Adoption of Crop versus Revenue Insurance: A Farm-Level Analysis

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Abstract

This research examines factors influencing the adoption of crop and revenue insurance. This is accomplished by estimating a multinomial logit model of insurance choices facing U.S. farmers. Results indicate significant differences in the probabilities of adoption of each insurance plan. The levels of selected explanatory variables, such as operator's education level, debt-to-asset ratio, off-farm income, soil productivity, participation in production and marketing contracts, and type of farm ownership, appear to be the determinants of the probability of having adopted each insurance plan.

Key words: adoption, crop insurance, multinomial logit, revenue insurance, stratified data

The 1996 Federal Agriculture Improvement and Reform (FAIR) Act replaced the complex system of deficiency payments and annual supply management programs, in place since 1973, with a set of known, annually declining payments. Without deficiency payments to compensate for commodity price variability, some have argued farmers' revenues could be more uncertain (Young and Westcott).¹

This new source of price risk may be compounded by both the new freedom to plant any crop based on price expectations and greater world market integration achieved via trade liberalization. Since producers also were extended greater flexibility in switching crops from year to year, price variability may increase. Alternatively, this new flexibility could reduce price variability if producers are better able to respond to market conditions.

There is much interest in how innovative risk management tools may enable farmers to adapt to the new risk environment created by the 1996 Farm Act. A significant number of farmers (Harwood et al.) use risk management tools such as diversification, forward contracting, hedging, crop insurance, and reserve lines of credit.

The 1985 Farm Bill mandated studies into the feasibility of providing revenue insurance through subsidized put options
on futures contracts and crop insurance
(Glauber, Harwood, and Miranda; Heifner
and Wright; Plato). Although traditional
multiple peril crop (yield) insurance
(MPCI) still accounts for much of the
federally subsidized crop insurance,
revenue insurance products that only
recently have become available are
increasingly popular.

Income Protection (IP) and Crop Revenue
Coverage (CRC) first became available for a
few crops in selected areas for the 1996
crop year, and Revenue Assurance (RA)
was added in the 1997 crop year. In fact,
for winter wheat, the USDA’s Risk
Management Agency estimates that from
2000 to 2001, revenue insurance coverage
increased from 17% to 58% of all acreage
insured under federally sponsored crop
insurance. Additionally, in 2002, corn and
wheat revenue products comprised roughly
66% of the insured acreage, and soybean
revenue products comprised nearly 50%.

Skees et al. point out that revenue
insurance offers the possibility of
combining existing price and yield
guarantee programs into a single program
which may be easier to administer and
easier for farmers to use. The ability
afforded to producers to insure against any
combination of low yields and/or prices
has made revenue coverage very attractive.
In addition, features of individual products
(CRC and RA with the harvest price option)
that pay indemnities on lost production at
current (harvest-time) prices have made
those plans very attractive to growers.

In their assessment of federal crop
insurance and the 1990 Farm Bill,
Glauber, Harwood, and Miranda note that
the target revenue insurance program was
the best at stabilizing per acre farmer
income and market prices. Comparing
dollars of public expenditures per dollar of
risk reduction, Turvey found revenue
insurance was the best at promoting self-
insurance through diversification. In
another study, Gray, Richardson, and
McClasky found revenue insurance
alternatives to be less expensive and more
effective at supporting farm income than
the current farm policy (deficiency
payments). Similar results were obtained
by Hennessy, Babcock, and Hayes.

Over the years, farmers have purchased
conventional crop insurance (multiple peril
crop insurance), a yield-based insurance.
However, with the introduction of revenue
insurance products—like crop revenue
coverage, income protection, and revenue
assurance—farmers could choose between
crop insurance and revenue insurance. A
question of particular importance to risk
management agencies, farmers, and
researchers concerns the factors affecting
farmers’ participation in crop and revenue
insurance programs. Therefore, it is of
interest to examine the factors influencing
their respective adoption.

Toward this end, the objective of this
study is to identify the factors influencing
the choice of crop versus revenue
insurance by farmers. An understanding
of those factors related to participation
and demand for insurance is essential for
comprehending the operation of the
programs. Policy makers have a vital
interest in understanding how farmers
respond to new programs and changes to
existing programs.

