The Effects of Transitional Yields on Adverse Selection in Crop Insurance

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Abstract

Transitional yields based on county average can be used by producers as the basis to obtain crop insurance on fields that have not previously produced the crop. Using field-level crop insurance contract data for several crops in five different growing regions we examine the impact of this asymmetric information on adverse selection. Our results indicate that adverse selection does exist from the use of transitional yields and that it is crop specific but not land-quality specific.

Keywords: adverse selection, crop insurance, transitional yields

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Production of agricultural commodities is risky by nature. One method for reducing risk is the purchase of crop insurance. Prior to 1994 the participation in crop insurance was minimal. In an attempt to entice producers to participate in crop insurance, the U.S. government enacted the Agricultural Reform Act of 1994 and the Agricultural Risk Protection Act (ARPA) of 2000, both of which increased premium subsidies. Policymakers thought that *ad hoc* disaster payments or emergency aid could be eliminated by increasing subsidies to crop insurance (Ker 2001). Results from ARPA indicate that participation in crop insurance has improved, but the incentives created from these higher subsidy levels may have increased producer opportunism. *Ad hoc* disaster payments remain.

Producer opportunism can arise because of asymmetric information between producers and the Federal Crop Insurance Corporation (FCIC). Asymmetric information can potentially plague crop insurance as each producer has a good idea of his/her land's characteristics and potential output, while the government does not have access to this private information. Asymmetric information can result in both adverse selection and moral hazard in crop insurance. Adverse selection occurs when there is "hidden information" and moral hazard is a problem of "hidden action" (Arrow, 1985). Although it is often difficult to distinguish empirically between adverse selection and moral hazard (Quiggin, Karagiannis, and Stanton 1993), it is generally regarded as adverse selection if the producer uses asymmetric information to his/her advantage in making the insurance decision, and as moral hazard if the producer changes behavior because s/he has insurance.

The opportunity for adverse selection and moral hazard in crop insurance are in part due to the large number of options available to the producer. Options include coverage level (50-85% for most crops), insurance type (multiple-peril yield, crop revenue coverage, revenue assurance, or income protection), unit structure on which policy is written (entire farm or individual field), and the option to use transitional yields (T-yields) based on county average yield when the unit does not have at least four years of proven yields (actual production history).

A considerable body of literature has addressed both theoretical and empirical impacts of asymmetric information in crop insurance. Among the empirical findings, Roberts, Key and O'Donoghue (2006) found evidence of moral hazard in production decisions on insured wheat and soybean farms in Texas. Makki and Somwaru (2001) found evidence of adverse selection in both coverage level and insurance type decisions. High-risk producers were more likely to select revenue insurance contracts and higher coverage levels. Just, Calvin and Quiggin (1999) found that the subsidy benefits of crop insurance outweighed its risk-aversion incentive and were largely due to adverse selection. Smith and Goodwin (1996) found that adopters of crop insurance engaged in moral hazard by using fewer inputs than non-adopters. Their findings were contradictory to those of Horowitz and Lichtenberg (1993). Skees and Reed (1986) found evidence of adverse selection due to asymmetric information in (a) the relationship between the producer's choice of coverage level and expected yields and (b) the bias introduced in coverage protection when trends are not used to establish expected yields.

In this paper we examine whether adverse selection is evident in the use of T-yields in field-level data for crop insurance. Adverse selection can occur when producers insure fields without actual production history (APH) that have expected yields sufficiently lower than the 10-year county average. Our study of adverse selection in crop insurance builds upon the previous literature and is innovative in two ways: it addresses for the first time the impact of using T-yields on adverse selection, and it uses field-level crop insurance and performance data which have only been used previously by Roberts, Key, and O'Donoghue (2006). The objective is important to policymakers. If a correlation exists between the use of T-yields and return from crop insurance, crop insurance policymakers can use this information to make appropriate changes in subsidy level and premium structure to offset the informational advantage held by agricultural producers.[1]

The T-yield option permits producers to enroll fields in the crop insurance program that have not previously, or only seldom, been used to produce a particular crop. Without an established APH, T-yields can be used as an alternative. Establishing APH yield requires a minimum of four and a maximum of 10 consecutive years of verifiable yield records for the crop. If the minimum of four consecutive years of actual yields is not available, a T-yield must be substituted for each missing year. T-yields are based on the 10-year county average yield. A new producer or one who has never planted the crop on the insured field receives 100 percent of the county average yield as his/her T-yield. The percents that apply to producers with 0-3 years of field production records are reported in table 1.

The option to insure a farm as one unit or as multiple units (typically fields) provides an important potential for adverse selection. If insured as multiple units, an indemnity may be received on one unit of the farm, for example on the south end because it received minimal moisture, when the north end had received normal moisture. If the producer opted to insure the farm as one unit, yields from both ends would be averaged. This averaging may or may not warrant an indemnity. No indemnity would occur if the higher yields on the north end increased total production sufficiently to exceed the production guarantee. If an indemnity is paid, it

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[1] Return = (indemnity – premium)/acre insured.

applies to the whole farm. Yet, little attention has been given to the unit structure decision or to examining data by field rather than by entire farm.

