoffs so that a low cost-higher risk alternative can be compared to a higher cost-lower risk product. To evaluate risk-return tradeoffs, certainty equivalent returns (CERs) are calculated using a negative exponential utility function:

$$U = 1 - e^{-\lambda g} \tag{10}$$

where U is utility, λ is a risk parameter and g is gross revenue. For a particular λ, CERs are calculated for each gross revenue distribution by calculating the expected utility for each gross revenue distribution. The CER then equals the certain return that results in the same expected utility as the risky gross revenue distribution. The inverse of (10) is used to find the CER in each case. Gross revenue distributions then are ordered based on their CERs.

Methods outlined Babcock, Choi, and Feinerman are used to find the λs at which the CERs are calculated. In this study, a particular λ is found by first determining the expected value of the gross revenue distribution for the no insurance case (E_{ni}). This expected value is multiplied by $(1 - \theta)$ where θ is a risk premium percent. The variable θ can be interpreted as the fraction of the expected value that the individual would sacrifice to avoid risk. A numerical search routine is used to find the λ that causes the expected utility for the gross revenue distribution for the no insurance case to equal the utility from a certain return equal to

$E_{ni} \cdot (1 - \theta)$.

The above procedure is used to find λs for θs between two and ten percent in two percent increments. In addition, CERs are found for a θ equal to zero, in which case the CERs equal the expected value of the respective gross revenue distributions. A θ equal to zero represents the case of risk neutrality while higher values of θ represent higher levels of risk aversion. The ten percent level was selected based on a comparison of profits typical from corn production in Illinois. At a ten percent level, the dollar amount of the risk premium implied by θ approximately equals the profit from corn production.

Results for Logan County

Results are first presented for a single county in Illinois so that risk impacts of crop insurance can be fully described in the context of an actual case farm. Then, results are summarized across all Illinois counties. The case farm for Logan County is chosen for detailed presentation because it represents a fairly typical county in Illinois. The farm yield distribution for Logan County has an expected value of 158 bu. and a standard deviation of 28 bu. (see table 1), representing a case that is similar to the average of all Illinois case farms. Logan County's expected value and standard deviation of gross revenue without insurance respectively are $339 and $62 per acre, again similar to the average across all case farms.

Panel A of table 2 shows premiums that farmers in Logan County would have paid for insurance products in 2002, given that the APH yield is 158 bu. These premiums are net of subsidies paid by the Federal government. If these subsidies were not in place, the premiums in table 2 would be between 45 and 65 percent higher.[9] The premiums for different products range from $2.11 per acre for GRP at a 70% coverage level up to $17.54 per acre for CRC at an 85% coverage level, reflecting the substantial difference in costs that farmers can incur when using crop insurance. For a given coverage level, APH has the lowest cost of the farm-level products, followed by RA-BP, and CRC. At an 85% coverage level, for example, APH's premium is $10.53, RA-BP's is $12.03, and CRC's is $17.54. GRP and GRIP have lower premiums than farm-level products. At an 85% coverage level, GRP's premium is $5.89 and GRIP's premium is $7.82.

Actuarially fair (AF) insurance premiums given based on the estimates of yield, price, and resulting gross revenue distributions are shown in panel B of table 2. These AF premiums equal the expected value of the gross revenue without insurance minus the expected value with insurance. Overall, the AF premiums display the same patterns as do farmer paid insurance premium. AF premiums increase as the coverage levels increase, with premiums for APH moving from $.82 for the 65% coverage level, $2.59 for the 75% coverage level and $6.87 for the 85% coverage level. Similar to farmer paid premium, AF premiums at a given coverage level are higher for APH than RA-BP or CRC. For example, APH's AF premium is $6.87 at the 85% coverage level compared to $9.85 for RA-BP and $14.48 for CRC.

Net costs, equaling the AF premiums minus farmer paid premiums, measure the average impacts on profitability of insurance product use. Positive costs indicate that the expected value of gross revenue decreases with the use of the insurance product while negative costs mean that the expected value of gross revenue increases with use. As can be seen in panel C of table 2, all farm-level products have positive net costs that increase with coverage level. APH products, for example, have net costs of $1.34 at the 65% coverage level, $1.63 at the 75% coverage level, and $3.66 at the 85% coverage level.

Of particular interest is the $1.34 per acre net cost for APH at the 65% coverage level. In 2002, the Federal Crop Insurance Corporation calibrated the APH premiums at the 65% level with the intent that they were actuarially fair with net costs that should be zero. A potential explanation for the positive net costs lies in the samples used to determine yield distributions. The FCIC data set includes only farms that purchased crop insurance while this study is designed to reflect all farms whether or not they purchased crop insurance. One would expect a higher proportion of farms with higher than average yield variability to purchase yield insurance compared to farms with lower variability. Hence, the farms in the FCIC data set likely have higher yield variability compared to case farms representing the "typical" farm in each county. This explanation also is consistent with Goodwin's finding that farms with lower yield standard deviations purchased less crop insurance than farms with higher standard deviations.

