Acreage Abandonment, Moral Hazard and Crop Insurance

Shu-Ling Chen

Graduate Research Associate, Department of Agricultural, Environmental and Development Economics. The Ohio State University
email: chen.694@osu.edu

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Abstract

Empirical evidence for the existence of moral hazard in the U.S. crop insurance program has been inconclusive. Here we use a nested-dynamic programming framework to estimate an intra-seasonal dynamic model that explicitly incorporates a farmer's crop abandonment decision. The estimation is implemented for selected Texas counties where actuarial performances of the crop insurance program are poor and high incidences of acreage abandonment are frequently observed.

Introduction

Adverse selection and moral hazard are usually suggested as causes for the poor actuarial performance of the U.S. crop insurance program (Miranda; Goodwin; Horowitz and Lichtenberg; Smith and Goodwin; Coble, et al.; Wu; Goodwin, Vandeveer and Deal). Although it has been shown in the empirical literature that inaccurate ex-ante premium rates lead to adverse selection (Miranda, Goodwin), empirical support for the existence of moral hazard has been difficult to find due to the lack of appropriate individual farm policy data.

Numerous empirical studies have evaluated how crop insurance affects producer's production decision, such as chemical use (Horowitz and Lichtenberg; Smith and Goodwin), cultivation practices (Goodwin, Vandeveer and Deal) and cropping patterns (Wu), but have provided only contradictory or inconclusive evidence of moral hazard. For example, Horowitz and Lichtenberg suggest that crop insurance has encouraged the chemical input usage for corn producers in the U.S. Midwest. However, Smith and Goodwin argue that the insured Kansas dryland wheat producers tend to use less chemical input than the non-insured. Another study of the effect of crop insurance on crop patterns and chemical use in Central Nebraska Basins is conducted by Wu. The research applies the survey data from individual corn producers and finds that crop insurance participation encourages producers to switch the crops in higher economic values. Goodwin, et al. study the acreage effects of crop insurance using the samples of corn and soybeans production in the U.S. Corn Belt and wheat and barley production in Northern Great Plains. The relatively modest acreage responses in the increases in crop insurance participation are suggested.

Several possibilities may explain the contradictory or inconclusive results. First, each crop producer's objective is to maximize expected profit, subject to the constraints imposed by market conditions, production environment and producer's characteristics (Goodwin). Thus the production decision will be complex and conditioned on all economic constraints. The possibility that the impacts of one factor, such as crop insurance, on production practice decision might be offset by other factors, such as weather, cannot be excluded. According to the Risk Management Agency (RMA) insurance protocols, crop insurance must be purchased prior to the start of the planting season. The decision on chemical use may be more likely to be driven by weather condition rather than crop insurance purchasing decision. As Horowitz and Lichtenberg state,

> "in regions and / or crops where high pest infestations occur primarily when crop growth conditions are good, pesticides work by increasing output in good states of nature and are thus likely to be risk-increasing."

The contradictory results of crop insurance decision on chemical use in agriculture can be expected. Second, production practices vary among individual farmers. In order to better understand producers' incentives to commit fraud and to effectively detect it, reliable individual farm data is required. Most studies employ county level data rather than individual farm data to analyze the individual farmer's behavior. The use of aggregate yield data may create the problems for underestimating moral hazard because aggregate yield are less variable than individual yields (Goodwin). Third, the counties or region chosen in these studies may not exhibit the extreme conditions necessary to induce widespread moral hazard. For example, the loss ratios[1] for Iowa corn exceeded on only once between 1989-2003. During the same fifteen-year period, however, the loss for Texas upland cotton in Texas exceeded one in all but four years (see Table 1). This suggests that the crop insurance program is more likely to have severe rating or monitoring problems in Texas than in Iowa.

Table 1: Comparison of Loss Ratios for Corn in Iowa and Upland Cotton in Texas: 1989-2003

	Loss Ratios	
Year	***Iowa Corn***[1]	***Texas Upland Cotton***
1989	0.82	2.76
1990	0.30	1.22
1991	0.72	2.09
1992	0.17	3.81
1993	4.96	0.86
1994	0.05	0.64
1995	0.98	1.27
1996	0.24	1.60
1997	0.09	0.54
1998	0.58	1.93
1999	0.32	1.15
2000	0.35	1.62
2001	0.67	1.62
2002	0.20	0.91
2003	0.18	1.55
1989-2003 average	**0.71**	**1.57**

[1] The report of loss ratios for corn in Iowa includes corn for grain only.

