OPTIONAL UNIT POLICY IN CROP INSURANCE

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ABSTRACT

Utilizing ordered logit we examine the presence of two kinds of asymmetric information -adverse selection (intertemporal variability) and moral hazard (interspatial and/or residual variability) as revealed by the choice of optional units in Federal crop insurance utilizing Risk Management Agency 's 1996-2000 cotton yield and loss data files. Further, a tobit model is estimated to examine the factors explaining the loss cost ratio from Risk Management Agency perspective. Potential costs of adverse selection and/or moral hazard due to optional unit provision are estimated to be as high as $180 million in US cotton over the 1996-2000 period.

Keywords: Adverse Selection, Moral Hazard, Optional Unit Policy, Crop Insurance, U.S. Cotton, Logit and Tobit models.

OPTIONAL UNIT POLICY IN CROP INSURANCE

Crop insurance has become much more important as a farm policy instrument since the Freedom to Farm Act of 1996. The Federal Crop Insurance Corporation (FCIC) through the Risk Management Agency (RMA) offers several crop insurance policies[1] relying on private companies for product delivery, service, and loss adjustment. Economists have examined numerous aspects of crop insurance including moral hazard (Chambers, 1989; Just and Calvin, 1993; Horowitz and Lichtenberg, 1993; Smith and Goodwin, 1996; Coble et al, 1997), adverse selection (Skees and Reed, 1986; Quiggin et al, 1994; Just and Calvin, 1995; Atwood, Shaik and Watts, 1999; Shaik and Atwood, 2002), demand for crop insurance (Coble et al, 1996), rating methodologies (Goodwin, 1993; Quiggin, 1994; Atwood et. al., 1997; Skees, Black and Barnett, 1997; Goodwin and Ker, 1998; Olivier Mahul, 1999;) and more importantly the effects of optional unit policy (Knight and Coble, 1996; reports by USDA Office of the Inspector General in 1994 and 1999; and the U. S. General Accounting Office in 1999) in Federal crop insurance.

In the early 1980's FCIC initiated the optional unit policy for purchasers of multiple peril crop insurance. Under the optional unit provisions, farms which satisfy certain spatial requirements are allowed to divided their farm into different insurable units and to report yields and collect indemnities separately on each unit. The optional units[2] provision is popular with producers due to its low cost (a 10% effective surcharge over basic premium charges) and its ability to indemnify legitimate losses on separate sections of land. Current crop insurance policies are faced with adverse selection within the RMA's insured pool of producers. Given adverse selection, there is avenue for potential abuse (moral hazard) of the optional unit provision as the current system relies heavily, although not totally, upon self-reporting.

With asymmetric information due to optional unit policy, a distinction can be drawn between hidden information (adverse selection), that is, situation in which a producer has more information about his or her risk of loss on the optional units than does the insurance provider, and hidden incentives (moral hazard), that is, producers due to self reporting can potentially manipulate their optional unit's yields to benefit them when determining if losses actually occurred. This kind of moral hazard risk due to optional unit policy is different from the traditional moral hazard, defined as the ability of the producer to increase his or her expected indemnities by actions taken after buying insurance especially use of inputs. The conventional model of asymmetric information is utilized to examine the presence of adverse selection and moral hazard in Federal crop insurance by the producer's risk. We assume risk is revealed (signaled) by the choice of number of optional units. Ordered logit model is employed to examine the presence of adverse selection and moral hazard due to crop insurance optional unit provision for all the U.S. cotton producers using 1996-2000 yield and loss data from RMA. Also a tobit model is estimated to examine the factors explaining the loss cost ratio (LCR) from the RMA. Finally the potential cost of adverse selection and/or moral hazard due to optional unit provision are estimated to be as high as $180 million in U.S. cotton over the 1996-2000 period.