While net costs are positive for all farm-level products, net costs for county-level products at higher coverage levels are negative. At a 90% coverage level, for example, GRP has net cost of -$4.20 and GRIP has net cost of -$5.22. These negative costs indicate that gross revenue increases with use of the county-level products at higher coverage levels – in other words the products pay back more on average than they cost

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Panel D of table 2 shows farmer-paid premiums as a percentage of AF premiums. The Risk Management Agency uses different rating methodologies to determine farmer-paid premiums for each of the products. The percentages in panel D shows the impacts of these different rating methodologies compared to the yield, price, and revenue distributions resulting from this study. APH insurance has the highest percentages compared to other products. At an 85% percent coverage level, the farmer paid premium is 153% of the AF premium. The next highest percent at the 85% level is 122% for RA-BP. These higher percentages imply that APH is a relatively costlier product for each dollar of premium paid by the farmer compared to the other products. Farm-level revenue products are less costly than APH, with RA-BP having slightly higher percentages than CRC. The county-level products typically have the lowest costs as percentages of their actuarially fair premiums.

Overall, premiums and costs in table 2 suggest that farm-level products are more costly than county-level products. Of the farm-level products, net costs are higher for APH than for the revenue products, particularly at high coverage levels. For the county-level products, net costs for GRP typically are slightly lower than net costs for GRIP.

Impacts of crop insurance on the entire revenue distribution can be examined using cumulative revenue distributions. Figure 1 shows cumulative revenue distributions for all insurance products at their maximum coverage levels. The cumulative distribution for the no-insurance case is also shown for comparison purposes. To focus on the more interesting parts of the distributions for insurance purposes, the range of the distributions displayed is restricted to revenues between \$240 and \$320 per acre. Several of the distributions have portions of their cumulative distributions below \$240. In the no-insurance case, for example, there is a .053 probability of having yields low enough to result in gross revenue below \$240 per acre. Likewise, all the products have possible gross revenues above \$320. However, the range presented from \$240 and \$320 range contains most of the intersections of the cumulative distribution functions, and presents the most meaningful information for comparing among products.

APH's cumulative distribution begins on the horizontal axis at \$251 of gross revenue (see figure 1), indicating that APH at the 85% coverage level effectively eliminates all probability of revenue below \$251. This result may be somewhat surprising because APH is a yield insurance that does not provide any protection for cases of low prices. The lower limit occurs because of the existence of the LDP program that provides a floor under prices at the loan rate. From the lower limit, APH's cumulative distribution rises and crosses the no-insurance distribution at a \$280 gross revenue with associated cumulative probability of .162. The crossing point indicates that APH has higher VaRs at probabilities less than .162 while the no-insurance case has higher VaRs at probabilities greater than .162.

RA-BP eliminates the lower tail of the gross revenue distribution, as illustrated by the lower limit of the cumulative distribution with the horizontal axis at gross revenue of \$260. RA-BP eliminates low revenues because of its revenue guarantee. This lower limit is \$9 higher than APH's intersection of \$251, indicating that RA-BP cuts off more of the tail risk than does APH. From the \$260 intersection, RA-BP rises and intersects the no-insurance cumulative distribution at \$290 of gross revenue with an associated probability of .20. As a result, RA-BP has higher VaRs than the no-insurance case at probability levels below .20 and lower VaRs at probability levels greater than .20. In the range shown in figure 1, RA-BP's cumulative distribution lies to the right of APH's cumulative distribution.

Similar to APH and RA-BP, CRC eliminates the lower tail of the gross revenue distribution. Its intersection with the horizontal axis occurs at \$255, between the lower boundaries for APH and RA-BP. Similar to the other farm-level products, the distribution function for CRC intersects the no-insurance case. This intersection occurs at \$298 of gross revenue with an associated probability of .242.

Overall, the impacts of the farm-level products on cumulative distributions are similar. All of the farm-level products effectively eliminate the extreme left tail of the gross revenue distribution as indicated by the intersections with the horizontal axis between \$251 and \$260 of revenue. Relative to the no-insurance case, the farm-level products effectively indemnify against very low revenues. At some probability level, however, all of the farm-level products cross the cumulative distribution for the no-insurance case, indicating that there are probability levels where the no-insurance case will have higher gross revenues than the cases with farm-level insurance. The crossings of the cumulative distributions of the farm-level products with the cumulative distributions of no insurance occur at probabilities less than .25.

In contrast to farm-level products, county-level products display different impacts on the cumulative gross revenue distributions. Figure 1 shows the cumulative distribution for GRIP at a 90% coverage level. GRP at its maximum coverage level is not shown because GRP's distribution is nearly identical to GRIP's distribution. The county-level products do not eliminate the lower tail of the cumulative distribution as effectively as the farm-level products. The cumulative distributions for both GRIP and GRP lie to the right of the no-insurance distribution for all revenues except at extremely low and extremely high revenues. Thus, GRIP and GRP have higher VaRs than the no-insurance case at most probability levels. In comparison to the farm-level products, county-level products provide less reduction in the probability of very low revenues; however, county level products provide higher VaRs at higher probability levels. As can be seen in figure 1, GRIP's cumulative distribution lies to the right of farm-level products at probabilities greater than .09.