Insured producers receive the indemnities if and only if the actual crop yield or revenue is less than the selected coverage level of the proving yield or revenue,

[1] The loss ratio, defined as the ratio of total indemnity paid by an insurance policy to the total premium received, is a standard measure of the actuarial performance of insurance program. For example, the loss ratio in 1990 for corn in Iowa indicates that on average, the insurance policies paid out approximately $0.30 of indemnity for every dollar of total premium received, including farmer paid premium plus government premium subsidies.

depending upon the type of insurance policy purchased. Therefore, if the expected profit of bring the crop to harvest is likely to be less than the net insurance profit, which equals indemnity received minus producer premium paid, the insured producers have incentive to abandon the acreage to increase the likelihood of collecting the indemnity. The differences in acreage between the planting season and harvest season can provide the information about how much acreage is abandoned. The existence of moral hazard can be further demonstrated by comparing the insured and the non-insured producers' acreage abandonment behaviors.

The objective of this paper is to examine whether the insurance participation decision encourages producers to abandon their crops. We begin by constructing an intra-seasonal dynamic optimization model that explicitly incorporates crop producer's acreage abandonment decision with and without purchasing crop insurance. Certain upland cotton producing counties in Texas are chosen for the empirical application based on their poor actuarial performance of the crop insurance program. For these counties, loss ratios have frequently been above one and there is a high incidence of acreage abandonment. Figure 1 illustrates the 1989-2003 upland cotton acreage abandonment ratios for these Texas[2] counties. The acreage abandonment ratio ranges from zero to more than eighty percent across counties and years. An interesting phenomenon is that not all of the counties have the same acreage abandonment ratio during the same period of time. It is possible that cotton producer's decision on acreage abandoned is made subject to not only the environmental condition but economic concerns.

[2] The absence information may be resulted from:
a) there is no changes between planted acreage and harvested acreage, which means zero acreage abandonment ratio;
b) missing data – note that county-level planted acreage less than 1,000 acres is not reported.

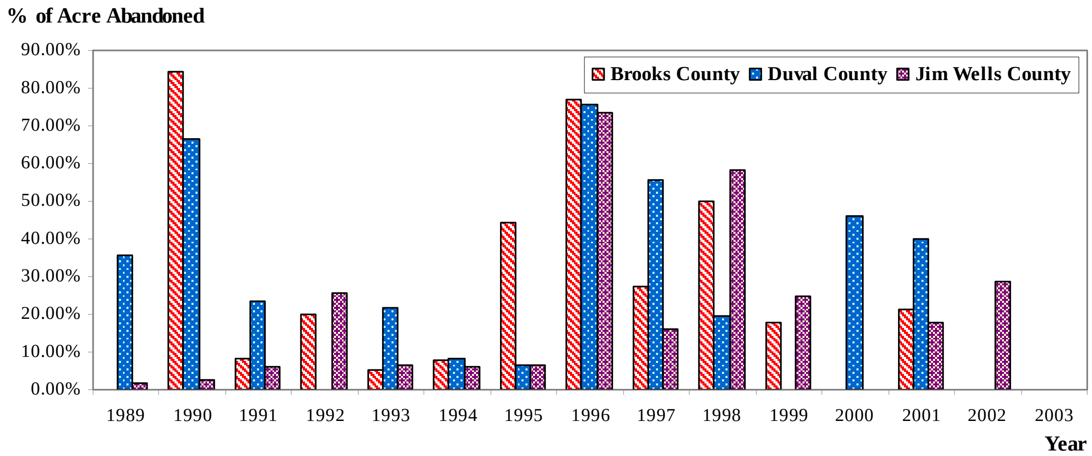

Figure 1: County-level Acreage Abandonment Ratios for Upland Cotton in Selected Counties, Texas: 1989-2003