The paper is organized as follows. We first present detailed hypotheses that will be tested to achieve the objectives. Then we describe our method of analysis and data. Findings are presented and interpreted in the results section. We discuss implications of our results in the conclusions section.

Hypotheses

In our examination of adverse selection in crop insurance, we pursue eight specific objectives through hypothesis tests. The objectives are to determine whether the use of T-yields results in evidence of adverse selection through indemnity payments, total return, or producer return; whether the use of additional T-yields alters the evidence of adverse selection; whether evidence of adverse selection from the use of T-yields differs by crop or region; whether the presence of a subsidy effects the amount of adverse selection; and whether evidence of adverse selection occurs by purchasing higher insurance coverage on higher-risk fields. The first seven all deal with the use of T-yields. The last one is more general. The specific hypotheses to be tested and their justification follow.

1. Indemnity per acre increases with the use of transitional yields. This hypothesis addresses the specific question: "Is indemnity increased from the use of T-yields?" Land quality is known to vary within counties. Therefore, expected yields also vary across individual fields within counties. A producer may know or have a good idea what the expected yield is for each field s/he farms. Because fields without verifiable production records can purchase crop insurance using T-yields, those with expected yields sufficiently below the county average may not only transfer risk but also increase expected profit from the field by purchasing insurance.

However, if the producer has been producing the insured crop on the field and has verifiable yield records, s/he is required to provide the yields from the field. If the producer did not keep good records or claims failure to keep good records, s/he must use T-yields to obtain insurance. Fraud is committed when the producer fails to report actual yields. Adverse selection is committed when those seeking insurance know that their risks are higher than insurers think they are. However, it is difficult to distinguish between adverse selection and fraud when producers use T-yields.

2. Total return increases with the use of transitional yields. Total return is the difference between the indemnity and the total premium. Total premium is the sum of government subsidy and producer premium. The amount of government subsidy is specific to each producer's crop insurance contract. Because society is contributing to crop insurance by the amount of the subsidy, this hypothesis asserts that use of transitional yields results in adverse selection from a societal perspective.

3. Producer return increases with the use of transitional yield. Producer return is the difference between the indemnity and producer premium. Producers likely have better knowledge of their risks than the Federal Crop Insurance Corporation (FCIC). Therefore, producers selecting the optimal coverage level and insurance product type may be able to profit as well as reduce risks from crop insurance participation. Profiting from crop insurance would imply that adverse selection exists at the producer level.

4. Producer return is increased with the use of additional transitional yields. Depending on the number of verifiable yield records, a producer may use 1-4 T-yields when purchasing crop insurance. As the number of T-yields used increases, a larger discount is taken from the county average yield in forming the producers APH (see table 1). The only exception is if the producer is a beginning producer or new to growing the crop. In this case, the producer receives 100 percent of the T-yield for his/her APH. As more transitional yields are used, less information is provided by the producer. Because less information is provided by the producer, the amount of asymmetric information between the producer and the government could increase. As the amount of asymmetric information increases, the probability of adverse selection is expected to increase.

5. Adverse selection due to the use of transitional yields varies among crops. Each county in each region has a unique set of characteristics for growing and marketing crops. Some favor a diverse set of crops and others a monoculture. Because not all producers have the same set of viable choices, it is expected that crop selection to affect the extent of adverse selection from the use of T-yields. We compare evidence for three crops to the extent relevant in five regions.

6. Counties with more heterogeneous land resources provide a higher return from the use of transitional yields than counties with more homogeneous land. Land quality is an important determinant of land use and yields (Hardie and Parks, 1997). Regions with highly variable land resources within counties may promote more asymmetric information in the use of T-yields than those with more homogeneous within-county resources. Producer opportunism for profiting from crop insurance would be expected to be greater in counties with more variable land resources across the county. The use of transitional yields could provide a yield guarantee well above the actual production ability of some fields.

7. Subsidization of crop insurance promotes adverse selection. The difference between total premium and producer premium is the subsidy provided by the government. It is expected that subsidizing crop insurance increases the extent of adverse selection. By comparing the results between total premium and producer premium we are able to calculate the amount of adverse selection, if any, contributed by the subsidy.

8. Higher insurance coverage is selected on higher-risk fields. Adverse selection models predict that high-risk types purchase higher insurance coverage (Rothschild and Stiglitz 1976). Because producers have a better idea of their field's risk than does the government, it is likely that producers in high-risk areas purchase higher insurance coverage. We test this hypothesis for each of the five growing regions.

Method of Analysis

In this section we outline how crop insurance works and how the yield guarantee can be manipulated. We then present the empirical model and identify variables used in the analysis as well as regions and crops studied. All equations are specified in per-acre terms. Return from crop insurance is equal to:

$$R_{hj} = I_{hj} - P_{hj},$$

where R_{hj} represents return, I_{hj} represents indemnity, and P_{hj} represents premium from crop insurance for field *h, h*=1,…,n and crop *j*, *j*=1,…,I. Indemnity for MPCI is calculated as:

$$I_{hj} = [YG_{hj} - AP_{hj}] \times PE_j,$$

where YG_{hj} represents the yield guarantee, AP_{hj} represents actual production, and PE_j is the price election. Price election is set by the government. Actual production is what the producer produced. Indemnity for revenue insurance is calculated as:

$$I_{hj} = [YG_{hj} * \max(P_{bj,} P_{haj})] - [AP_{hj} * P_{haj}],$$

where P_{bj} and P_{haj} represent the base and harvest price, respectively. The base price is typically determined by the average of a futures contract just prior to planting. Harvest price is typically determined by the average of a futures contract when the crop is maturing. As an example, the base price for corn is the average of December futures contract price during February. The harvest price for corn is the average of December futures contract price during October.