DECOMPOSITION OF FARM'S RISK

The presence of two kinds of asymmetric information -adverse selection and moral hazard can be examined by decomposing the farm's variability, as farm with multiple units is identical to a panel of unit level data over time. The three-way error component decomposition (two-way random effects model) is utilized to decompose farm risk into 1) intertemporal risk generally identified with adverse selection, 2) interspatial risk that can be identified with systematic difference between the units and 3) residual risk that can also be identified with potential moral hazard. The farm's variability due to optional unit policy can be decomposed as:

$$(1)\qquad \underbrace{\sum_i \sum_t (y_{it} - \bar{y})^2}_{\text{farm risk}} = \underbrace{T\sum_i (\bar{y}_i - \bar{y})^2}_{\text{intertemporal risk}} + \underbrace{N\sum_t (\bar{y}_t - \bar{y})^2}_{\text{interspatial risk}} + \underbrace{\sum_i \sum_t (y_{it} - \bar{y}_i - \bar{y}_t + \bar{y})^2}_{\text{residual risk}}$$

where, T is the time period and N is the number of optional units within a farm, $y_{i,t}$ is yield for optional unit i and time t, $\bar{y}_i$ is the mean of unit i, $\bar{y}_t$ is the mean of period t, and $\bar{y}$ is the overall mean.

For a farm with single optional unit, the farm risk is equivalent to the intertemporal risk defined as the square root of $T\sum_i (\bar{y}_i - \bar{y})^2$, a proxy identified with adverse selection. However for farm with more than one optional unit[3] (panel data), the farm risk can be decomposed into intertemporal risk (α^T) defined as the square root of $T\sum_i (\bar{y}_i - \bar{y})^2$ identified with adverse selection, interspatial risk (α^N) defined as the square root of $N\sum_t(\bar{y}_t - \bar{y})^2$ identified with systematic difference across units, and residual risk (α^{NT}) defined as the square root of $\sum_i\sum_t(y_{it} - \bar{y}_i - \bar{y}_t + \bar{y})^2$ identified with potential moral hazard. To illustrate that potential moral hazard can be identified with interspatial and/or residual risk, let as assume a farm with three units and yield information over ten years. Table 1 presents the yield information for a three-unit farm. Under the extreme assumption that a producer is committing fraud, it would be optimal to report 100 bushels of yield on one unit and zero on the remaining two units in a year. Next year follow up by reporting 100 bushels on second unit, and zero yields on the first and third units and so on. This would allow the producer to maintain his or her average yield and premium rates on each unit, but at the same time trigger maximum indemnity payments on individual units sequentially each year. Under optimal yield switching for the above example, the overall risk is explained by interspatial and/or residual risk. Result from Table 1 extends it support to the notion that the overall variability (standard deviation) of a producer engaged in optimal yield switching is explained by interspatial (4.71) and residual (38.21) risk, associated with potential moral hazard.

The intertemporal, interspatial and residual components of the risk are employed in the ordered logit model to examine the presence of asymmetric information in RMA's insuree pool due to adverse selection and moral hazard along with other variables. The three components of risk along with other variable are also employed in a tobit model to examine the factors influencing the loss cost ratio from the RMA perspective. Logit and tobit models are presented in the next section of the paper. The third section discusses the empirical ordered logit and Tobit model to test the presence of adverse selection and moral hazard along with the description of the data. The regression results are presented in the next section followed by the potential costs of optional unit provision in U.S. cotton. We conclude with the results and conclusion section.

THEORETICAL MODEL OF ASYMMETRIC INFORMATION

Consider a stylized producer facing a potential loss of future output. Assume that the producer is initially endowed with a level of wealth W. At the end of the next time period the producer will realize one of the two possible states[4] of the world - State 1 with probability of loss p and State 2 with probability of no loss $(1-p)$. We assume that the producer's preferences over risky choices can be modeled using expected utility. The objective function can than be modeled as:

(2) $U = p\,u(W-L) + (1-p)\,u(W)$

Assume that producer purchase insurance for a premium Z payable in state 1, the utility objective function is:

(3) $U = p\ u(W-L+I-Z) + \ (1-p)\ \ u(W-Z)$

where W is the initial wealth, L is the loss, I is the indemnity and Z is the premium of insurance. Further the indemnity paid depends on the type of insurance product opted by the individual producer as signaled by his or her choice of number of optional units insured within a farm policy. Under the assumption of no transaction cost, the premium is a function of intertemporal risk α^T, interspatial risk α^N, and residual risk α^{TN} influencing crop insurance optional unit policy and other observable characters (β).

