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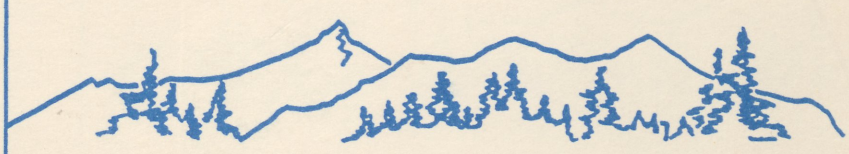

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Comparative Performance of Individual and Area Measured Crop Insurance Programs

Gordon L. Carriker Kansas State Univ.
Jeffery R. Williams Kansas State Univ.
G. Art Barnaby, Jr. Kansas State Univ.

ABSTRACT

This study compares the effectiveness of two area yield insurance programs to an individual farm yield insurance plan, similar to the current FCIC multi-peril program with alternative coverage levels. Results indicate that the individual crop insurance program provides more than twice the average reduction in gross return variability as the area programs with equivalent total expenditures for indemnity payments.

BACKGROUND AND JUSTIFICATION

Recently the expense and divergence of opinion about the usefulness of the current Federal Crop Insurance Corporation (FCIC) crop insurance program has intensified the discussion of alternatives. Adverse selection and moral hazard are significant problems which contribute to the high cost of the current crop insurance program. Adverse selection occurs when farmers with higher relative yield risk can buy insurance at the same cost as farmers who have lower relative yield risk when yield guarantees are based on the expected individual farm yield (Skees and Reed). If farmers recognize this, over time the insurance program will attract a larger group with relatively high yield risks, thereby causing insurance rates to increase and compounding the adverse selection problem. If rates are not increased, under the pretense of increasing participation, this could create a situation in which indemnity payments increase relative to premiums. In fact, indemnities paid to farmers in the 1980-1988 period exceeded the premiums collected by 56% (GAO). Moral hazard occurs when farmers have incentive to alter production or harvest practices to increase the chance of collecting crop insurance. This can happen when indemnity payments are based on farm-specific measured yield losses and the market price is less than the price election used to calculate the indemnity payment. Area measured crop insurance eliminates moral hazard and reduces adverse selection problems.

Halcrow proposed an alternative to all-risk crop insurance in 1949 which is based on an expected area yield and deviations from that yield rather than the expected farm yield and deviations therefrom. In his plan, the premiums and indemnities are based on yields received in an area of uniform crop production such as a county. Indemnities are paid in bushels to any insured producer in those years in which the area average yield falls below the guaranteed area yield level (the historical mean of the area average yield or a percentage thereof). All participating farmers receive the same per-acre indemnity and pay the same premium rate based on the historical area yield data. Barnaby proposes a less restrictive alternative which uses an area percentage measure and a liability based on a farm's ASCS program yield.

Under the area-yield (Halcrow) or "area-hedge" (Barnaby) approach, the adverse selection and moral hazard inherent in the current crop insurance program are greatly reduced. In the current FCIC program, insurance premiums are based on the insured pool of farmers. The pool has tended, over time, to attract more farmers who have higher yield variability and fewer farmers with lower yield variability causing insurance rates to increase, exacerbating the adverse selection problem. By contrast, the area plan pays an idemnity to each producer

based on a uniform average area yield loss with no individual loss adjustment; the area yield loss measurement includes both insured and uninsured farmers, thus reducing adverse selection. The probability of collecting an indemnity is the same for all insured farmers in the area, although the "effective" cost and coverage vary. Moral hazard is prevented because an individual farmer cannot influence the indemnity by altering production and/or harvest practices.

Although the use of crop insurance as a risk management tool has been widely examined, most current studies have examined crop insurance and government program designs that are either currently in place or existed in the late 1970's and early 1980's. To date, little analysis has been performed to determine the effectiveness of an area-yield measurement plan. Miranda recently completed a preliminary analysis of Halcrow's alternative using farm level data for 102 Western Kentucky soybean farms. By comparing the reduction in the variance of insured and uninsured yield distributions, without crop prices or deficiency payments, he concludes that an area-yield measurement is capable of providing effective yield-loss coverage. Carriker et al. compare individual farm-yield insurance similar to the current federal multi-peril program and an area-yield insurance design similar to Halcrow's. They conclude that although individual farm-level insurance is complex and suffers from moral hazard and adverse selection problems, it provides more farm income risk reduction than an area design for wheat producers.