The risk implications of the crop insurance products can be further observed in table 3. Panels A, B, and C respectively show VaR changes at 5%, 10%, and 25% levels. The definition of the $VaR_{.05}$ change is the $VaR_{.05}$ for the insurance product minus the $VaR_{.05}$ for the no-insurance case. The $VaR_{.05}$ changes for all insurance products are positive (see panel A), indicating that the cumulative distributions for the insurance products lie to the right of the no insurance distribution. At a 10% level (see Panel B), VaR changes are negative for low coverage levels, meaning that cumulative distributions associated with those products have intersected and lie to the left of the no-insurance distribution. By the 25% level (see panel C), all farm-level insurance products are negative indicating that the cumulative distributions for the farm-level insurance products lie to the left of the no-insurance distribution.

The above results indicate that there are important risk-return implications of crop insurance choices. Farm-level products have higher net costs than county-level products. However, farm-level products eliminate very low revenues and have higher VaR changes at low probabilities as compared to county-level products. For the farm-level products, net costs increase with coverage level increases. However, VaRs at low levels will be higher for higher coverage levels. Risk preferences obviously will influence product choice.

To further examine risk preference impacts, table 4 shows CERs generated using the negative exponential utility function. The first two columns labeled "0%" show the products and their corresponding CERs given a 0% risk premium percent. This case represents risk neutrality and the CERs equal the expected value of the gross revenue distribution for each insurance case. Higher risk aversion is represented by higher risk premiums. The columns labeled "2%" show results given that an individual would be willing to pay 2% of the $340 expected value of the no insurance gross revenue distribution, or $6.80 per acre, to receive a certain payment of $333.20 per acre rather than the risky no-insurance distribution. For each risk premium percentage, results are shown for all products at three different coverage levels (65, 75, and 85 percent for farm-level products and 70, 80, and 90 percent for county-level products).

Under risk neutrality (0% risk premium), products are ranked according to their net costs with products with lower net costs receiving a higher rank. GRIP at the 90% coverage level has the lowest net cost and hence is ranked the highest among the products under risk neutrality. As risk aversion increases, farm-level products increase in rank. For example, RA-BP at the 85 percent coverage level ranks below no insurance at 0% premium percent and ranks above no insurance at 2% premium percent. At a 10% risk premium percentage, CRC at the 85% coverage level has the highest CER. The results indicate that county-level products will be selected by individuals with lower risk aversion and farm-level products will be selected by individuals with higher risk aversion.

Summary Results for All Illinois Counties

The results averaged across all counties in Illinois display the same general relationships as those for the Logan County farm. Table 5 summarizes the state results for average farmer paid premiums, net costs, and VaR changes across all case farms. Similar to the Logan County case, farmer paid premiums increase for higher coverage levels. For a given coverage level, farmer paid premiums are higher for farm-level products and lower for county-level products (see panel A of table 5). Similar to the Logan County farm, net costs are higher for farm-level products and lower for county-level products (see panel B). Average net costs are positive for farm-level products, but can be negative at high coverage levels of the group products. Farmer paid premiums as a percentage of AF premiums are higher for APH, followed by the farm-level revenue products, followed by county-level products (panel C). For the farm-level products, all products have average $VaR_{.05}$ changes that are positive (panel D), $VaR_{.10}$ changes that are less than the $VaR_{.05}$ changes (panel E), and $VaR_{.25}$ changes that are negative (panel F), except at high coverage levels of the group products. These results indicate that the cumulative distributions for the farm-level insurance products cross the distributions for the no insurance case somewhere below the .25 probability level.

At 85% coverage levels for farm level products and 90% for county level products, RA-BP has the highest average $VaR_{.05}$ change ($23.45 (see panel D of table 5)) followed by CRC ($19.63), APH ($10.43), GRIP ($8.77), and GRP ($6.72). This sequence (RA-CRC-APH-GRIP-GRP) has the farm-level revenue products providing the most risk reduction when measured at the .05 probability level, followed by the farm-level yield insurance, and then by the county-level products. At their maximum coverage levels, county-level products have the lowest net costs (-$.99 for GRP and $.77 for GRIP (see panel C of table 3)), followed by RA-BP ($4.71), APH ($8.38) and CRC ($9.39).

The $VaR_{.05}$ change sequence of (RA-CRC-APH-GRIP-GRP) is remarkably consistent across the county case farms with 31% of the counties displaying the same sequence (see table 6). Farm-level revenue products usually provide the highest $VaR_{.05}$ changes, with 87 percent of the counties having RA-BP and CRC in the first two positions. Counties where this pattern does not occur are near metropolitan areas or in counties with small corn acreages. A county-level product provides the least increase in $VaRs_{.05}$ in 64% of the cases, with APH occupying the last position in the other 36% of the cases. Similarly, the net costs sequence of (GRIP-GRP-RA-APH-CRC) is remarkably consistent across the counties with 38 percent of the farms having an identical sequence (see table7). All counties have one of the county-level products as the lowest net costs with APH and CRC having the highest costs in all counties.