The introduction of revenue coverage is
probably the largest major change to crop
insurance since its inception in the 1930s.
The fact that this insurance has only
recently become available suggests our
current understanding of factors
influencing the crop insurance choice may
be based upon a different type of insurance
program, and thus may be open to question.
A secondary issue important to our
analysis is to determine how to quantify
and test whether the factors influencing a
joint insurance adoption decision are
different from those associated with
independent choices of either crop
insurance or revenue insurance.

Our analysis is conducted on a farm-level
data set with the unique feature of
having a larger sample than has been
previously evaluated, comprising farms of different economic sizes and in different regions of the United States. Previous empirical studies have focused only on crop insurance. Typically, other insurance plans (such as revenue insurance) are available concurrently, resulting in simultaneous adoption decisions.

This investigation differs from previous studies in several ways. First, using a multinomial logit model, our analysis investigates the factors affecting the adoption of crop and revenue insurance simultaneously. Second, this is the first study to use farm-level farm business and household data. Third, in contrast to earlier work, we model insurance choices jointly to determine the marginal impact of exogenous variables.

### The Model

Assume there is a finite set of \( m \) possible insurance plans from which to choose. The \( i \)th individual’s decision may be modeled as maximizing the expected utility of profits by choosing the \( j \)th bundle of insurance from among the \( m \) discrete insurance plans:

\[
\text{Max} \left\{ E[U(B_{ij})] \right\} = f_i(X_i),
\]

\( j' = 1, \ldots, m \),

where \( f_i \) is a function of \( X_i = X_{i1}, \ldots, X_{iq} \), which is a \( 1 \times q \) vector of attributes of the \( i \)th individual affecting the desirability of an insurance plan. Assume \( q_j \) is a random variable that is independently and identically distributed with a Weibull density function.

Let \( y_{ij} = 1 \) if the individual chooses the \( j \)th insurance plan, and \( y_{ij} = 0 \) otherwise. Then, following McFadden (1974) or Maddala, the probability of the \( i \)th individual choosing the \( j \)th insurance plan may be represented as a multinomial logit model:

\[
(2a) \quad P_{ij} = \frac{\exp f_i(X_i)}{\sum_{j'=1}^{m} \exp f_{j'}(X_i)},
\]

\( j' = 1, 2, \ldots, m \) and

\[
(2b) \quad P_{im} = \frac{1}{\sum_{j'=1}^{m} \exp f_{j'}(X_i)},
\]

where the \( P \)'s are conditional probabilities of the insurance plans, given the explanatory variables (Amemiya). For this study, these represent the probability of choosing crop insurance or revenue insurance. \( P_1 \) and \( P_2 \) are the probabilities of choosing either insurance plan, respectively, and \( P_3 \) is the probability of choosing both. \( P_4 \) is the probability of choosing neither the crop insurance nor revenue insurance plan, so that, for example, \( m = 4 \). The probability of choosing crop insurance is \( P_1 \) plus \( P_3 \), while the probability of choosing revenue insurance is \( P_2 \) plus \( P_3 \).

The conditional probabilities can be estimated by the maximum-likelihood estimation (MLE) method. In the absence of a priori information about \( f_i(X_i) \), a linear form \( f_i(X_i) = \mathbf{x}_i \mathbf{s}_i \) is used, where \( \mathbf{s}_i = \mathbf{s}_{i1}, \ldots, \mathbf{s}_{iq} \). Because the \( \mathbf{s} \)'s enter the probabilities \( P_j \) nonlinearly, these coefficients cannot be interpreted directly. However, a convenient interpretation of the coefficient can be obtained by taking the logarithm of the coefficient can be obtained by taking the logarithm of the ratio of \( P_j / P_4 \):

\[
(3) \quad \ln \left( \frac{P_{ij}}{P_{i4}} \right) = \mathbf{x}_i \mathbf{s}_{jq}, \quad j' = 1, 2, 3,
\]

where equation (3) is the logarithm of the odds in favor of outcome \( j \) relative to outcome 4, and \( \mathbf{s}_{jq} \) is the marginal effect of \( X_{iq} \) on the logarithm of this ratio.
Choice of attributes associated with choosing an insurance plan is guided by human capital theory, farm and production characteristics, and other adoption models. Earlier research (Nelson and Phelps; Khaldi; Wozniak) uses education as a measure of human capital to reflect the ability to adopt innovation (either technology or insurance).