Yield guarantee is calculated as:

$$YG_{hj} = CL_j \times APH_{hj}$$

where CL_j represents coverage level and APH_{hj} represents actual production history.

Return is expected to be a function of county weather characteristics (i.e., growing degree days (GGD)), location, year, insurance decisions the producer makes (i.e., coverage level and insurance type), field practice (i.e., whether the land was in fallow the previous year), and number of T-yields used to create the APH. GGD is the only continuous variable. We include dummy variables for county, year (8 variables), coverage level (7 variables), insurance type, crop, field practice (1 variable), and T-yields (4 variables). The number of dummy variables for county, insurance type, and crop depend on the region. Table 2 defines the variables used.

To test hypotheses 1-7, we assume the functional form of each estimation equation to be linear:

$$Y_{hijkt} = \alpha_k + \delta_t + X_{jikt}\beta + TY_{ijhkt}\gamma + \varepsilon_{hijkt} \quad \text{for } h = 1,\ldots,H; i = 1,\ldots,I; \mathrm{j} = 1,\ldots,\mathrm{N}; \\ k = 1,\ldots,K; t = 1,\ldots,T. \tag{1}$$

where, depending on the hypothesis, *Y* represents the magnitude of the indemnity, total return, or producer return; α_k and δ_t are county and year fixed-effects; *X* is a matrix comprised of a column of ones, GGD, and dummy variables for coverage level, insurance type, crop, and field practice; TY represents dummy variables when *i* T-yields are used for crop *j*. Fixed-effects regression is used as the estimation method because of the large panel data set. County and year fixed-effects are used to capture unobserved heterogeneity in agricultural production between counties and between years.

The constant in the equations estimated to test hypotheses 1-7 represents a producer that provided all actual yields for the field's APH in year 2002; for a specific county; with MPCI insurance, on a continuous cropped field, and who grew wheat. The structure on the constant allows a direct interpretation of the effect of T-yields on the dependent variable by the estimated coefficient from each T-yield.

Estimation was done using STATA. All models showed evidence of heteroskedasticity. Therefore, a robust estimator, White's variance sandwich estimator, was used. Because some producers have many fields and we have field-level data, we do not assume independent and identically distributed (IID) sampling error across a producer but we do assume IID sampling error between producers. To account for this sampling error problem, we use a robust cluster estimator which adjusts for within-cluster correlation (Wooldridge, 2002). The robust cluster variance estimator is:

$$(2) \qquad V = (x'x)^{-1} * \sum_{g=1}^{nc} U_g{}' * U_g * (x'x)^{-1}$$

where x is the regressor vector, $U_g = \sum_{g} e_h * x_h$, and nc is the total number of clusters.

Estimation to test hypotheses 1, 2, and 3 are conducted with the dependent variable in equation (1) specified as indemnity, total return, and producer return, respectively. Hypotheses 4, 5, and 6 are tested with producer return as the dependent variable. Hypothesis 7 is tested using results from hypothesis 2 and 3. And hypothesis 8 is testing using a bivariate probit.

For hypothesis 1, a positive and significant relationship between a T-yield and the dependent variable would identify that adverse selection exists in support of the hypothesis. An insignificant or a significant negative relationship would indicate a lack of adverse selection and rejection of the hypothesis. In hypothesis 1 we are interested in the effect of T-yields on the magnitude of an indemnity if there is one. Thus, we exclude all fields that received no indemnity from the sample. Because most producers do not receive an indemnity, the distribution of indemnity for all fields consists of a large number of zeros and a slightly right-skewed distribution of distributions. Including in the regression a large number of observations with dependent variable values of zero can provide inconsistent parameter estimates.

For hypotheses 2 and 3, a positive and significant relationship between a T-yield and the dependent variable would identify that adverse selection exists in support of the hypothesis. Data for all insured fields in the selected regions are included in the sample to test these and subsequent hypotheses.

Support for hypothesis 4 is provided if the parameters on T-yields are positive and significant and increase in magnitude as the number of T-yields used increases. Support for hypothesis 5 occurs if the parameters on T-yields for some crops are positive and significant and differ significantly from other crops. Support for hypothesis 6 occurs if the parameters on T-yields are positive and significantly greater for regions with more heterogeneous land resources than for regions with more homogeneous land resources.