The objective of this study is to extend previous work and compare the effectiveness of an individual yield insurance plan with alternative coverage levels, like the current Federal Crop Insurance Corporation (FCIC) program, to the area-yield methods proposed by Halcrow and Barnaby. These plans are examined for reduction in gross income variability using farm-level yield data from 98 dryland wheat farms in southcentral Kansas. Gross return distributions, for each design, estimated for each farm with government deficiency payments are also compared using second-degree stochastic dominance.

PROCEDURES AND DATA

This section contains a discussion of the alternative programs examined as well as a brief description of the procedures and data. The alternative programs considered are:

1. Government Commodity Program Without Insurance - NC;
2. Area Multiple Peril Crop Insurance with an Area Liability Level - AIA;
3. Area Multiple Peril Crop Insurance with a Farm Liability Level - AIP; and
4. Individual Farm Multiple Peril Crop Insurance - FI.

To evaluate the alternative crop insurance programs gross return distributions for each program are estimated and compared. These comparisons are made using distributions derived from the insurance designs described by equations [1] and [2]. The coefficients of variation (C.V.) for gross returns are calculated for each of 98 southcentral Kansas dryland wheat farms for each insurance program and compared to the gross return C.V.s for the government program strategy with no insurance. The reduction in relative variability is also the percent difference between the standard deviations for the insurance program and no insurance because of the use of actuarially fair premiums. Second degree stochastic dominance analysis is also used to select the preferred program. This is a particularly useful technique for selecting preferred management strategies when gross return distributions are altered by insurance premiums and indemnity payments. Gross returns are defined as the total of crop

sales, government deficiency payments and indemnity payments less insurance premiums. The yield data used to estimate gross returns is historical yield data for each of the 98 farms from 1973-1987. The mean area yields used in the analysis and annual deviations from the area averages are the weighted average NASS county yields from planted acres for the 15-year period. Market prices for southcentral Kansas for the period 1973 to 1987 are converted to 1988 dollars using the USDA index of prices received by farmers. Deficiency payments are based upon the provisions of the 1985 Food Security Act for the 1988 crop year. Actuarially fair premiums are used in all of the insurance programs examined. Actuarial fairness means that total premiums equal total indemnities for the actuarial period. The target price is used as the price election for crop insurance indemnity payments in the area and individual measurement designs. The deductible is initially set at 0% (100% coverage) in both the area-yield and individual farm-yield insurance programs. Further analysis which examines the effectiveness of the insurance programs under equivalent expenditures uses higher deductible (lower coverage) levels.

Individual Farm-Yield Insurance

Under current FCIC procedures, each farm has an insurance yield based on historical farm-level yields. The farm is reimbursed for any yield loss below the guaranteed yield (the insurance yield) less an adjustment for the deductible level selected by the producer. Under this plan, gross returns (net of the insurance premium) per acre are described as

$$[1] \quad GR_F = [max(P,EL) * Y_F] + \max(\{[TP - max(EP,EL)] * Y_P,0\}) - CIP + INDEM ,$$

where: GR_F = gross returns to the farm enterprise ($/acre);
P = market price ($/bu);
EL = effective national average loan rate ($/bu);
Y_F = actual farm yield produced on planted acres (bu/acre);
TP = target price ($/bu);
EP = expected national average price ($/bu);
Y_P = commodity program yield based on 1980-1984 farm yields (bu/acre);
CIP = the actuarially fair crop insurance premium ($/acre);
$INDEM = max\{0, IP * [(HY_F * LC) - Y_F]\}$; indemnity payment ($/acre);
IP = indemnity price election (the per bushel price at which the yield is insured) ($/bu);
HY_F = historical average farm yield from planted acres; the insurance yield (bu/acre); and
LC = 1 - % deductible.

Gross returns without insurance are calculated by dropping the CIP and INDEM variables from equation [1].

Area-Yield Insurance

Halcrow's alternative to individual all-risk crop insurance bases the premiums and indemnities on yields received in an area of uniform crop production. Indemnities are paid in bushels to any insured producer in those years in which the area average yield falls below the guaranteed area yield level (the historical mean of the area average yield or a percentage thereof). All

participating farmers receive the same per-acre indemnity and pay the same premium rate based on the historical area yield data.