Analytical work examining revenue insurance commenced in the mid-1980s, when Trechter developed a theoretical model of the supply and demand for revenue insurance. At the same time, Gineo investigated how the design of a revenue insurance policy would affect farmers’ benefits and what would be the possible effects on production and resource allocation. Since then, there have been a limited number of empirical studies on this subject. Nevertheless, in assessing the factors affecting a farmer’s decision to purchase revenue insurance, one can rely on state and regional studies on crop insurance.

Three major studies have estimated models of crop insurance purchase decisions using county-level data: Smith and Baquet for Montana wheat farmers, and Smith and Goodwin and Coble et al. for Kansas wheat farmers. In addition, Goodwin also estimated the demand for crop insurance using aggregate county-level data from Iowa. While there are several other studies on the demand for crop insurance that pursue a different angle of investigation, the works cited above pay particular attention to the factors affecting the insurance purchasing decisions of farmers.

The present study differs from earlier analyses (Smith and Baquet; Smith and Goodwin; Calvin; Coble et al.; and Just and Calvin) in several ways. First, all of these studies have examined only standard multiple peril crop insurance. Second, the data sources for these studies are at the state level and are comprised of relatively small samples of farms. Finally, previous studies have not modeled the use of crop and revenue insurance simultaneously.

The history of receiving deficiency payments, disaster payments, and conservation reserve payments was an important variable in many previous studies on crop insurance demand and purchasing decisions. A deficiency payment variable was found to be statistically significant in explaining the decision to purchase insurance in investigations by Smith and Baquet and Just and Calvin, but was not significant in studies conducted by Barnett, Skees, and Hourigan; Edelman, Schmiessing, and Khajasteh; and Goodwin. The above researchers who found the deficiency payment variable to be statistically significant argue that receiving payments may reflect higher returns to insurance because historically yields have been more variable.

Under the 1996 FAIR Act, the government expected to bear little or no risk, and government intervention was expected to be minimized. This may have been the intent of the 1996 Farm Bill, but certainly has not been the result. Emergency (market loss assistance and disaster assistance) payments, Agricultural Market Transition Act (AMTA) (production flexibility contract) payments, and loan deficiency payments (LDPs) have contributed to relative stability in income, and considerable risk has continued to be borne by the government.

A farmer’s education level proved significant both for the purchasing and for the coverage level decision in the Smith and Baquet study. This confirms results of earlier studies by Just and Calvin, and by Edelman, Schmiessing, and Khajasteh, who found participation in MPCI is positively correlated with education level. Smith and Baquet also incorporated other demographic variables (age, years in farming) in their analysis. However, these variables were not found to be significant.

Farm size is another variable that has been used by various researchers to
explain crop insurance purchasing decisions by farmers. Although Goodwin reported a positive and significant correlation between farm size and demand for MPCI, no significant relationship was found by Smith and Goodwin, or by Smith and Baquet.

Many studies have used a measure of wealth including a farmer’s net worth or a debt-to-asset ratio, and off-farm income. Smith and Baquet; Smith and Goodwin; and Coble et al. all found a farmer’s net worth to be a significant variable in explaining purchase decisions. However, off-farm income was not found to be significant by Smith and Goodwin. These findings suggest that farmers with larger beginning wealth or current-period income are less likely to purchase crop insurance, and therefore these would be indicators of capability for self-insurance.

In addition to these results, there is the expectation that through the subsidization of crop insurance premiums, producers are encouraged to expand production at the extensive margin into higher risk areas since the “real cost” to the producer of yield loss and variability is partially mitigated through the subsidy.

Elasticities are calculated to measure the percentage change in probability of insurance use for a percentage change in the explanatory variable. Elasticities can be calculated using the average values of the explanatory variables and the average probability of adoption. However, this approach would not reflect the distribution of the individuals in the sample. Therefore, elasticities are calculated for each individual and are weighted by the individual’s probability of insurance adoption.