To test hypothesis 7 requires a test of significant difference between the parameters on T-yields from hypotheses 2 and 3 for which private adverse selection was found to(i.e., hypothesis 3):

$$(3) \qquad \Delta\beta = \hat{\beta}_{wo} - \hat{\beta}_{w}$$

where *wo* represents the estimated significant coefficient from T-yields in hypothesis 2 when the dependent variable accounts for the full cost of the insurance,, and *w* represents the estimated coefficient from T-yields in hypothesis 3 when the dependent variable accounts only for the producer's cost. If the subsidy had not been available, then the producer would have had to pay the total premium to get crop insurance. Total premium includes both producer premium and the subsidy. This would result in a social adverse selection effect of $\hat{\beta}_{wo}$. With the subsidy, the producer only paid the producer premium. Paying the producer premium would result in a private adverse selection effect of $\hat{\beta}_{w}$. A significantly positive difference between $\hat{\beta}_{wo}$ and $\hat{\beta}_{w}$ would indicate support for hypothesis 7. A Wald test is conducted to test for significant difference between the parameters.

To test hypothesis 8, we implement a test for the presence of adverse selection developed by Chiappori and Salani (2000). When policyholders have private information, adverse-selection models predict that high-risk individuals will purchase higher insurance coverage than low-risk individuals. Hypothesis 8 is tested by determining whether producers select higher insurance coverage on fields with higher risk than on those with lower risk.

Because only a small portion of fields are insured at high coverage levels, we categorize coverage levels into two groups: high (with coverage levels of 75 percent and above) and low (with all lower coverage levels).[2] We specify two probit models, one for the choice of coverage, V_{jt}, and the other for the occurrence of an indemnity, Z_{jt}.

$$(4) \qquad V_{hijkt} = 1(\alpha_k + \delta_t + X_{ijkt}\beta + TY_{hijkt}\gamma + \varepsilon_{hijkt})$$

and

$$(5) \qquad Z_{hijkt} = 1(\alpha_k + \delta_t + X_{jikt}\beta + TY_{hijkt}\gamma + \eta_{hijkt})$$

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[2] Coverage levels above 75 percent represent the following percent of the population of "new" fields: 2.7% for Oklahoma, 25.5% for Montana, 33.8% for Washington, 11.1% for Nebraska, and 35.9% for Iowa.

where the structure in (4) and (5) indicates a variable which equals 1 when the condition in the parentheses is greater than zero and zero when it is not (Green, 2003). ε_i and η_i are distributed as N(0,1).

We estimate equations (4) and (5) as a bivariate probit or system of two equations. From the bivariate probit, we are interested in the correlation coefficient between the two equations, ρ. Support for the hypothesis if the correlation coefficient is statistically different from zero. Only fields entering the insurance program for the first time are analyzed because information was not previously shared between the producer and the government. With the exception of coverage level, which is now the dependent variable in equation (4), regressors are the same as in equation (1).

Data

The data include observations of crop insurance contract information and corresponding performance records for all insured fields for each of eight years between 1995 and 2002. The data were obtained from the Risk Management Agency (RMA). Although there was *ex ante* asymmetry of information, all of the information we need to examine the effects of asymmetric information on crop insurance was observed by the government *ex post.* Our study differs from previous work because we have an unbalanced panel with a moderate time-series (eight years) and a very large cross section of field-level data. Most prior studies have used a cross section of farm- and/or county-level data, so their findings have generally been limited to the more aggregate units for only one year (e.g., Smith and Goodwin, 1996; Horowitz and Lichtenberg, 1993; Goodwin and Kastens, 1993). Only Roberts, Key and O'Donoghue (2006) have used field level data and few have used a panel. Field-level data allows us to precisely analyze how crop insurance choices (i.e., producer selected components) and the resulting performance (i.e., an indemnity) could be a result of adverse selection. Aggregation to the county-level may disguise or dampen the true effects of crop insurance choices.

For the analysis to address heterogeneity of land resources, the data used in our sample consist only of dry-land agricultural production. The data include all the information that the FCIC has for each crop insurance contract: indemnity amount, premium paid by producer, premium before subsidy, amount of subsidy, crop type, field practice, coverage level, insurance type, county location of field, and APH. Field-level crop insurance contract data was supplemented with county-level annual growing degree-day data. Growing degree-day data along with county and year fixed effects act as control variables for heterogeneity between counties and years that could come from differences in weather and land quality.

Since T-yields vary by crop, they were split into four different crop types: wheat, corn, soybeans, and other. The three individual crops represent the highest-value insured crops grown in the U.S. The other category represents all other insured crops grown in that specific region.

The study area is composed of five different growing regions, two relatively homogenous (Iowa and Western Nebraska) and three heterogeneous growing regions (Oklahoma, North-central Montana, and Eastern Washington). The five growing regions produce some of the same crops but crop mix differs by area. We use soil organic matter as our land quality indicator. Soil organic matter is an important indicator of soil quality (Pulleman et. al., 2000). Figure 1 presents soil organic matter content for the continental U.S. Darker (lighter) regions indicate a higher (lower) amount of soil organic matter. Regions such as Oklahoma and North-central Montana have predominantly lower amounts of soil organic matter and vary much more across relatively small areas such as counties than regions such as Iowa, Western Nebraska and Eastern Washington.