Equation (2) can be re-written as:

$$(4)\quad U = p\ u\ ((W - L + I(\alpha^T, \alpha^N, \alpha^{NT}) - Z(\alpha^T, \alpha^N, \alpha^{NT}, \beta))\ + \\ (1-p)\ \ u(W - Z(\alpha^T, \alpha^N, \alpha^{NT}, \beta))$$

which has first order conditions (FOC):

$$(5)\quad p\ u'(W - L + I(\alpha^T, \alpha^N, \alpha^{NT}) - Z(\alpha^T, \alpha^N, \alpha^{NT}, \beta))\ \ (I'(\alpha^T, \alpha^N, \alpha^{NT}) \\ - Z'(\alpha^T, \alpha^N, \alpha^{NT}, \beta)\ -\ (1-p)\ \ u'(W - Z(\alpha^T, \alpha^N, \alpha^{NT}, \beta))\ Z'(\alpha^T, \alpha^N, \alpha^{NT}, \beta))$$

or

$$(6)\quad \frac{u'(W - L + I(\alpha^T, \alpha^N, \alpha^{NT}) - Z(\alpha^T, \alpha^N, \alpha^{NT}, \beta))}{u'(W - Z(\alpha^T, \alpha^N, \alpha^{NT}, \beta))} = \\ \frac{(1-p)\ Z'(\alpha^T, \alpha^N, \alpha^{NT}, \beta)}{p\,(\,I'(\alpha^T, \alpha^N, \alpha^{NT}) - Z'(\alpha^T, \alpha^N, \alpha^{NT}, \beta)\,)}$$

Sufficient second order conditions for a maximum are that producers be risk averse i.e., $u'' < 0$ over the relevant domain. Drawing upon the implicit function theorem, if the first order conditions are satisfied equation (6) can be rewritten with number of optional units insured within a farm as:

$$(7)\quad \mathit{Optional\,Units} = f(\alpha^T, \alpha^N, \alpha^{NT}, \beta)$$

where $(\alpha^T, \alpha^N, \alpha^{NT})$ are the intertemporal, interspatial and residual risk respectively influencing crop insurance optional unit policy and (β) other observable characters.

Equation (7) can be employed to examine the presence of adverse selection and moral hazard expressing individual producer’s choice of number of optional units insured within a farm as a function of risk differentiated into intertemporal, interspatial and residual risk; individual farm productivity (average yields), 50% normalized loss cost ratio, price election, insured share, type of insurance product, type and level of insurance coverage, actual yields reported, interaction of number of actual yields reported with insurance product and coverage, practice dummy (irrigated versus dryland), state dummies, and finally year dummies. The empirical model examines if RMA's insuree pool is adversely selected apart from the presence of moral hazard with lower (higher) risk producers insuring less (more) number of optional units. These results have important implications with respect to the RMA's ability to achieve the often-conflicting policy objectives of higher insurance participation, charging actuarially fair premiums, and avoiding excessive loss cost ratios. Results presented below provide strong evidence that the insured pool is indeed strongly asymmetric due to adverse selection and moral hazard.

From the RMA perspective we examine the effects of asymmetric information – adverse selection and moral hazard along with individual farm productivity (average yields), price election, insured share, type of insurance product, type and level of insurance coverage, number of optional units (more importantly to account for the basic unit and optional unit structure), actual yields reported, interaction of number of actual yields reported with insurance product and coverage, practice dummy (irrigated versus dryland), state dummies, and finally year dummies on loss cost ratio normalized to 50%.

EMPIRICAL MODEL AND DATA

To examine the presence of adverse selection and moral hazard due to optional units policy, ordered logit model is estimated with the producer's choice of number of optional units insured within a farm policy as the dependent variable. The producer's choice of the number of optional unit policy coded as 0,…..,9 for the ordered logit model where 0 corresponds to one optional unit and 9 corresponds to ten or more optional units within a farm policy. Loss cost ratio takes the value that range from 0 to 1, hence a Tobit model is employed to examine the importance of adverse selection, moral hazard and other factors on LCR from the RMA perspective.