Data

The major obstacle of evaluating crop producer's fraud behavior is the availability and reliability of individual farm level data (Rejesus, et al). Numerous types of agricultural data are recorded by various government agencies under the U.S. Department of Agriculture (USDA). They are often tabulated in a different basis. In this analysis, the data for individual insured units are obtained from unpublished Risk Management Agency (RMA) Corporate Database, which contains all detailed insurance contract data submitted by insurance providers. Various records are collected, including type 10 record – policy holder, type 15 record – yield, type 11 record – acreage, and type 21 record – loss claim. The detailed information for each insured units contains reported acreage at planting season, coverage level, base premium rate, total premium, producer premium, liability, indemnity, production, determined acreage at harvest season and 10-year APH yield There is no direct report for the non-insured in agricultural data so the agricultural county-level data downloaded from USDA's National Agricultural Statistics Service (NASS) database, such as planted acreage, harvested acreage, yield and production, is applied in this research. However, the NASS county-level data, which is collected through sample surveys, tabulates acreages based on reports from operators while RMA insurance data tabulates acreages from owners and operators. The magnitudes of sampling and nonsampling errors[3] in NASS county data are unknown. If in a given county, the sizes of farm for most farm enterprises are small, the magnitudes of sampling and nonsampling errors are more likely to be severe. The selected counties in this study encounter the problem that the NASS county-level planted acreage less than the reported acreage at the planting season for the insured in RMA insurance data are frequently observed. This may potentially suggest the magnitudes of sampling and nonsampling errors are grave in NASS county data.

Regardless of the potential problem in NASS county data, the RMA insurance data and NASS county data both provide consistent information. Figure 2-4 illustrated 1989-2003 acreage abandonment ratios in selected Texas counties. Note that the county-level acreage abandonment ratio is the weighted average of the acreage abandonment ratio for the insured and for the non-insured. Figure 2 and Figure 3 imply that the acreage abandonment ratios for the non-insured in Brooks County and in Duval County would be much lower than the ratios for the insured. The differences in acreage abandonment ratio between the insured and the non-insured suggest the potential existence of moral hazard. In contrast, the acreage abandonment ratio for the insured is not consistently higher than the acreage abandonment ratio for the all farmers in Jim Wells County. The potential existence of moral hazard effect is ambiguous though the

[3] See Lohr for more detailed discussion.

acreage abandonment ratios for the insured producers are higher than the ratios for all farmers in most years.

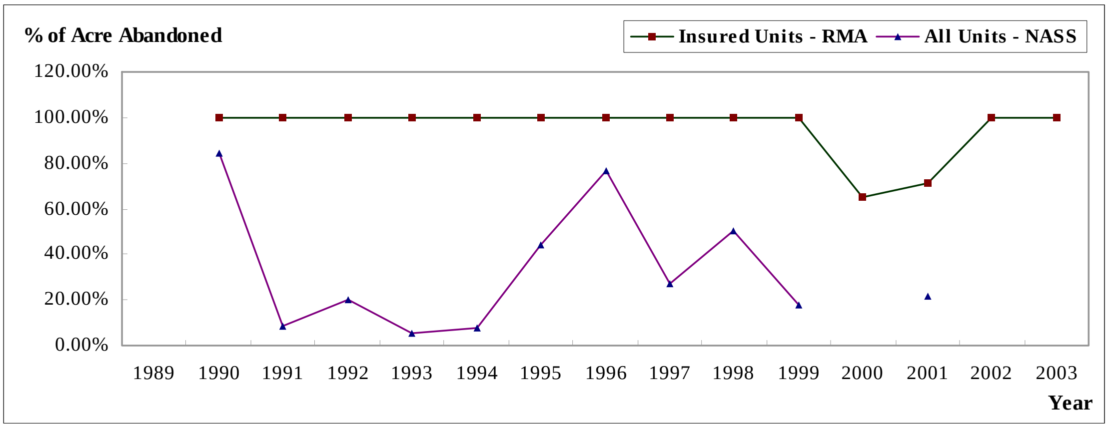

Figure 2: Comparison of Acreage Abandonment Ratio between Insured and All Farmers in Brooks County, Texas: 1989-2003