Results

Since we have a large number of estimated coefficients, it would be impractical to comment on them all. We only report and discuss those pertinent to the tested hypotheses.[3] All hypotheses are tested using a 10% level of significance. The coefficients of interest are the ones on the T-yield dummy variables. We focus on three commodities, wheat, corn, and soybeans, but also make comment on the "other" category when appropriate. This category is composed of a variety of insured crops.[4]

Estimation results relevant for hypothesis 1 are reported in table 3. For this hypothesis, we test whether indemnity per acre increases with the use of transitional yields. For wheat, significantly positive parameter estimates were found on all transitional yield variables in Oklahoma and Montana and on half in Nebraska and only one in Washington. For corn, a significantly positive parameter estimate was found for one transitional yield variable in Iowa and none in Oklahoma or Nebraska. For soybeans, a significantly positive parameter estimate was found for one transitional yield variable in Iowa. For other crops, significantly positive parameter estimates were found on one or more transitional yield variables in Montana, Washington, Nebraska, and Iowa, but not in Oklahoma. Thus, evidence of adverse selection on indemnity was found in the use of T-yields for at least one crop in all five regions and for each crop (or crop group) in at least one region. Only for cotton, which was grown only in Oklahoma, was there no evidence of adverse selection on indemnity.

Results for hypothesis 2 are presented in table 4. For this hypothesis, we test whether total return increases with the use of transitional yields. For wheat, significantly positive

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[3] The complete regression results are available on request to the authors.

[4] Crops included in the other category for each state are: Oklahoma – cotton, Montana – barley, Washington – barley, oats, and canola, Nebraska – millet, Iowa – canola.

parameter estimates were found on one or more of the transitional yield variables in Oklahoma, Montana, and Nebraska, but not in Washington. For corn and soybeans, none of the relevant parameters were significantly positive. For other crops, a significantly positive parameter estimate was only found in Iowa. Thus, evidence of adverse selection on total return was found in the use of T-yields for wheat in most regions and for canola in one region. Only in Washington was there no evidence of adverse selection from the use of T-yields. Because producers do not have to pay the total premium, adverse selection is used here in a social rather than private sense.

Results for hypothesis 3 are presented in table 5. For this hypothesis, we test whether producer return increases with the use of transitional yields. The results are similar to those for hypothesis 3. Significantly positive parameter estimates were found for wheat on one or more of the transitional yield variables in Oklahoma, Montana, and Nebraska, but not in Washington. Also, none of the relevant parameters were significantly positive for corn or soybeans. The only difference occurred for other crops where significantly positive parameter estimates were found in all regions except Montana. Thus, evidence of adverse selection on producer return was found in the use of T-yields for wheat in most regions and for other crops (including cotton, canola, barley, oats, and millet) in most regions. There was evidence of adverse selection in the traditional private sense from the use of T-yields in all regions such that producers could profit from using T-yields. This result provides further support to Just, Calvin, and Quiggin's (1999) finding that producers participate in crop insurance because of adverse selection possibilities. Our results are also consistent with the findings from Roberts, Key and O'Donoghue (2006) in that wheat displayed some evidence of moral hazard. They also found evidence of moral hazard in soybean production in Texas. We found no evidence of adverse selection in soybean production. However, we only studied one region with dry-land soybean production, Iowa. Differences in results could come from the fact that our approach through T-yields is quiet different from their approach.

For the fourth hypothesis, we test whether producer return increases with the use of additional transitional yields. Results from table 5 indicate that only wheat in Montana provided evidence that producer return unambiguously increases with the use of additional transitional yields. Corn and other crops in Oklahoma and other crops in Iowa also provided general support for the hypothesis. The remaining cases failed to support or gave ambiguous results. Thus, we conclude that there is little evidence to support the hypothesis that additional T-yields is associated with increased producer return.

For the fifth hypothesis, we test whether adverse selection from the use of T-yields varies between crops. Results from table 5 provide clear support for this hypothesis. Without a clear way to statistically conduct a test of this hypothesis, we approach it by comparing the number and mean of the significant positive parameter estimates on T-yields for each crop. Wheat has five significant positive parameters that imply adverse selection with a mean of 0.98. Corn and soybeans have no significant positive parameters and consequently no evidence of adverse selection. Other crops have four significant positive parameters with a mean of 1.81. Evidence of adverse selection is apparent for only two of the four crops, and its average magnitude differs substantially.

For the sixth hypothesis, we test whether regions with counties having more heterogeneous land resources provide a higher return from the use of T-yields than those with more homogenous counties. Table 5 was used to test this hypothesis. Oklahoma, North-central Montana, and Eastern Washington have greater land heterogeneity than Iowa or Western

Nebraska (see figure 1). We approach this hypothesis similarly to the previous one by looking at the number and average of the positive significant parameters on T-yields. Since there is no evidence of evidence of higher returns from the use of corn or soybean T-yields, we confine our attention to wheat and other crops. For wheat, there are three significant positive parameters with an average value of 0.85 in the more heterogeneous area and two with an average value of 1.16 in the more homogeneous area. For other crops, there are two significant positive parameters in each area. Their average is 2.02 in the heterogeneous area and 1.60 in the more homogeneous area. Thus, the hypothesis is supported for other crops but not for wheat, corn, or soybeans. With the relatively small difference between areas even for other crops and because that is a broad grouping, we conclude that we do not find appreciable support for hypothesis 6.