The weighted average elasticities are derived analytically from equations (2a) and (2b). The estimated elasticity in terms of known and estimated values is designated by:

\[ \hat{E}_{ij}^{*} = \frac{\sum_{i=1}^{n} \hat{P}_{ij} \left( \hat{\beta}_{ij} \hat{\mathbf{X}}_{i0} + X_{ij} \hat{\mathbf{G}}_{i1} \hat{\mathbf{X}}_{i2} \right) \mathbf{q}_{ij} \hat{\mathbf{G}}_{i3} \hat{\mathbf{X}}_{i0} \hat{\mathbf{G}}_{i1} \hat{\mathbf{X}}_{i2} \right)}{\sum_{i=1}^{n} \hat{P}_{ij} \left( \hat{\mathbf{G}}_{i1} \hat{\mathbf{X}}_{i2} \right) \mathbf{q}_{ij} \hat{\mathbf{G}}_{i3}}, \]

where \( j \) is the insurance choice category \((j = 1, 2, 3)\); \( q \) is the explanatory variable; \( n \) is the number of individuals; and \( \hat{P}_{ij} \) is the \( j \)th conditional probability estimate for the \( i \)th individual.

While equation (4) gives the elasticity for each adoption category, it is of interest to calculate the relationship between explanatory variables and the probability of adoption of the crop or revenue insurance plan. The elasticity of crop and revenue insurance use together is simply the weighted average of the respective elasticities:

\[ \hat{E}_{ih}^{\text{ag}} = \frac{\sum_{i=1}^{n} \left( \hat{E}_{ij}^{\text{ag}} \hat{\mathbf{G}}_{i1} \hat{\mathbf{X}}_{i2} \hat{\mathbf{G}}_{i3} \right) \mathbf{q}_{ij} \hat{\mathbf{G}}_{i3} \hat{\mathbf{X}}_{i0} \hat{\mathbf{G}}_{i1} \hat{\mathbf{X}}_{i2} \right)}{\sum_{i=1}^{n} \left( \hat{P}_{ih} \hat{\mathbf{G}}_{i1} \hat{\mathbf{X}}_{i2} \right) \mathbf{q}_{ij} \hat{\mathbf{G}}_{i3}}, \quad h = 1, 2, \]

where

\[ \hat{E}_{ij}^{\text{ag}} = \hat{\beta}_{ij} \hat{\mathbf{X}}_{i0} + X_{ij} \hat{\mathbf{G}}_{i1} \hat{\mathbf{X}}_{i2} \hat{\mathbf{G}}_{i3}, \quad j = 1, 2, 3.\]

**Data**

Data for the analysis were taken from the 1998 Agricultural Resource Management Survey (ARMS), formerly known as the Farm Costs and Returns Survey (FCRS). The ARMS is conducted annually by the USDA’s Economic Research Service and the National Agricultural Statistics Service. ARMS uses a multi-phase sampling design and allows each sampled farm to represent a number of farms that are similar in the population, the number of which represents the survey expansion factor (for more technical detail, see Kott; Dubman).

\(^3\)The level of participation in revenue insurance reflects a program that had been available for only two years.
Table 1. Definitions and Summary Statistics of Variables Used in the Multinomial Logit Regression ($N = 1,962$ farm households)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operator/Household Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$OPEDUC$</td>
<td>Farm operator’s education level (years)</td>
<td>12.95</td>
</tr>
<tr>
<td>$OPAGE$</td>
<td>Operator’s age (years)</td>
<td>51.92</td>
</tr>
<tr>
<td>$OPAGESQ$</td>
<td>Operator’s age squared</td>
<td>2,896.68</td>
</tr>
<tr>
<td>$OFFINCOME$</td>
<td>Total off-farm income received by farm household ($000s)</td>
<td>43.75</td>
</tr>
<tr>
<td><strong>Farm and Production Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$DEBTASSET$</td>
<td>Debt-to-asset ratio</td>
<td>0.17</td>
</tr>
<tr>
<td>$FVALPROD$</td>
<td>Value of agricultural production sold by the farm ($000s)</td>
<td>12.03</td>
</tr>
<tr>
<td>$PIMEAN$</td>
<td>Mean productivity index (%)</td>
<td>76.20</td>
</tr>
<tr>
<td>$FINDEMPAY$</td>
<td>Indemnity received by the farm ($000s)</td>
<td>1.14</td>
</tr>
<tr>
<td>$FPOWNER$</td>
<td>Farm ownership = 1 if farm operated by part owner (%)</td>
<td>53.47</td>
</tr>
<tr>
<td>$FSTENANT$</td>
<td>Farm ownership = 1 if farm operated by tenant (%)</td>
<td>20.39</td>
</tr>
<tr>
<td>$PMCONTRACT$</td>
<td>Value = 1 if operator participated in either production or marketing contracts (%)</td>
<td>21.63</td>
</tr>
<tr>
<td>$GOVTPMT$</td>
<td>Total government payments received ($000s)</td>
<td>14.41</td>
</tr>
</tbody>
</table>

Notes: Dependent variable = $REVINSUR$. Data derived from 1998 ARMS survey (USDA).