The CER results also are relatively stable across counties. This stability is illustrated in table 8 which show CERs for Dekalb county (a county with low yield variability), Logan County (average variability), and Livingston County (high variability). At a 0% risk premium, county-level products rank above farm-level products. At a 10% risk premium, farm-level products rank above county-level products. These results indicate that individuals with relatively low risk aversion will prefer county-level products while individuals with relatively high risk aversion will prefer farm-level products.

While sequences and CER results are relatively stable across counties, the degree of overall risk reductions offered by all products varies meaningfully across counties. For example,

$VaR_{.05}$ changes for RA-BP at the 85% coverage level range from \$5.46 to \$52.25. The correlation between $VaR_{.05}$ changes and county standard deviations of yields is .816. A graphical description of this relationship is shown in figure 2, which shows each county's standard deviation and $VaR_{.05}$ change for RA-BP at the 85% coverage level. As the standard deviation increases there is more yield variability, and hence more risk. As one would expect, crop insurance products reduce risk more in areas where there is greater risk to insure.

Net costs tend to be lower in areas where risk reductions from crop insurance are higher. A graphical presentation of this relationship is shown in figure 3, which plots the$VaR_{.05}$ changes and the net cost for RA-BP at an 85% coverage level. As can be seen net costs are lowest for case farms that high higher $VaR_{.05}$ changes. VaR changes then decrease as net costs increase.

Summary results across the case farms indicate that results for the vast majority of counties in Illinois are qualitatively the same as for the Logan County case farm. Relative performance of the products is similar across counties. Case farms differ across counties in the risk reductions offered by crop insurance. In areas of greater yield variability, risk reductions offered by crop insurance are higher than in areas where yield variability is low. Net costs are higher in areas with low yield variability as compared to areas where yield variability is high.

Summary and Conclusions

This research examines risk reductions possible for a wide range of crop insurance products. Data from Illinois FBFM and NASS have been used to develop a case for each county in Illinois representing an average acre of corn production in each county. For each county, gross revenue distributions have been developed for a no-insurance case and cases representing different insurance products. Simulated insurance products include farm-level products (APH, RA-BP, and CRC) and county-level products (GRP and GRIP) at a wide range of coverage levels. Risk reduction impacts of the insurance products are quantified using net costs, values-at-risk (VaRs), and certainty equivalent returns (CERs).

Use of farm-level revenue products result in revenue guarantees that effectively eliminate low revenues caused by low probability events. However, with LDP provisions, farm-level yield insurance also eliminates extremely low revenues. Farm-level products provide less revenue protection for events that occur with regularity, particularly in counties that have relatively low yield variability.

County-level products do not provide similar protection against catastrophic events. However, compared to farm-level products, county-level products have lower, and often negative, net costs. This result highlights the risk-return tradeoffs between county-level products and farm-level products. Farmers who are less risk averse and wish to increase returns may prefer county-level products to farm-level products. However, it is likely that the absence of absolute revenue guarantees offered by county-level products will be a continuing hindrance to their use.

The farm-level products involve a risk-return tradeoff because a farmer will incur positive costs to insure against low revenues. Other risk management strategies such as hedging, maintaining liquidity, and maintaining debt reserves may substitute for crop insurance, and at potentially lower costs. Studies evaluating these tradeoffs, most likely in a multi-period context, should be conducted.

This research shows that risk reductions possible with insurance depends on yield variability, with areas with higher yield variability experiencing greater risk reductions with the use of crop insurance. The relationships also suggest that areas with low variability may be disadvantaged as insurance products do not perform as well in a relative sense. This issue may be important given the Federal subsidizes involved with crop insurance. Further research should examine designs of crop insurance that provide the same relative risk protections in low yield variability areas as in high yield variability areas.

This research has a limited geographical scope and only examines one crop. Future research should extend the research presented here to other crops and other locations. In particular it would be useful to look at risk-returns beyond Illinois. While Illinois has a wide range of conditions, it would still be considered a high yielding, low variability area from a national perspective. Thus, it would be useful to see if the relationships between VaR changes and net costs hold in other areas of the U.S.

Endnotes

[1]Loan deficiency payments are actually based on posted county prices that may differ from cash prices. Posted county prices closely follow cash prices; hence, this assumption is reasonable.

[2]Sales information is available from the Risk Management Agency, U.S. Department of Agriculture (see http://www.rma.usda.gov/data/).

[3]There is a difference in the way harvest prices are calculated for CRC and RA-BP. For CRC, settlement prices of the December Chicago Board of Trade contract during the month of October are averaged to determine the harvest price while RA averages settlement prices during November.

[4]Limits are $1.50 per bu. for corn and $3.00 for soybeans.

[5]The Federal Crop Insurance Corporation determines the expected yield for each county based on a trend-line evaluation of previous yields from that county.

[6]RA and CRC determine there base price averages settlement prices for the December Chicago Board of Trade contract for the entire month of February. GRIP averages settlement prices from the last five business days in February.

[7]In specific, equation (7) of Sherrick, Garcia, and Tiruppatur is used to determine the parameters of the futures price distribution.