For hypothesis 7, we test whether the subsidization of crop insurance promotes adverse selection. Using equation (3), Wald tests are conducted for a significant positive difference in the coefficient value due to subsidization when evidence of private adverse selection was found (i.e., hypothesis 3). The values in table six are the difference in parameter estimates from hypothesis two and hypothesis three, in dollars per acre. Results from the Wald test indicate a significance difference in parameter estimates for all cases where adverse selection was found. Only the results for wheat in Oklahoma and canola in Iowa were consistent with the hypothesis. In the remaining six cases, accounting for subsidization decreased the evidence for adverse selection. With two-thirds of the significant parameter estimates supporting the hypothesis, we conclude that we do not have strong enough evidence to support hypothesis 7.

For hypothesis 8, we test whether higher insurance coverage is selected on higher-risk fields. This hypothesis is tested using the correlation coefficients from the bivariate probit, equations (4) and (5). As reported in table 7, they indicate a positive and significant estimate for ρ in all regions. This result suggests a moderate to strong relationship between choosing high insurance coverage and having an indemnity. Thus, we conclude that adverse selection does exist in these crop insurance markets. This result is consistent with previous research by Makki and Somwaru (2001) in that high-risk producers are more likely to select higher coverage levels.

Conclusions

Results from this paper are based upon field-level crop insurance contracts for several crops in five different regions. Using an unbalanced panel data set rich in crop insurance contract information, our results indicate that adverse selection occurs in some crops because of the use of T-yields. Not only do our results suggest that adverse selection exists but producers can make a profit from using T-yields. However, adverse selection does not occur in all crops, and we were unable to explain the differences based on heterogeneity of land resources. Our results also suggest that as less of information is provided by the insurer does not result in additional amounts of adverse selection. We were also unable to draw a clear conclusion on the effect that the subsidy has had on the use of T-yields.

Our results provide three important pieces of information to policymakers. First, we have documented that use of T-yields can be a source for adverse selection and warrants redesign of insurance contracts, especially for wheat. Second, we have identified that the yield guarantee can be a source of adverse selection. The yield guarantee is linked closely to producer premium. Further analysis of producer premium structure can potentially lead to a more efficient crop insurance program. Third, we found a strong positive correlation between having an indemnity and choosing high coverage level which also warrants additional care in contract design.

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Table 1: Yield Discounts Associated with T-yields

Number of T-yields Needed	Percent of County Average Yield used in T-yield Calculation
1	100 percent
2	90 percent
3	80 percent
4	65 percent

Table 2: Variable Description

Variable Name	Variable Definition
Indemnity	indemnity/acre insured
Producer Return	(indemnity – producer premium)/acre insured
Total Return	(indemnity – total premium)/acre insured
Growing Degree Days	county average number of growing degree days above 20 degrees Celsius
County	county fixed-effect
Year	year fixed effect: 1995 to 2002
Coverage level	50% to 85% in 5% increments
Insurance Type	multiple peril crop insurance, crop revenue coverage, revenue assurance, or income protection
Field Practice	= 1 if field was cropped the previous year, 0 otherwise
T-yields	= 1 if “t” number of T-yields were used, zero otherwise, t = 1, 2, 3, 4

Table 3. Parameter Estimates for Hypothesis One [a]

Crop	Parameter	Region				
		Oklahoma	North-central Montana	Eastern Washington	Western Nebraska	Iowa
Wheat	4 T-Yields	3.663*	4.729*	-2.012*	-0.970	—
		(5.18)	(3.61)	(-2.13)	(0.75)	
	3 T-Yields	2.090*	3.433*	-1.134	0.889	—
		(4.14)	(1.87)	(-0.95)	(0.65)	
	2 T-Yields	2.882*	4.484*	0.203	2.803*	—
		(5.24)	(2.81)	(0.17)	(2.08)	
	1 T-Yield	2.715*	2.494*	-0.688	-3.854*	—
		(5.59)	(2.62)	(-0.60)	(2.91)	
Corn	4 T-Yields	4.741	—	—	-3.571	-2.201
		(0.50)			(1.36)	(.44)
	3 T-Yields	-3.631	—	—	-6.289*	-1.067
		(0.40)			(1.91)	(.34)
	2 T-Yields	-5.445	—	—	-5.281*	1.333
		(0.71)			(1.86)	(.49)
	1 T-Yield	0.309	—	—	-2.925	6.815*
		(0.03)			(1.15)	(2.54)
Soybeans	4 T-Yields	—	—	—	—	2.401
						(.76)
	3 T-Yields	—	—	—	—	5.505*
						(2.43)
	2 T-Yields	—	—	—	—	1.357
						(.76)
	1 T-Yield	—	—	—	—	2.723
						(1.58)
Other	4 T-Yields	-0.842	-4.520*	-4.384*	-7.482*	-11.402*
		(0.51)	(3.87)	(-2.73)	(4.75)	(2.30)
	3 T-Yields	-2.123	-4.253*	-0.241	-3.605*	-8.531
		(1.21)	(2.31)	(-0.09)	(1.98)	(1.32)
	2 T-Yields	-3.206	-4.490*	2.694	-5.752*	-4.591
		(1.33)	(3.25)	(1.13)	(3.33)	(.72)
	1 T-Yield	-2.134	-2.920*	4.744*	-0.851	-5.893
		(0.77)	(2.17)	(2.70)	(0.36)	(.39)
Observations		28,778	17,774	8,534	11,710	18,194

[a] Units are in dollars per acre. Absolute values of asymptotic t-values are in parentheses. * implies parameter is significant at the 0.10 level.