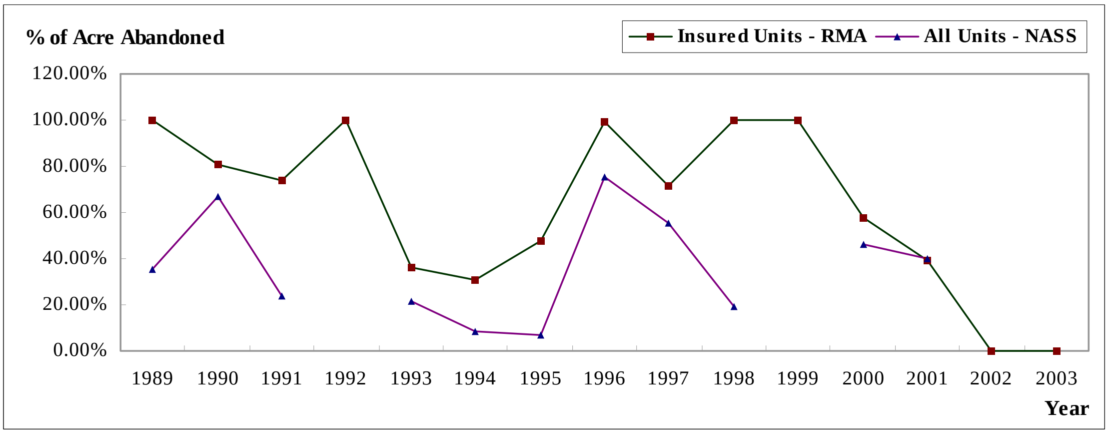

Figure 3: Comparison of Acreage Abandonment Ratio between Insured and All Farmers in Duval County, Texas: 1989-2003

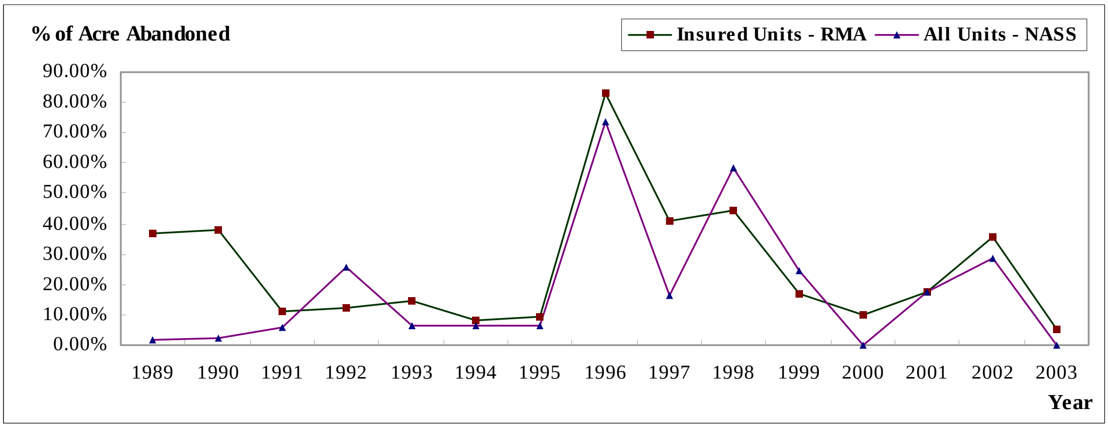

Figure 4: Comparison of Acreage Abandonment Ratio for Insured and All Farmers in Jim Wells County, Texas: 1989-2003

Dynamic Optimization Models

The paper is primarily interested in constructing an intra-seasonal dynamic optimization model that explicitly incorporates crop producer's acreage abandonment decision with and without purchasing crop insurance. Each producer's objective is to maximize expected profits. Before the planting season, each farmer decides whether to participate in the insurance policy, which crop to be insured and what coverage level to purchase. Later in the growing season, but before the harvest, the farmer observes crop conditions and the status of the economic market and makes the optimal decision to curtail or continue to make efforts to bring his crop to harvest. In other words, if the state variables, market price and crop condition, which are mainly subject to weather random shock, suggest that if the net insured profit is more likely to be higher than the crop sale profit, crop insurance may encourage the insured farmer to abandon more crops to maximize his expected profits while the non-insured producer may take the risks to continue his efforts.