The expansion factor, in turn, is defined as the inverse of the probability of the surveyed farm being selected. The survey collects data to measure the financial condition (farm income, expenses, assets, and debts) and operating characteristics of farm businesses, the cost of producing agricultural commodities, and the well-being of farm operator households.

The target population in the survey is operators associated with farm businesses representing agricultural production across the United States. A farm is defined as an establishment that sold or normally would have sold at least $1,000 of agricultural products during the year. Farms can be organized as sole proprietorships, partnerships, family corporations, nonfamily corporations, or cooperatives. Data are collected from one operator per farm, the senior farm operator. A senior farm operator is the operator who makes most of the day-to-day management decisions. For the purpose of this study, operator households organized as nonfamily corporations or cooperatives were excluded.

Summary statistics for each variable utilized in the analysis are presented in Table 1. The 1998 ARMS survey queried farmers about their participation in crop and revenue insurance programs (Yes = 1 and No = 0). The dependent variable ($REVINSUR$) is used to investigate the effect of various farm, operator, and financial characteristics on the likelihood of purchasing crop revenue insurance.

**Results**

The software package STATA is used to estimate the empirical version of equations (2a) and (2b) with the farm-level data. The coefficients are estimated by maximum likelihood, and asymptotic t-statistics are calculated. Table 2 provides information on the overall fit of the model. Since an $R^2$ does not accurately measure the fit of a multinomial logit model, two commonly used pseudo-$R^2$’s are calculated. As reported in Table 2, Cragg and Uhler’s pseudo-$R^2$ is 0.57 and the likelihood ratio is 247.43, representing a relatively good fit for a multinomial logit model (see Hensher and Johnson).
Table 2. Predicted and Actual Probabilities of Insurance Use

<table>
<thead>
<tr>
<th>Insurance Program</th>
<th>Predicted Conditional Probability</th>
<th>Actual Unconditional Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_1$: Crop insurance</td>
<td>0.56</td>
<td>0.56</td>
</tr>
<tr>
<td>$P_2$: Revenue insurance</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>$P_3$: Both crop and revenue insurance</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>$P_4$: Neither insurance</td>
<td>0.30</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Cragg and Uhler's Pseudo-$R^2$ = 0.57
Likelihood Ratio = 247.43***

Note: *** denotes statistical significance at the 1% level.

* Predicted probabilities are conditional upon the level of an individual's explanatory variables.

b Actual unconditional probabilities are proportions derived from the sample.

The predicted conditional probabilities are identical to the unconditional probabilities (Table 2). The conditional probabilities are a weighted average of the individual's probability of adoption predicted by the model conditional upon the values of the explanatory variables; unconditional probabilities are the proportion of respondents falling into each category, as derived from the sample.

Table 3 reports the estimated coefficients of the multinomial logit model of factors affecting farmers’ adoption of crop and revenue insurance. Results show that the set of significant explanatory variables varies across insurance models. However, four of the 12 variables are significantly associated with the adoption of both insurance plans (adoption model $3$).

The coefficient of the farm operator’s education ($OP\$EDUC$) has the expected sign and is statistically significant at the 1% level. In the case of $OP\$EDUC$, results suggest farm operators with a higher level of education are more likely to purchase crop and revenue insurance. This finding may reflect the notion that many of the crop and revenue insurance policies might require more knowledge to understand. Early adopters are likely to be producers with the highest level of education—consistent with the adoption literature which indicates education plays an important role in adopting new technologies. This finding also corroborates results obtained by Nelson and Phelps, and by Welch.

The coefficient of the debt-to-asset variable ($DEBT\$ASSET$) is positive and statistically significant at the 1% level (Table 3). As the debt-to-asset ratio increases, so does the probability of purchasing both crop and revenue insurance (adoption model $3$). One possible explanation is that farm operators with high debt-to-asset ratios are more likely to buy revenue insurance because of pressures from lending institutions.