[8]Complete descriptions of the farm-level and county-level statistics are available on request from the authors.

[9]Subsidy information is available from the Risk Management Agency, U.S. Department of Agriculture (see http://www.rma.usda.gov/data/).

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Table 1. Yield and Gross Revenue Distributions for Logan County, Illinois, 2002.

Farm yield distribution	
Expected value	158 bu. per acre
Standard deviation	28 bu. per acre
$VaR_{.05}$[1]	108 bu. per acre
$VaR_{.10}$[1]	120 bu. per acre
$VaR_{.25}$[1]	135 bu. per acre
County yield distribution	
Expected value	158 bu. per acre
Standard deviation	23 bu. per acre
$VaR_{.05}$[1]	118 bu. per acre
$VaR_{.10}$[1]	128 bu. per acre
$VaR_{.25}$[1]	144 bu. per acre
Gross revenue without insurance	
Expected value	\$339 per acre
Standard deviation	\$62 per acre
$VaR_{.05}$[1]	\$238 per acre
$VaR_{.10}$[1]	\$262 per acre
$VaR_{.25}$[1]	\$302 per acre

[1] VaR_{xx} is value-at-risk at the xx percent.

Table 2. Crop Insurance Attributes for Logan County, Illinois, 2002.[1]

Coverage Level	APH	RA-BP	CRC	GRP	GRIP
Panel A. Farmer Paid Insurance Premiums ($ per acre)[2]					
65%	2.16	2.22	3.65		
70%	2.83	3.30	4.77	2.11	1.88
75%	4.22	5.07	7.07	2.87	3.00
80%	6.60	7.82	11.01	4.58	5.24
85%	10.53	12.03	17.54	5.89	7.82
90%				8.62	12.43
Panel B. Actuarially Fair Insurance Premiums ($ per acre)[3]					
65%	0.82	0.94	1.62		
70%	1.48	1.90	3.09	1.56	1.03
75%	2.59	3.50	5.47	2.80	2.57
80%	4.31	6.05	9.12	4.84	5.54
85%	6.87	9.85	14.48	8.03	10.47
90%				12.82	17.65
Panel C. Net Costs ($ per acre)[4]					
65%	1.34	1.28	2.03		
70%	1.35	1.40	1.68	0.55	0.85
75%	1.63	1.57	1.60	0.07	0.43
80%	2.29	1.77	1.89	-0.26	-0.30
85%	3.66	2.18	3.06	-2.14	-2.65
90%				-4.20	-5.22
Panel D. Farmer Paid Premiums as Percentages of Actuarially Fair Premiums					
65%	263%	235%	225%		
70%	191%	174%	155%	136%	183%
75%	163%	145%	129%	102%	117%
80%	153%	129%	121%	95%	95%
85%	153%	122%	121%	73%	75%
90%				67%	70%

[1] APH is Actual Production History, RA-BP is Revenue Assurance with the base price option, CRC is Crop Revenue Coverage, GRP is Group Risk Plan, and GRIP is Group Risk Income Plan.

[2] Farmer paid premiums for 2002. These premiums are net of Federal subsidies.

[3] Estimated payments from insurance policies.

[4] Actuarially fair premiums minus farmer paid premiums.

Table 3. Insurance Impacts on Risk, Logan County, Illinois Farm.[1]

Coverage Level	APH	RA-BP	CRC	GRP	GRIP
Panel A. $VaR_{.05}$ Change ($ per acre)[2]					
65%	$1.59	$2.17	$4.31		
70%	$3.94	$5.08	$9.98	$1.86	$1.95
75%	$7.54	$10.43	$17.24	$2.78	$4.02
80%	$11.55	$20.19	$24.18	$4.36	$6.53
85%	$15.25	$30.00	$29.50	$7.26	$10.13
90%				$11.17	$16.29
Panel B. $VaR_{.10}$ Change ($ per acre)[3]					
65%	-$1.49	-$1.52	-$0.60		
70%	$0.03	$0.34	$3.09	$0.02	-$0.14
75%	$2.03	$2.85	$7.93	$1.51	$2.38
80%	$4.04	$6.59	$11.61	$2.95	$4.87
85%	$5.86	$11.48	$11.61	$5.86	$8.40
90%				$8.24	$11.77
Panel C. $VaR_{.25}$ Change ($ per acre)[4]					
65%	-$1.82	-$2.17	-$3.04		
70%	-$2.24	-$2.62	-$3.07	-$0.98	-$1.00
75%	-$2.93	-$2.97	-$2.54	-$0.74	-$0.52
80%	-$3.70	-$2.97	-$1.59	-$0.77	$0.47
85%	-$4.25	-$2.59	-$1.29	$0.70	$3.06
90%				$1.85	$4.60

[1] APH is Actual Production History, RA-BP is Revenue Assurance with the base price option, CRC is Crop Revenue Coverage, GRP is Group Risk Plan, and GRIP is Group Risk Income Plan.

[2] Equals 5% VaR with insurance product minus 5% VaR with no insurance. The 5% VaR with no insurance equals $238.

[3] Equals 10% VaR with insurance product minus 10% VaR with no insurance. The 10% VAR with no insurance equals $262.