Table 4. Parameter Estimates for Hypothesis Two [a]

		Region				
Crop	Parameter	Oklahoma	North-central Montana	Eastern Washington	Western Nebraska	Iowa
Wheat	4 T-Yields	-0.619*	1.633*	-0.393*	-0.559*	—
		(2.88)	(3.53)	(5.01)	(1.89)	
	3 T-Yields	-1.35*	0.734	-0.356*	0.103	—
		(6.64)	(1.31)	(3.32)	(.37)	
	2 T-Yields	0.621*	0.552	-0.249*	0.537*	—
		(2.95)	(1.11)	(1.84)	(1.85)	
	1 T-Yield	0.575*	0.122	-0.203	1.030*	—
		(2.86)	(0.41)	(1.49)	(3.38)	
Corn	4 T-Yields	0.204	—	—	-1.995	-1.180*
		(.06)			(1.55)	(2.61)
	3 T-Yields	-4.706	—	—	-5.116*	-0.800*
		(1.44)			(3.60)	(3.83)
	2 T-Yields	-2.868	—	—	-3.391*	-0.852*
		(.85)			(2.57)	(3.84)
	1 T-Yield	4.695	—	—	-0.974	-0.202
		(1.39)			(.70)	(.86)
Soybeans	4 T-Yields	—	—	—	—	-0.070
						(.14)
	3 T-Yields	—	—	—	—	-0.165
						(.42)
	2 T-Yields	—	—	—	—	-0.465
						(1.51)
	1 T-Yield	—	—	—	—	-0.151
						(.49)
Other	4 T-Yields	1.122	-0.779*	-0.397*	-2.681*	2.447*
		(1.50)	(2.09)	(5.02)	(4.96)	(2.75)
	3 T-Yields	-1.512	-1.071*	-0.227*	-1.518*	-1.430*
		(1.59)	(2.17)	(2.17)	(2.11)	(1.84)
	2 T-Yields	-2.022	-0.982*	0.114	-1.916*	0.665
		(1.62)	(2.38)	(.68)	(3.45)	(.61)
	1 T-Yield	-0.938	-0.684	0.276	-0.549	-0.223
		(.81)	(1.20)	(1.43)	(.68)	(.18)
Observations		101,982	63,917	97,545	55,715	184,661

[a] Units are in dollars per acre. Absolute values of asymptotic t-values are in parentheses. * implies parameter is significant at the 0.10 level.

Table 5. Parameter Estimates for Hypotheses Three, Four, Five, and Six [a]

		Region				
Crop	Parameter	Oklahoma	North-central Montana	Eastern Washington	Western Nebraska	Iowa
Wheat	4 T-Yields	-0.715*	1.724*	-0.134*	-0.064	—
		(3.21)	(3.57)	(1.70)	(0.21)	
	3 T-Yields	-1.496*	0.865	-0.101	-0.513*	—
		(7.05)	(1.49)	(0.97)	(1.80)	
	2 T-Yields	0.448*	0.684	0.043	0.930*	—
		(2.06)	(1.32)	(.32)	(3.17)	
	1 T-Yield	0.390*	0.236	0.020	1.398*	—
		(1.89)	(.77)	(.15)	(4.54)	
Corn	4 T-Yields	-0.213	—	—	-1.900	-1.284*
		(0.08)			(1.43)	(3.04)
	3 T-Yields	-3.108	—	—	-5.038*	-0.352
		(1.29)			(3.39)	(1.55)
	2 T-Yields	-2.767	—	—	-3.158*	-0.427*
		(1.15)			(2.30)	(1.82)
	1 T-Yield	-4.896*	—	—	-0.866	0.154
		(1.81)			(0.61)	(.60)
Soybeans	4 T-Yields	—	—	—	—	0.041
						(.10)
	3 T-Yields	—	—	—	—	0.127
						(.35)
	2 T-Yields	—	—	—	—	-0.185
						(.63)
	1 T-Yield	—	—	—	—	0.218
						(.80)
Other	4 T-Yields	3.708*	-0.802*	-0.213*	-2.127*	1.570*
		(4.50)	(2.11)	(2.75)	(4.02)	(2.21)
	3 T-Yields	1.273	-1.179*	-0.023	1.135	-0.703
		(1.39)	(2.36)	(0.23)	(1.54)	(.89)
	2 T-Yields	0.477	-1.064*	0.231	1.632*	1.164
		(0.40)	(2.54)	(1.37)	(2.92)	(1.15)
	1 T-Yield	1.421	-0.791	0.327*	-0.270	0.577
		(1.17)	(1.42)	(1.68)	(0.33)	(.42)
Observations		101,982	63,917	97,545	55,715	184,661

[a] Units are in dollars per acre. Absolute values of asymptotic t-values are in parentheses. * implies parameter is significant at the 0.10 level.