Receiving payments from government programs is often considered a primary risk-reducing mechanism (Kramer and Pope; Musser and Stamoulis). Goodwin and Schroeder note government programs are intended to decrease the risks facing agricultural producers. The coefficient of participation in government programs ($GOVT\$PMT$) is positive and statistically significant at the 5% level, indicating farm operators who received government payments are more likely to buy insurance (crop and revenue) as compared to their counterparts who did not participate in insurance programs.

Soil productivity is a factor known to affect farm profitability. With higher soil productivity, one would expect short-run profitability to be higher for any given level of input use. Therefore, farmers are less likely to buy insurance. The coefficient of
Table 3. Estimated Coefficients ($\beta$) of the Multinomial Logit Model: The Odds of the $j$th versus the Fourth Insurance Choice

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>$\beta_1$</th>
<th>$\beta_2$</th>
<th>$\beta_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.244***</td>
<td>3.048**</td>
<td>3.033***</td>
</tr>
<tr>
<td></td>
<td>(0.888)</td>
<td>(1.614)</td>
<td>(1.648)</td>
</tr>
<tr>
<td>OP$EDUC$</td>
<td>0.121</td>
<td>0.104*</td>
<td>0.191***</td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
<td>(0.062)</td>
<td>(0.064)</td>
</tr>
<tr>
<td>OP$AGE$</td>
<td>1.013</td>
<td>1.017</td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.048)</td>
<td>(0.048)</td>
</tr>
<tr>
<td>OP$AGESQ$</td>
<td>0.003</td>
<td>0.0002</td>
<td>0.0004</td>
</tr>
<tr>
<td></td>
<td>(0.0002)</td>
<td>(0.0005)</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>DEBT$ASSET$</td>
<td>2.745***</td>
<td>2.727***</td>
<td>1.843***</td>
</tr>
<tr>
<td></td>
<td>(0.339)</td>
<td>(0.337)</td>
<td>(0.557)</td>
</tr>
<tr>
<td>GOVT$PMT$</td>
<td>0.017***</td>
<td>0.009</td>
<td>0.013**</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>F$VALPROD$</td>
<td>0.006</td>
<td>0.018***</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.008)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>PI$MEAN$</td>
<td>1.012**</td>
<td>1.022***</td>
<td>1.021**</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.009)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>OFF$INCOME$</td>
<td>1.0001</td>
<td>1.003</td>
<td>1.008***</td>
</tr>
<tr>
<td></td>
<td>(0.0009)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>F$INDEMPAY$</td>
<td>0.034**</td>
<td>0.033**</td>
<td>0.041***</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.019)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>PM$CONTRACT$</td>
<td>0.315***</td>
<td>0.466**</td>
<td>0.828***</td>
</tr>
<tr>
<td></td>
<td>(0.143)</td>
<td>(0.243)</td>
<td>(0.248)</td>
</tr>
<tr>
<td>F$POWNER$</td>
<td>0.707</td>
<td>0.940***</td>
<td>0.339</td>
</tr>
<tr>
<td></td>
<td>(0.539)</td>
<td>(0.339)</td>
<td>(0.313)</td>
</tr>
<tr>
<td>F$TENANT$</td>
<td>0.031</td>
<td>0.860***</td>
<td>0.275**</td>
</tr>
<tr>
<td></td>
<td>(0.182)</td>
<td>(0.381)</td>
<td>(0.140)</td>
</tr>
</tbody>
</table>

Notes: Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% levels, respectively. Values in parentheses are standard errors. Insurance choices ($j = 1, 2, 3$): 1 = crop insurance only, 2 = revenue insurance only, 3 = both crop and revenue insurance, and 4 = neither insurance.

soil productivity ($PI$MEAN) is negative and statistically significant at the 5% level for adoption model $\beta_3$.

Off-farm income diversifies a farm operator’s income portfolio and reduces the probability that a farm operator will purchase revenue insurance. Off-farm income provides additional income to households. Off-farm jobs usually yield much more stable incomes than farm income (Mishra and Goodwin) and can be useful in managing overall risks. The coefficient of off-farm income ($OFF$INCOME) is negative and statistically significant at the 1% level for adoption of both crop and revenue insurance (model $\beta_4$). This result is in agreement with findings reported by Calvin, and by Just and Calvin. A negative and significant coefficient for $OFF$INCOME supports the potential ability of a farmer to self-insure.