The area percentage method used in this study, which is less restrictive than Halcrow's plan, allows the liability and consequently the premium to be based on an area yield or the ASCS farm program yield by farm. Equation [2] would replace INDEM in Equation [1]; the remainder of Equation [1] is unaffected.

$$[2] \quad INDEM = max\{0, LIAB * [((HY_A - Y_A)/HY_A) - (1 - LC)]\} ,$$

where: LIAB = total potential liability ($/Acre)
HY_A = historical average area yield; insurance yield (bu/acre); and
Y_A = actual area average yield produced on planted acres (bu/acre).

Two levels of liability are examined in the analysis. A strict interpretation of Halcrow's method requires that total liability equal the value of the historical area yield ($LIAB = IP * HY_A$). An alternative, suggested by Barnaby is to allow the liability to be based on each individual farm's expected ASCS commodity program yield ($LIAB = IP * Y_P$).

RESULTS

The reduction in relative variability in the gross return distributions under the insurance programs relative to those without insurance, as measured by the percent reduction in the coefficients of variation, are presented in table 1. The individual farm-yield insurance plan with a 0% deductible or 100% coverage level (FI-0.00) is the most effective at reducing relative income variability. Relative income variability is reduced between 15.5% and 55.7% with an average reduction of 36.9% for the 98 wheat farms. The area plans have a substantially smaller average percent reduction. The area-yield insurance program with total liability based on the weighted NASS county average yield (AIA) is 13% and the area-yield insurance program with total liability based on the each farm's ASCS commodity program yield (AIP) is 13.4%. The range is greater for the area yield designs because the AIA design increases gross return variability on 7 farms and AIP design increases it on 11 farms.

Table 2 provides a summary of the total expenditures for indemnity payments under the alternative strategies for all 98 farms. Total expenditures for indemnity payments is the largest under the individual crop insurance program with a 0% deductible (FI-0.00). The individual crop insurance program with a 10% deductible has the smallest total expenditure for indemnities. An individual crop insurance program with a 5.75% deductible (FI-5.75) has approximately the same total expenditure as the area crop insurance program with a 0% deductible and a liability based upon the area average county yield (AIA). The individual crop insurance program with a 2.85% deductible (FI-2.85) has approximately the same total expenditure as the area crop insurance program with a 0% deductible and a liability based upon the individual farm's program yield (AIP). The results in table 1 and table 2 indicate that the individual crop insurance program has more than twice the average reduction in gross return variability as the area programs with equivalent total expenditures for indemnity payments.

Results of the second-degree stochastic dominance analysis are reported in table 3. The numbers in the table indicate how many times a program is dominated by another program. For example the AIA program is dominated on 65 of the 98 wheat farms by another program, when all programs (set #1) are included. The least dominated strategy is then removed from the set of programs compared and the stochastic dominance analysis is repeated (sets #2 through #7). Table 3

indicates that the individual insurance program with any of the deductible levels are preferred to either of the area insurance programs and the government program alone.

DISCUSSION AND CONCLUSIONS

Although an individual farm yield insurance plan like the current FCIC program suffers from moral hazard and adverse selection problems it provides more reduction in gross return variability than the area measured programs given an equivalent level of expenditures for indemnity payments. However, the area-based policies should be less costly to administer than the present crop insurance program, because they would not require individual farm yield loss adjustment and would prevent moral hazard problems from occurring. The area plans could also eliminate the need for price forecasting to determine premiums, an issue that FCIC presently faces, and would allow implementation procedures similar those for private hail insurance with which the insurance industry is already acquainted. Each farm manager would determine the amount of liability and deductible level, thereby eliminating the need for the insurer to price forecast and also the costly practice of maintaining farm level yield records. Further analysis which takes into consideration administrative costs, implementation requirements and overall cost effectiveness of the alternative programs would be useful.