[4] Equals 25% VaR with insurance product minus 25% VaR with no insurance. The 25% VaR with no insurance equals $302.

Table 4. Certainty Equivalence Results for Logan County, Illinois, 2002[1]

Risk Percent[1]											
0%		2%		4%		6%		8%		10%	
Product[2]	CER[3]	Product[2]	CER[3]	Product[2]	CER[3]	Product[2]	CER[3]	Product[2]	CER[3]	Product[2]	CER[3]
	($/acre)		($/acre)		($/acre)		($/acre)		($/acre)		($/acre)
GRIP-90	345	GRIP-90	339	GRIP-90	333	GRIP-90	327	RAHp-85	323	RAHp-85	320
GRP-90	344	GRP-90	337	GRP-90	331	RAHp-85	326	GRIP-90	322	RABp-85	319
GRIP-80	340	RAHp-85	334	RAHp-85	330	RABp-85	325	RABp-85	322	GRIP-90	316
GRP-80	340	GRIP-80	334	RABp-85	329	GRP-90	325	RAHp-75	319	RAHp-75	315
None	340	GRP-80	333	RAHp-75	328	RAHp-75	323	GRP-90	319	APH-85	315
GRP-70	339	RABp-85	333	GRIP-80	328	RABp-75	322	APH-85	318	RABp-75	314
GRIP-70	339	RAHp-75	333	RABp-75	327	APH-85	322	RABp-75	318	GRP-90	314
RABp-65	338	None	333	GRP-80	327	GRIP-80	322	APH-75	316	APH-75	312
APH-65	338	RABp-75	332	APH-75	327	APH-75	321	GRIP-80	316	RAHp-65	310
RAHp-75	338	GRP-70	332	APH-85	326	GRP-80	321	RAHp-65	315	GRIP-80	310
RAHp-85	338	GRIP-70	332	RAHp-65	326	RAHp-65	320	GRP-80	315	RABp-65	309
RABp-75	338	APH-75	332	None	326	RABp-65	320	RABp-65	314	GRP-80	309
RAHp-65	338	RABp-65	332	RABp-65	326	APH-65	320	APH-65	314	APH-65	309
APH-75	338	APH-65	332	GRP-70	326	GRP-70	319	GRP-70	313	GRP-70	306
RABp-85	337	RAHp-65	332	APH-65	326	None	319	GRIP-70	313	GRIP-70	306
APH-85	336	APH-85	331	GRIP-70	326	GRIP-70	319	None	312	None	306

[1] Risk percents represent risk aversion where 0% is risk neutral and higher percentages represent higher levels of risk aversion.

[2] Letters denote product and numbers denote coverage level. APH is Actual Production History, RABp is Revenue Assurance with with the base price option, RAHp is Revenue Assurance with the harvest price option, GRP is Group Risk Plan, and GRIP is Group Risk Income Plan.

[3] Certainty equivalence returns.

Table 5. Insurance Statistic Averages for Case Farms in all Illinois Counties.[1]

Coverage Level	APH	RA-BP	CRC	GRP	GRIP
Panel A. Farmer Paid Insurance Premium ($ per acre).					
65%	3.01	3.28	4.67		
70%	3.94	4.38	6.12	1.97	1.82
75%	5.86	6.24	9.07	2.65	2.77
80%	9.18	9.14	14.13	4.08	4.83
85%	14.65	13.54	22.41	5.48	7.18
90%				8.09	11.28
Panel B. Net Costs ($ per acre).					
65%	2.15	2.32	3.03		
70%	2.37	2.55	3.15	0.73	1.06
75%	3.37	2.96	4.00	0.50	1.00
80%	5.16	3.62	5.86	0.51	1.11
85%	8.38	4.71	9.49	-0.28	0.14
90%				-0.97	-0.77
Panel C. Farmer Paid Premium as a Percent of Actuarially Fair Premium.					
65%	348%	342%	285%		
70%	251%	238%	206%	158%	238%
75%	235%	190%	179%	123%	157%
80%	228%	166%	171%	114%	130%
85%	234%	153%	173%	95%	102%
90%				89%	94%
Panel D. $VaR_{.05}$ Change ($ per acre).[2]					
65%	-3.72	1.02	3.25		
70%	3.18	4.12	7.97	1.03	0.95
75%	5.38	9.32	13.16	1.78	2.28
80%	7.70	16.21	17.62	2.59	3.59
85%	10.43	23.45	19.63	4.47	5.92
90%				6.72	8.77
Panel E. $VaR_{.10}$ Change ($ per acre).[3]					
65%	-4.00	-1.68	-0.70		
70%	-0.40	-0.23	2.22	0.45	0.04
75%	0.88	2.09	5.20	1.21	1.15
80%	1.58	5.12	7.13	1.94	2.63
85%	0.87	8.72	7.40	3.57	4.78
90%				4.90	6.70
Panel F. $VAR_{.25}$ Change ($ per acre).[4]					
65%	-5.33	-3.10	-3.83		
70%	-3.19	-3.53	-3.95	-0.78	-1.03
75%	-4.25	-4.04	-4.36	-0.66	-0.81
80%	-5.85	-4.43	-5.15	-0.80	-0.77
85%	-8.47	-4.94	-7.33	-0.31	0.32
90%				-0.19	1.02

[1] APH is Actual Production History, RA-BP is Revenue Assurance with the base price option, CRC is Crop Revenue Coverage, GRP is Group Risk Plan, and GRIP is Group Risk Income Plan.