Table 6. Amount of Adverse Selection due to Subsidy (Hypothesis Seven) [a]

Crop	Parameter	Region Oklahoma	 North-central Montana	 Eastern Washington	 Western Nebraska	 Iowa
Wheat	4 T-Yields	—	-0.091*	—	—	—
	3 T-Yields	—	—	—	—	—
	2 T-Yields	0.173*	—	—	-0.393*	—
	1 T-Yield	0.185*	—	—	-0.368*	—
Other	4 T-Yields	-2.586*	—	—	—	0.877*
	3 T-Yields	—	—	—	—	—
	2 T-Yields	—	—	—	-3.548*	—
	1 T-Yield	—	—	-0.051*	—	—

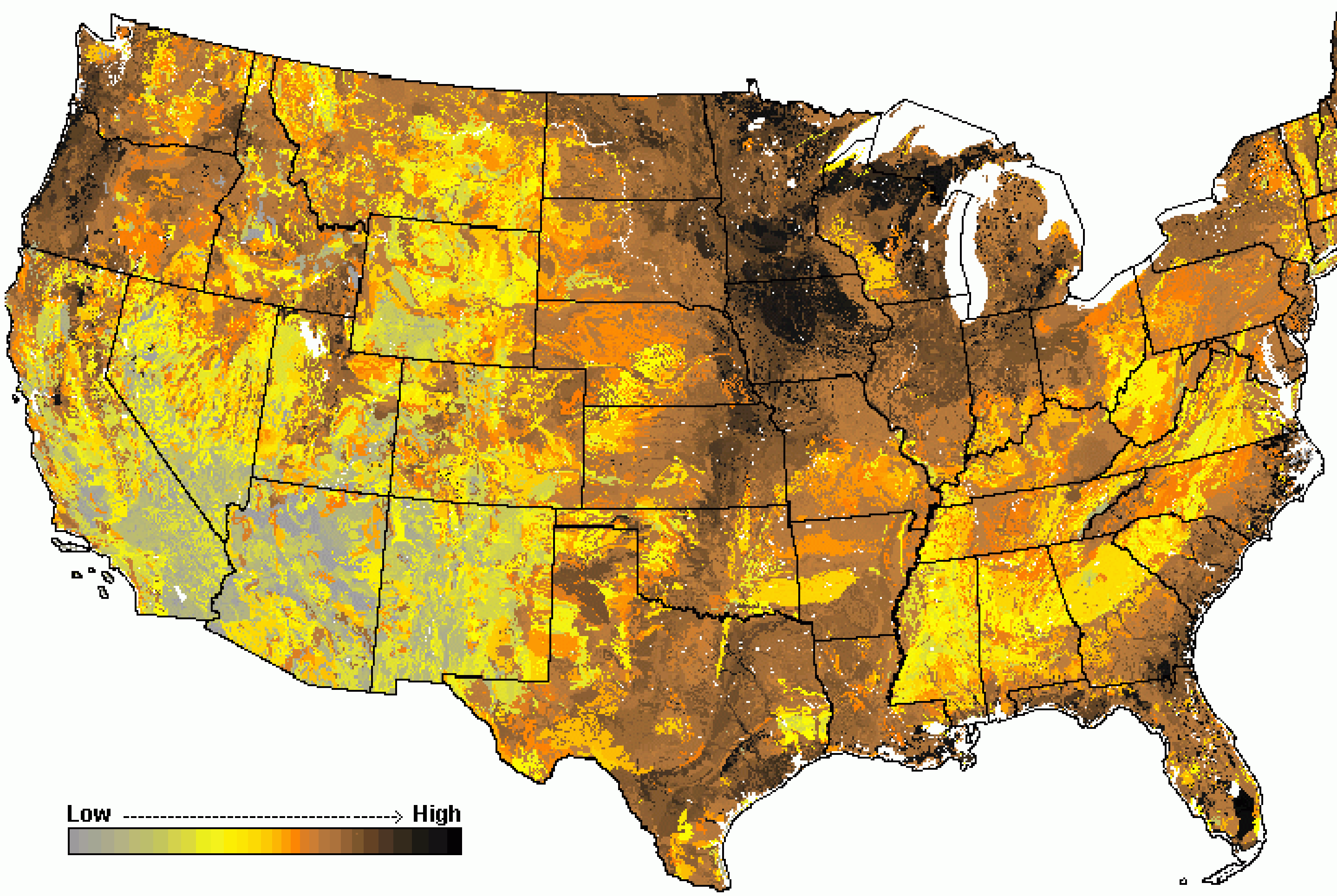
[a] * implies difference is significant at the 0.10 level.

Table 7. Correlation Coefficients for Biprobit Estimates of Hypothesis Eight [a]

Parameter	Region Oklahoma	 North-central Montana	 Eastern Washington	 Western Nebraska	 Iowa
ρ	.168*	.236*	.335*	.194*	.410*
	(.042)	(.037)	(.032)	(.048)	(.015)
Observations	8,375	3,329	8,363	3,179	22,317

[a] Standard errors are in parentheses; * implies difference is significant at the 0.10 level.

Figure 1. Soil Organic Matter Content



Source : W.W. Hargrove and R. J. Luxmoore