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Table 1. Frequency of Relative Reduction in Gross Return Variability for 98 Southcentral Kansas Farm Management Association Dryland Wheat Farms, by Crop Insurance Program, 1973 to 1987.[a]

Percent Reduction in Variability	Comparison[b]						
	AIA	AIP	FI-0.00	FI-2.85	FI-5.00	FI-5.75	FI-10.00
-30 to -26	.	1	.	.	.	.	.
-25 to -21	.	.	.	.	.	.	.
-20 to -16	1	.	.	.	.	.	.
-15 to -11	.	2	.	.	.	.	.
-10 to -6	4	3	.	.	.	.	.
-5 to 0	2	5	.	.	.	.	.
0 to 5	13	15	.	.	.	.	2
6 to 10	17	13	.	.	1	1	7
11 to 15	21	18	.	2	5	6	12
16 to 20	18	12	3	5	9	10	22
21 to 25	13	14	6	10	20	24	21
26 to 30	6	8	14	27	23	19	15
31 to 35	3	4	24	16	14	15	11
36 to 40	.	2	15	19	16	14	7
41 to 45	.	1	21	11	6	8	1
46 to 50	.	.	9	7	4	1	.
51 to 55	.	.	4	1	.	.	.
56 to 60	.	.	2	.	.	.	.
Average	13.0%	13.4%	36.9%	32.6%	29.4%	28.3%	22.4%
Minimum	-18.2%	-28.6%	15.5%	11.3%	8.7%	8.0%	4.2%
Maximum	31.6%	40.8%	55.7%	52.6%	50.0%	49.0%	44.5%

[a] The reduction in relative variability is measured as the percent difference between the CV statistics for the program indicated by the column label and no insurance (government commodity program participation only - the baseline). The reduction in relative variability is also the percent difference between the standard deviations for the insurance program and no insurance because of the use of actuarially fair premiums.

[b] Comparisons:
AIA = Area-Yield Insurance vs. No Insurance;
AIP = Area-Yield ASCS-Base Insurance vs. No Insurance;
FI-0.00 = Farm-Yield Insurance (0% Deductible) vs. No Insurance;
FI-2.85 = Farm-Yield Insurance (2.85% Deductible) vs. No Insurance;
FI-5.00 = Farm-Yield Insurance (5% Deductible) vs. No Insurance;
FI-5.75 = Farm-Yield Insurance (5.75% Deductible) vs. No Insurance; and,
FI-10.00 = Farm-Yield Insurance (10% Deductible) vs. No Insurance.

Table 2. Insurance Indemnity Expenditures Under Each Insurance Program for, 98 Southcentral Kansas Dryland Wheat Farms, for 1973 to 1987.

	Program[a]						
	AIA	AIP	FI-0.0	FI-2.85	FI-5.0	FI-5.75	FI-10.0
Total Indemnities[b]	$5,837	$7,174	$8,696	$67,177	$6,150	$5,821	$4,201
Average Indemnity Per-Acre[c]	$7.63	$9.38	$11.37	$9.38	$8.04	$7.61	$5.49

[a] Program:
AIA = Area-Yield Insurance;
AIP = Area-Yield ASCS-Base Insurance;
FI-0.0 = Farm-Yield Insurance (0% Deductible);
FI-2.85 = Farm-Yield Insurance (2.85% Deductible);
FI-5.0 = Farm-Yield Insurance (5% Deductible);
FI-5.75 = Farm-Yield Insurance (5.75% Deductible);
FI-10.0 = Farm-Yield Insurance (10% Deductible); and,
NC = No Insurance Coverage.

[b] Reported in 1,000's of 1988 dollars.
[c] Total indemnities (1988 dollars) divided by total planted acres (765,000) over the 15-year period.

Table 3. Number of Times Each Program is Dominated by Any Alternative Strategy Under Second-Degree Stochastic Dominance Analysis (98 Farms).[a]

	-Set #-						
Program[b]	1	2	3	4	5	6	7
NC	85	84	82	75	69	39	32
AIA	65	52	39	25	14	5	0
AIP	57	44	35	22	10	2	--
FI-10.0	72	64	52	39	1	--	--
FI-7.75	63	53	38	0	--	--	--
FI-5.0	63	43	0	--	--	--	--
FI-2.85	39	0	--	--	--	--	--
FI-0.0	0	--	--	--	--	--	--

[a] Refer to the text for further explanation of the numbers.
[b] Refer to Table 2 for a description of the strategies.