In the following regressions, the individual producer choice of number of optional units within a farm policy is modeled as a function of (1) *farm risk* (α) decomposed into intertemporal risk (x_1^T) defined as the square root of $T\sum_i (\bar{y}_i - \bar{y})^2$ identified with adverse selection, interspatial risk (x_1^N) defined as the square root of $N\sum_t (\bar{y}_t - \bar{y})^2$ and the residual risk (x_1^{TN}) defined as the square root of $\sum_i \sum_t (y_{it} - \bar{y}_i - \bar{y}_t + \bar{y})^2$ identified with potential moral hazard, (2) farm's *loss cost ratio 50%* (x_2) defined as annual normalized indemnities to 50% divided by annual normalized liabilities to 50% reflecting the expected downside farm risk for the ordered logit model (or) O*ptional units* (x_2), defined as the number of units within a farm policy for the Tobit model, (3) *farm productivity* (x_3) defined as average yields, (4) *Price election* (x_4), defined as the percent of price elected for a insured level of yields, (5) *Insured share* (x_5), defined as the percentage share of crop on the unit owned by the insured, (6) *Insurance product*

(x_6), defined as 0 for CRC revenue insurance and 1 for MPCI yield insurance, (7) *Coverage level* (x_7), defined as 0, 1, …..,6 with 0 for catastrophic, 1 for 50% buyup and 6 for 75% buyup, (8) *Actuals* (x_8), defined as the 0 for units that reported less than four actual yields that include zero actuals, and 1 for units that report more than four actual yields, (9) *Actuals*IP* (x_9), an interaction of number of actual yields and insurance product, (10) *Actuals*CT* (x_{10}), an interaction of number of actual yields and coverage level, (11) *Actuals*UT* (x_{11}), an interaction of number of actual yields and unit type – basic or optional units used only in the loss cost ratio model, (12) *practice* dummy (D_prac)- irrigated versus dryland, (13) *state* dummy variables (D_states) and (14) *year* dummy for the years 1997 through 2000 (D_year). The annual dummy variables are included to account for the effect of increases in subsidies and changes in policy provisions across the years 1996-2000.

The ordered logit model can be represented as:

$$\text{(8) Optional Units} = \alpha_0 + \alpha_1^T x_1^T + \alpha_1^N x_1^N + \alpha_1^{TN} x_1^{TN} + \sum_{i=2}^{10} \alpha_i x_i + \beta_0 D\_prac + \sum_{j=1}^{15} \beta_i D\_states_j + \sum_{k=1}^{4} \gamma_k D\_year_k + \varepsilon$$

To examine the factors explaining loss cost ratio (LCR) normalized to 50 percent coverage, the Tobit model can be represented as:

$$\text{(9) } LCR50 = \alpha_0 + \alpha_1^T x_1^T + \alpha_1^N x_1^N + \alpha_1^{TN} x_1^{TN} + \sum_{i=2}^{11} \alpha_i x_i + \beta_0 D\_prac + \sum_{j=1}^{15} \beta_i D\_states_j + \sum_{k=1}^{4} \gamma_k D\_year_k + \varepsilon$$

Information on each insuree who purchased cotton insurance for the years 1996-2000 was extracted from RMA's yield history and loss history data files[5]. During this time period, producer's were able to select either multiple peril crop insurance (MPCI) yield insurance or crop revenue coverage (CRC) revenue insurance; buyup coverage levels (catastrophic coverage, 50% - 75% election); and the number of actual yields reported by the producer by irrigated or dryland practice. Each farm's risk is decomposed into measures of adverse selection and moral hazard utilizing the three-way error components decomposition. The decomposed components are used as a measure of farm level risk. An alternative downside measure of risk is the amount of the indemnity actually paid to the producer at the end of the year. For each of the five years of RMA's loss history data, farm level indemnities were divided by farm level liabilities giving an end-of-year farm level loss cost ratio. The farm level loss cost ratio is used along with the decomposed farm risks, as a measure of downside farm level risk in the regression analysis.

The number of insured cotton farms, risk decomposed into intertemporal, interspatial and residual risk, mean loss cost ratio, mean insured share and mean yields by number of optional units insured within a farm is presented in Table 2. The intertemporal risk (interspatial and residual risk) demonstrates a decreasing (increasing) trend with increase in the number of optional units. While the average yield, insured share and the loss cost ratio indicates an increasing trend with increase in the number of optional units. Normalized 50% loss cost ratios are substantially higher for multiple unit farms (average 13.9%) than for single unit farms (average 7.38%). These results are similar in direction but higher in magnitude than the results presented by Knight and Coble where they also found that optional unit loss cost ratios were higher for multiple unit farms.