[2] Equals 5% VaR with insurance product minus 5% VaR with no insurance. The 5% VaR with no insurance equals $238.

[3] Equals 10% VaR with insurance product minus 10% VaR with no insurance. The 10% VAR with no insurance equals $262.

[4] Equals 25% VaR with insurance product minus 25% VaR with no insurance. The 25% VaR with no insurance equals $302.

Table 6. Ranking of Insurance Products By 5% VaR Across Illinois Counties, 2002.[1]

Order[2]	Percent of Counties
RA-CRC-APH-GRIP-GRP	31
RA-CRC-GRIP-GRP-APH	18
RA-CRC-APH-GRP-GRIP	16
RA-CRC-PRIP-APH-GRP	11
CRC-RA-APH-GRIP-GRP	5
CRC-RA-GRIP-GRP-APH	4
RA-GRIP-CRC-GRP-APH	3
CRC-RA-GRIP-APH-GRP	2
GRIP-RA-GRP-CRC-APH	1
RA-CRC-GRP-GRIP-APH	1

[1]Rankings are for policies at the maximum coverage level.

[2]An order of RA-CRC-APH-GRIP-GRP, for example means that the RA policy has the highest VAR, followed by CRC, etc.

Table 7. Ranking of Insurance Products By Net Costs Across Illinois Counties, 2002.[1]

Order[2]	Percent of Counties
GRIP-GRP-RA-APH-CRC	38
GRP-GRIP-RA-APH-CRC	35
GRIP-GRP-RA-CRC-APH	12
GRP-GRIP-RA-CRC-APH	9
GRP-RA-GRIP-APH-CRC	5
GRP-GRIP-CRC-RA-APH	1

[1]Rankings are for policies at the maximum coverage level.

[2]An order of GRIP-GRP-RA-APH-CRC, for example, means that the GRIP policy has the lowest net cost, followed by GRP, etc.

Table 8. Certainty Equivalence Results for Dekalb, Logan, and Livingston Counties, Illinois, 2002.[1]

0% Risk Premium						10% Risk Premium					
Dekalb		Logan		Livingston		Dekalb		Logan		Livingston	
Product[1]	CER[2] ($/acre)	Product[1]	CER[2] ($/acre)	Product[1]	CER[2] ($/acre)	Product[1]	CER[2] ($/acre)	Product[1]	CER[2] ($/acre)	Product[1]	CER[2] ($/acre)
GRIP-90	323	GRIP-90	345	GRP-90	297	RABp-85	296.7	RABpHp-85	320	RAHp-85	280
none	322	GRP-90	344	GRIP-90	296	RAHp-85	294	RABpBp-85	319	RABp-85	277
GRIP-80	322	GRIP-80	340	RAHp-85	293	RABp-75	293.4	GRIP-90	316	RAHp-75	275
GRIP-70	321	GRP-80	340	GRP-80	292	RAHp-75	293.4	RABpHp-75	315	APH-85	274
GRP-80	321	None	340	RAHp-75	292	GRIP-90	292.8	APH-85	315	GRIP-90	273
GRP-70	321	GRP-70	339	RABp-85	291	APH-85	291.4	RABpBp-75	314	GRP-90	273
GRP-90	321	GRIP-70	339	GRIP-80	291	APH-75	291.3	GRP-90	314	RABp-75	272
RABp-65	320	RABpBp-65	338	RABp-75	290	GRP-90	291	APH-75	312	APH-75	271
APH-65	320	APH-65	338	APH-75	290	RAHp-65	290.6	RABpHp-65	310	RAHp-65	269
RAHp-65	319	RABpHp-75	338	GRP-70	290	RABp-65	290.5	GRIP-80	310	GRP-80	267
RABp-75	319	RABpHp-85	338	RAHp-65	290	GRIP-80	290.5	RABpBp-65	309	GRIP-80	267
APH-75	319	RABpBp-75	338	APH-85	289	APH-65	290.1	GRP-80	309	RABp-65	266
RAHp-75	318	RABpHp-65	338	APH-65	289	none	289.9	APH-65	309	APH-65	266
RABp-85	317	APH-75	338	RABp-65	289	GRP-80	289.9	GRP-70	306	GRP-70	263
APH-85	314	RABpBp-85	337	none	289	GRIP-70	289.4	GRIP-70	306	GRIP-70	263
RAHp-85	314	APH-85	336	GRIP-70	288	GRP-70	289.3	None	306	none	260

[1] Letters denote product and numbers denote coverage level. APH is Actual Production History, RABp is Revenue Assurance with the base price option, RAHp is Revenue Assurance with the harvest price opiton, GRP is Group Risk Plan, and GRIP is Group Risk Income Plan.