Results indicate farm operators respond to returns from insurance ($F$INDEMPAY). In our model we included the amount of indemnity\(^4\) the farm operator household received. The coefficient of indemnity

\(^4\) We believe farmers have good information about expected payouts, and thus assume this is a good indicator of expected receipts.
received ($INDEMPAY) is positive and statistically significant at the 1% level under adoption model $3$.

Further, as one reviewer pointed out, the very mechanism of the subsidy is likely influencing the results where farmers purchase crop insurance. Since the subsidy is based on a percentage of the premium, relatively more transfers will also be made in the higher risk regions. Producers have an incentive to purchase insurance in higher risk areas and/or to expand production into higher risk areas because of the subsidized insurance premiums. Consequently, producers reduce their exposure to the riskier producing situation by using the subsidized insurance.

Both production and marketing contracting are private risk management strategies farmers have used to reduce the risk and uncertainty associated with farm income (Harwood et al.). Contracting transfers risk from the producers to the contractors or other agents. As shown in Table 3, the coefficient on $PM\_CONTRACT$ is positive and statistically significant, indicating farm operators with either production or marketing contracts (or both) are more likely to purchase crop and revenue insurance. Perhaps this result demonstrates that farm operators who are risk averse adopt other risk management strategies as well, and that revenue insurance and production or marketing contracts (or both) are complements.

Based on the empirical literature, farm tenure (full-owner, part-owner, and tenant) has a significant impact on the adoption of technologies. Part-owners and tenants may also be less aware of the production characteristics of a given tract and thus may face production uncertainty. Additionally, because part-owners are usually more leveraged, they may be subject to the insurance requirements of creditors (Gardner and Kramer). The coefficient of tenant ($TENANT$) is positive and statistically significant at the 1% level for the joint adoption decision (model $3$, Table 3). Results suggest part-owners and tenants are more likely to buy revenue insurance compared to full-owners.$^5$

Estimates of elasticities using equations (4) and (5) are presented in Table 4 to provide a measure of the change in probability of adoption of an insurance set for a change in the explanatory variables. As an example, a 1% increase in the debt-to-asset ratio ($DEBT\_ASSET$) increases the probability of using both types of insurance by 0.09%, whereas a 1% increase in off-farm income of a farm household ($OFF\_INCOME$) decreases the probability by 0.32%.

The elasticities are relatively large for productivity ($PI\_MEAN$). A 1% increase in the productivity index decreases the probability of revenue insurance by 1.13% and by 1.04% for both insurances (crop and revenue). Since these are regression mean estimates, the levels of the explanatory variables are important determinants of the values of the elasticities across adoption categories.

Given that the set of significant explanatory variables is different for each insurance decision, how do they differ when comparing crop insurance versus revenue insurance jointly? A Wald test is used to determine if there is a significant difference in the coefficients for the adoption of crop insurance and revenue insurance. Testing the coefficient of $P_1$ plus $P_3$ versus $P_2$ plus $P_3$ is equivalent to testing whether all the coefficients of $P_1$ are equal to all those of $P_2$, i.e., whether $\$_1$ is equal to $\$_2$. The Wald statistic is 15.51 and is significant at the 5% level, resulting in rejection of the hypothesis that all the coefficients are equal. This finding supports justification for modeling crop insurance adoption separately from revenue insurance adoption.

$^5$ Full-owner is used as the benchmark group in this analysis.
Table 4. Elasticities of Insurance Use: Percentage Change in Insurance Choice for Each 1% Change in the Exogenous Variable, 1998