Table 3 presents the results of both the tobit and the ordered logit models. The regression results indicate that the various sources of total farm variability are identically related to both the loss cost ratio and the number of units insured. After the decomposition of errors, increases in the intertemporal risk component tend to be associated with lower LCR's and fewer optional units. Interspatial and residual risks tend to be associated with both higher LCRs and an increased number of optional units.

Other interesting results are apparent from Table 3 as well. Producers with more optional units tend to elect higher price elections and associated with higher insured share. Higher price elections and insured share also tends to be associated with higher normalized loss ratios as well. Producers with higher normalized LCRs tend to purchase higher coverage a result consistent with the predictions of the model presented earlier. This result is the classic adverse selection result that predicts that producers with higher risk will tend to purchase higher coverage if they are charged the same premium rate as lower risk producers. LCR's are predicted to be higher for multiple unit farms than for single unit farms -a result consistent with previous discussion and with the results presented by Knight and Coble for corn, soybeans, and wheat. Producers with more than four actual yields reported tend to insure less number of optional units, however the interaction of actual yields reported to insurance product and coverage level seems to be positively related to the optional units. In the tobit model, producers with less than four actual reported yields are associated with higher LCR, but the interaction of actual yields reported to insurance product and coverage level seems to be negatively related to LCR.

Intertemporal, interspatial, and residual variability appear to be associated differentially with loss cost ratios and the number of optional units insured. Research is currently being conducted to ascertain to what degree these measures can be used to differentiate between adverse selection and moral hazard. However, it is clear that farms with optional units associated on average have higher loss cost ratios than do single unit farms. As we briefly discuss in the following section, most of these higher costs are likely to be associated with adverse selection or moral hazard in some form. In the next section we attempt to estimate the costs associated with adverse selection and/or moral hazard in optional units in US cotton.

POTENTIAL COSTS OF OPTIONAL UNIT PROVISIONS IN US COTTON

In this section we attempt to estimate the program costs of optional unit provisions over the time period 1996-2000. Previous studies by Knight and Coble, and Kuhling have discussed the provisions of RMA's unit structure in detail. Both studies reported that RMA's policy of charging a surcharge to producers who insure multiple optional units is justified in that loss-cost ratios are generally significantly higher for optionally insured units. RMA's current practice effectively charges a ten percent (10%) surcharge for optionally insured units.

While these studies have shown that the loss rates associated with optionally insured units are higher, no study, to our knowledge, has documented a legitimate reason why such rates should be higher. Given Knight and Coble's results as to the striking similarities between the size and other characteristics of singly insured basic and optional units, we can find no theoretical reason to believe that losses *per unit* for larger multiple unit producers should exceed that of smaller "single unit" producers when the separately insured units are of similar size[6].

To examine the costs of optional units in US cotton, cotton indemnification information from RMA's loss history data-base was aggregated by the number of optional units insured for the year's 1996 through 2000 for each cotton producing state. Table 4 presents summary statistics for each state aggregated over the five-year period. Table 4 lists by state the number of farms, acreage insured, the insured liability and the average LCR of all producers who insured one or independently insured more than one optional unit during the period 1996-2000.

The LCR values in the sixth column were computed as the simple average across all producers in the given category. To estimate the amount by which optional unit provisions increase program costs, we first compute the approximate indemnities associated with multiple units (column 6). The approximate indemnities associated with multiple units are computed as product of total liability (column 4) times the average LCR (column 5) across producers. The excess indemnities in column 7 are computed as the difference in the LCR's of the multiple and single unit farms multiplied by the amount of liability (column 4) of the multiple unit farms. For example in Alabama the LCR of the single unit farms was (0.143) while the LCR of the multiple unit farms was (0.190). The liability of the multiple unit farms was $488,127,165. The estimated excess indemnity generated by insuring multiple units is thus (0.190 - 0.143)*$488,147,165 = $22,941,977. If all farms with multiple units had the average LCR the estimated amount of approximate indemnities to the multiple unit group would be $92,744,161. Thus for Alabama we estimate that $22,941,977 (over 23%) of the total multiple unit approximate indemnifications of $92,744,161 were generated by abuses of optional unit provisions. In the US as a whole we estimate that costs of optional units in US cotton (in excess of loss rates associated with single unit farms) were approximately $180 million over the period 1996-2000. For the US as a whole this amounted to about 15% of total indemnifications to multiple unit farms during this time period. If Texas is excluded, total excess indemnifications are estimated to have been about $129 million -an amount equal to 28% of total indemnifications to non-Texas multiple unit farms.