Using individual farm policy data provided by the Risk Management Agency (RMA), we estimate the parameters of the structural model using a nested dynamic programming procedure in which the structural model is resolved numerically with each perturbation of the maximum-likelihood (or least-square) criterion function. Before proceeding to the intra-seasonal dynamic optimization analysis, a simple probit model is utilized to examine the sensitivity analysis of moral hazard effect. A system of linear equations for three selected counties over the years 1989-2003 is estimated for all farmers and the insured farmers. The model is given by

(1) $$y_i = \alpha + X_i \beta + e_i$$

where y_i is the acreage abandonment ratio for county i, α and β are parameters of the equation and e_i is the error term. The independent variable includes net insured profit, which is considered as the expected net return to insurance for the insured producers. Table 2 and Table 3 provide the definition and statistics summary of all relevant variables for each selected Texas counties.

Table 2: Definition of Variables

Variable	**Description**
acplt	Total number of acres planted.
achar	Total number of acres harvested.
abn_ratio	= (acplt – achar) / acplt.
acplt_ins	The number of acres/tons reported by the insured before adjustment for share.
achar_ins	Acres on which has positive production as determined by the adjuster at the time of loss.
insabn_ratio	= (acplt_ins – achar_ins) / acplt_ins.
net insured profit	Total dollar amount of the loss received, including indemnity and subsidy, minus total premium paid.

Table 3: Summary Statistics of Variables Relevant to the Sensitivity Analysis: Three Selected Texas Counties, 1989-2003

	Brooks County		Duval County		Jim Wells County	
Variable	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
acplt	2054.55	792.92	3072.73	2699.29	13546.67	5972.66
achar	1281.82	567.13	1636.36	928.73	11293.33	6420.11
abn_ratio	0.33	0.27	0.36	0.23	0.18	0.22
acplt_ins	1610.79	1184.02	2428.40	2703.12	15212.67	6803.82
achar_ins	1610.79	1184.02	2076.13	2780.01	7098.53	6494.10
insabn_ratio	0.95	0.11	0.62	0.36	0.26	0.21
net insured profit	211923.21	189261.37	185018.47	342261.96	530061.47	764200.22

Empirical Evidence

The parameter estimates for the probit model, shown in Table 4, reflects that as net insured profit increases, the acreage abandonment ratio for all farmers in Duval county increases significantly as well as for the insured producers in Jim Wells county. In addition, the significant positive coefficients on the intercept terms in the equation II for the three counties indicated that there may be other potential factors which play important roles on the insured producer’s acreage abandonment decision.

Future Study

In an attempt to address the problem of moral hazard, certain cotton producing counties in Texas are chosen for the empirical application due to the poor actuarial performance of the crop insurance in these counties and the high incidence of acreage abandonment ratio. The RMA individual insured farm policy data and the NASS county level data illustrate the potential existence of fraud behaviors in acreage abandonment between the insured and the non-insured cotton producers. The next step of this research is to construct an intra-seasonal dynamic optimization model that incorporates crop producer's acreage abandonment decision with and without purchasing crop insurance. In addition, more data at county level or at state level will be obtained to extend the scope of this study.

Table 4: Estimated Parameter Results: Three Selected Texas Counties, 1989-2003

	Brooks County		Duval County		Jim Wells County	
Variable	**Parameter Estimate**	**Standard Error**	**Parameter Estimate**	**Standard Error**	**Parameter Estimate**	**Standard Error**
Equation I: acreage abandonment ratio for all farmers						
intercept	0.182	0.154	0.274*	0.068	0.129	0.067
net insured profit	0.000	0.000	0.000*	0.000	0.000	0.000
Equation II: acreage abandonment ratio for the insured						
intercept	0.897*	0.044	0.562*	0.104	0.157*	0.051
net insured profit	0.000	0.000	0.000	0.000	0.000*	0.000

* indicates statistical significant at the 0.05 level.

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