[2] Certainty equivalence return.

Figure 1. Cumulative Probability Distribution, Logan County, Illinois, 2001

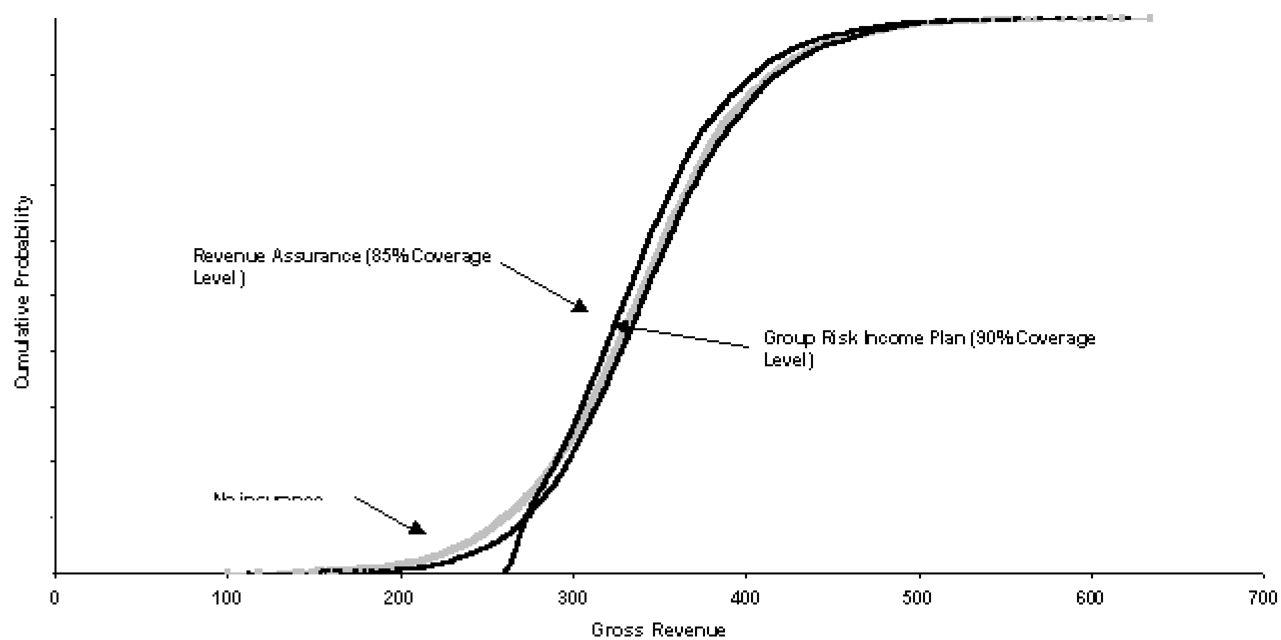

Figure 2. Relationship between 5% VAR Change on Revenue Assurance and County Yield Standard Deviation, Illinois Counties, 2002.

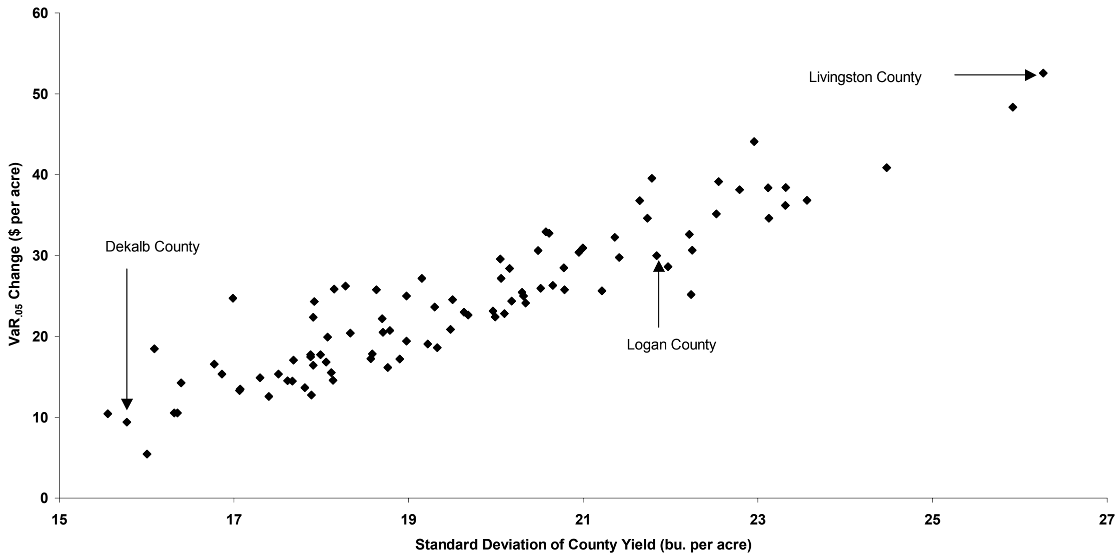

Figure 3. Relationship between Net Costs and 5% VARs for Revenue Assurance, Illinois Counties, 2002.