SUMMARY AND CONCLUSIONS

This paper used error components procedures to decompose multiple unit farm level variability into intertemporal, interspatial, and residual risk. Regression results indicate that the three components are differentially associated with loss cost ratios and the number of units insured by a given farm. Regression results also support the conclusion that loss cost ratios are higher for multiple unit farms as contrasted to single unit farms. The costs of adverse selection or moral hazard in US cotton are estimated to have been at least $180 million over the 1996-2000 period.

Further research needs to be done to statistically ascertain to what degree these measures can be used to differentiate between adverse selection and moral hazard. Additional source of moral hazard associated with reconstituting the farms can and needs to be address extending the three-way to four-way error decomposition. From the RMA perspective, the choice of crop insurance policy (in this case number of optional units) and the LCR model needs to be estimated simultaneously.

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Table 1. Decomposition of Risk for an Ideal Case of Optimal Yield Switching for a Three Unit Farm

Intertemporal & Interspatial Risk

Year	Unit 1	Unit 2	Unit 3	**mean**	**Intertemporal Risk**
1990	100	0	0	33.33	0.00
1991	0	100	0	33.33	0.00
1992	0	0	100	33.33	0.00
1993	100	0	0	33.33	0.00
1994	0	100	0	33.33	0.00
1995	0	0	100	33.33	0.00
1996	100	0	0	33.33	0.00
1997	0	100	0	33.33	0.00
1998	0	0	100	33.33	0.00
1999	100	0	0	33.33	0.00
mean	40.00	30.00	30.00	**33.33**	**0.00**
Interspatial Risk	44.44	11.11	11.11	**22.22**	

Risk	**Interspatial**	**Intertemporal**	**residual**	**farm**
Variance	**22.22**	**0.00**	**1460.00**	**1482.22**
stdev	4.71	0.00	38.21	38.50

Residual Risk

Year	Unit 1	Unit 2	Unit 3	**mean**
1990	3600	0	0	1200
1991	0	4900	0	1633.3
1992	0	0	4900	1633.3
1993	3600	0	0	1200
1994	0	4900	0	1633.3
1995	0	0	4900	1633.3
1996	3600	0	0	1200
1997	0	4900	0	1633.3
1998	0	0	4900	1633.3
1999	3600	0	0	1200
mean	1440	1470	1470	**1460.0**

Table 2. Summary Statistics of the all US Cotton Producers by Number of Optional Units, 1996-2000

Number of Optional Units	No:of Farms	RISK (Adverse Seletion & Moral Hazard)			MEAN		
		Intertemporal	Interspatial	Residual	Farm Yield	Insured Share	LCR 50
1	151,612	161.64	0	0	509.25	0.442	0.078
2	46,039	155.24	36.28	52.24	496.43	0.589	0.116
3	23,688	155.76	55.99	72.97	510.40	0.683	0.126
4	14,712	152.64	66.15	82.84	515.43	0.739	0.135
5	10,153	154.02	73.20	90.40	518.94	0.754	0.134
6	6,927	152.52	78.77	95.37	522.28	0.778	0.144
7	4,928	153.46	82.99	98.80	526.68	0.787	0.138
8	3,679	152.08	85.00	100.07	537.15	0.807	0.144
9	2,803	147.24	87.74	102.42	533.62	0.797	0.150
10	8,882	147.78	96.48	106.32	537.11	0.803	0.163
1	151,612	161.64	0	0	509.25	0.442	0.078
>2	121,811	152.30	73.62	89.05	522.01	0.748	0.139

Table 3. Tobit and Ordered Logit Results Examining Optional Units Policy US Cotton States, 1996-2000

Parameters	Tobit Model LCRatio 50		Parameters	Ordered Logit Model (1,…..,9)	
	coefficient	**t-ratio**		**coefficient**	**t-ratio**
Intercept	-1.1601	-8.45	Intercept	-1.6835	-5.66
Intermporal Risk	-0.0003	-9.09	Intermporal Risk	-0.0050	-77.05
Interspatial Risk	0.0001	1.08	Interspatial Risk	0.0082	62.90
Residual Risk	0.0006	9.70	Residual Risk	0.0281	207.89
Average Yield	-0.0011	-85.38	Average Yield	-0.0002	-6.63
			Loss Cost Ratio 50%	0.0763	5.13
Price Election	1.3469	41.34	Price Election	1.4039	22.08
Insured Share	0.1328	17.33	Insured Share	1.8316	122.83
Insurance Product	-0.1911	-4.32	Insurance Product	-0.2205	-2.27
Coverage level	0.1477	27.39	Coverage level	-0.1320	-13.03
Optional Units	0.0503	13.27	Optional Units		
Actuals	0.2246	2.91	Actuals	-0.4779	-2.86
Actuals*IP	0.0324	1.29	Actuals*IP	0.1199	2.17
Actuals*CT	-0.0729	-25.49	Actuals*CT	0.0602	11.34
Actuals*UT	-0.0126	-6.02			
Practice (Irrigated=1)	0.3273	50.58	Practice (Irrigated=1)	0.6747	53.29
County Rate	0.0003	15.34	County Rate	0.0001	2.53
Alabama	-0.0568	-4.97	Alabama	-0.1249	-5.04
Arizona	0.2457	5.67	Arizona	-0.3385	-5.26
Arkansas	-0.3332	-18.27	Arkansas	0.1868	7.25
California	0.2167	6.91	California	-0.8837	-17.12
Florida	-0.0360	-1.14	Florida	-0.5150	-8.38
Georgia	0.0133	1.30	Georgia	-0.4750	-23.91
Louisiana	-0.0799	-5.15	Louisiana	-0.2259	-8.30
Missouri	-0.4042	-21.78	Missouri	-0.4245	-14.48
Mississippi	-0.2930	-13.96	Mississippi	0.4044	12.82
North Carolina	-0.0776	-1.94	North Carolina	-0.6215	-8.81
New Mexico	-0.4274	-29.48	New Mexico	0.1879	7.68
Oklahoma	0.1776	13.34	Oklahoma	0.0125	0.41
South Carolina	-0.0570	-2.43	South Carolina	0.3154	7.54
Tennessee	-0.4476	-20.70	Tennessee	0.3455	10.31
Virginia	-0.7502	-15.38	Virginia	0.1457	2.65
D_97	-0.3964	-35.03	D_97	-0.0042	-0.20
D_98	0.3407	32.03	D_98	0.0172	0.82
D_99	0.0199	1.87	D_99	0.1301	6.29
D_00	0.1407	13.11	D_00	0.1491	7.10
SIGMA	0.8090	459.41	LIMIT2	1.5005	218.85
			LIMIT3	2.4120	277.96
			LIMIT4	3.0843	309.44
			LIMIT5	3.6462	328.15
			LIMIT6	4.1188	338.11
			LIMIT7	4.5297	342.03
			LIMIT8	4.9058	341.42
			LIMIT9	5.2597	336.88

where, IP is the insurance products, CT coverage level and UT unit type

Table 4. Estimated Cost of Crop Insurance Optional Unit Provision in US Cotton, 1996-2000

State	# Optional Units	Number of Farms	Insured Acres	Total Liability	Average LCR across Producers	Approximate Indemnities	Excess Indemnities	% Excess Indemnities
Alabama	1	6,099	309,743	71,523,823	0.143			
	>=2	5,709	1,919,472	488,127,165	0.190	92,744,161	22,941,977	0.247
Arizona	1	1,191	418,763	110,571,517	0.021			
	>=2	633	427,148	200,921,940	0.052	10,427,922	6,184,570	0.593
Arkansas	1	7,296	732,290	106,825,176	0.016			
	>=2	5,172	2,213,043	337,171,992	0.016	5,394,752	0	0.000
California	1	3,731	1,538,365	402,268,269	0.013			
	>=2	816	827,435	281,800,084	0.042	11,892,973	8,198,812	0.689
Florida	1	505	67,120	13,356,704	0.174			
	>=2	946	313,524	76,152,182	0.184	13,980,148	758,917	0.054
Georgia	1	10,909	1,345,666	287,024,117	0.128			
	>=2	14,108	4,430,783	1,007,845,438	0.178	179,798,591	50,726,670	0.282
Kansas	1	247	12,372	1,246,163	0.161			
	>=2	169	40,847	4,323,823	0.163	704,831	8,788	0.012
Louisiana	1	6,247	707,364	123,532,357	0.054			
	>=2	4,450	1,669,945	302,707,462	0.056	16,871,406	512,042	0.030
Mississippi	1	5,718	1,698,947	339,209,155	0.033			
	>=2	3,731	2,211,447	547,477,357	0.070	38,299,434	20,388,646	0.532
Missouri	1	3,565	164,894	19,466,774	0.020			
	>=2	2,986	856,213	109,309,059	0.024	2,614,359	386,034	0.148
New Mexico	1	833	71,681	12,189,279	0.066			
	>=2	533	142,676	24,327,825	0.136	3,303,030	1,698,651	0.514
North Carolina	1	4,480	424,506	65,245,811	0.038			
	>=2	7,596	2,498,982	463,842,951	0.068	31,365,602	13,758,797	0.439
Oklahoma	1	3,630	105,500	15,006,106	0.325			
	>=2	2,740	609,351	104,110,482	0.341	35,503,536	1,619,609	0.046
South Carolina	1	1,332	255,874	37,309,230	0.083			
	>=2	1,990	727,007	123,607,870	0.088	10,904,760	673,631	0.062
Tennessee	1	2,388	176,811	25,726,846	0.031			
	>=2	2,774	1,065,145	168,280,407	0.034	5,673,155	528,727	0.093
Texas	1	92,811	3,820,408	591,716,718	0.236			
	>=2	66,532	18,219,048	3,037,792,674	0.253	767,443,522	50,898,108	0.066
Virginia	1	668	39,556	6,046,825	0.003			
	>=2	965	228,484	40,071,244	0.019	780,817	662,021	0.848
US						1,227,703,000	179,946,001	0.147
Excluding Texas						460,259,478	129,047,893	0.280

FOOTNOTES

[1] The various crop insurance programs are Multli-Peril Crop Insurance (MPCI), Crop Revenue Coverage (CRC), Revenue Assurance (RA), Income Protection (IP) and Group Risk Protection (GRP).

[2] Subdivision of the farm into optional units is allowed for land in different sections under rectangular survey, and for irrigated versus dryland production. A section is one square mile (or 640 acres) and where legal descriptions are not based on rectangular survey, alternative criteria such as Farm Agency Service farm serial number and non-contiguity are used to define insurable units. For details see pp 36-44 under section 4 of the 2002 Crop Insurance Handbook (APH), Issued: 06/2001 and available at the following website http://www.rma.usda.gov/FTP/Publications/directives/18000/pdf/02_18010.pdf.

[3] Since we are addressing the issue of moral hazard due to potential yield switching it does not matter if the unit is a basic, optional, enterprise unit. In regards to the choice model, the differentiation holds out, but the percent of enterprise unit is less than 0.001.

[4] While this example is a highly simplified two-state model, these results can be generalized to a continuous distribution using methods similar to those presented in Borch.

[5] RMA's database consists of a number of different databases containing information with respect to insurance companies, agents, adjusters, and producers. RMA's yield history data set contains producers' reported historical yields used in establishing an average or "approved" yield at the beginning of the insurance year. RMA's loss history data set records indemnities paid at the end of the insurance year.

[6] The lack of a legitimate reason for "higher per unit losses" for multiply insured units should not be confused with the fact that loss cost ratios are expected to decline with increases in the number of units combined into a larger singly insured "enterprise" unit. Indeed, if a single producer were to continue insuring larger and larger tracts of land as a "single unit" expected loss cost ratios would decline eventually approaching RMA's GRP type rates associated with insuring aggregate countywide yields.

Alternatively, assume that a single entity initially insured an entire county as one insurable tract. In this situation the single entity's premium rates should be identical to the county or GRP rate. If this large tract of land were broken into smaller and smaller tracts of separately insured units, the expected costs per tract would be expected to increase *relative to the GRP-type rates*. However, this does not imply that the large producer's expected losses *on any given section* or unit should exceed those of a smaller producer insuring similar acreage and quality of land within any given section. For a more detailed discussion of these concepts see Kuhling. Knight and Coble's examination of RMA's loss history data indicates that the losses per unit are larger for similar sized but optionally insured units.