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>$P_1$</th>
<th>$P_2$</th>
<th>$P_3$</th>
<th>$P_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP$^*$EDUC</td>
<td>0.739</td>
<td>0.518</td>
<td>1.639</td>
<td>0.829</td>
</tr>
<tr>
<td>OP$^*$AGE</td>
<td>0.249</td>
<td>0.475</td>
<td>1.571</td>
<td>0.421</td>
</tr>
<tr>
<td>OP$^*$AGESQ</td>
<td>0.370</td>
<td>0.232</td>
<td>0.708</td>
<td>0.400</td>
</tr>
<tr>
<td>DEBT$^*$ASSET</td>
<td>0.251</td>
<td>0.248</td>
<td>0.089</td>
<td>0.241</td>
</tr>
<tr>
<td>GOVT$^*$PMT</td>
<td>0.133</td>
<td>0.007</td>
<td>0.076</td>
<td>0.117</td>
</tr>
<tr>
<td>F$^*$VALPROD</td>
<td>0.023</td>
<td>0.171</td>
<td>0.080</td>
<td>0.407</td>
</tr>
<tr>
<td>P$^*$MEAN</td>
<td>0.385</td>
<td>1.127</td>
<td>1.039</td>
<td>0.552</td>
</tr>
<tr>
<td>OFF$^*$SINCOME</td>
<td>0.024</td>
<td>0.114</td>
<td>0.317</td>
<td>0.027</td>
</tr>
<tr>
<td>F$^*$INDEMPAY</td>
<td>0.019</td>
<td>0.018</td>
<td>0.027</td>
<td>0.020</td>
</tr>
<tr>
<td>PM$^*$CONTRACT</td>
<td>0.026</td>
<td>0.059</td>
<td>0.137</td>
<td>0.042</td>
</tr>
<tr>
<td>F$^*$OWNER</td>
<td>0.189</td>
<td>0.314</td>
<td>0.008</td>
<td>0.189</td>
</tr>
<tr>
<td>F$^*$TENANT</td>
<td>0.009</td>
<td>0.160</td>
<td>0.041</td>
<td>0.016</td>
</tr>
</tbody>
</table>

Notes: $P_1$ = crop insurance only, $P_2$ = revenue insurance only, $P_3$ = both crop and revenue insurance, and $P_4$ = neither insurance.

Summary and Conclusions

A model is developed to estimate and test factors influencing farmers’ choice of insurance plans. Analyzing the use of two or more insurance plans (crop and revenue) separately and jointly allows comparison of the factors influencing the choice of insurance. This approach permits a test to determine whether the explanatory variables are different for each joint insurance decision, and to assess how they differ when comparing crop insurance versus revenue insurance. This strategy is more flexible and realistic than modeling insurance choices as independent of one another.

The percentage of area covered under the revenue insurance program has increased substantially since its inception. Revenue insurance provides farmers with a revenue guarantee based on their approved yield and current market price. Revenue insurance also protects against losses resulting from a decrease in market price, a loss of production, or a combination of these. Revenue coverage is offered under several different plans. The most popular versions (Crop Revenue Coverage and Revenue Assurance with the Harvest Price Option) not only provide revenue protection, but also will pay indemnities on lost production at harvest-time prices, regardless of what that price is (though CRC imposes a price cap). The substantial increases in participation and shifts toward revenue coverage clearly indicate the revenue plans are helping to fulfill farmers’ risk management needs.

The level of producer participation in revenue insurance programs was just beginning to grow when the ARMS data for this study were collected (1998). Despite this limitation, however, the empirical analysis demonstrates that differences do exist between farmers purchasing revenue insurance versus those purchasing traditional crop insurance, and reveals how farmers respond to the different (crop and revenue) insurance plans. Based on our findings, education, farm size, and type of farm ownership are significant in explaining the adoption of revenue insurance; however, the same variables do not have significant impact on the adoption of crop insurance.
Other results of the research indicate that off-farm income and soil productivity are negatively associated with adoption of both types of insurance. In contrast, debt-to-asset ratio, government payments, and participation in production and marketing contracts are positively associated with adoption of both insurances.

Hypothesis tests show there are significant differences in the set of coefficients explaining the probability of crop insurance adoption and revenue insurance adoption. This finding offers some justification for modeling the adoption of each insurance combination separately. Our findings also provide evidence suggesting the results reported from earlier studies based upon standard crop insurance may not fully reveal factors affecting the demand for insurance under the new programs.

Knowledge of how producers responded to the fundamental changes in insurance plans that have occurred over the last several years is essential for an understanding of the operation of the programs and the potential acceptance of new programs which are continually being introduced. Our analysis provides such information and quantifies how farm and operator characteristics affect crop and revenue insurance decisions.

One of the key factors in the policy debate is indemnity payments. Our results show a positive correlation between indemnity received by farmers and their participation in crop and revenue insurance programs. A number of other studies (e.g., Goodwin; Goodwin and Smith; Calvin) have found a positive correlation between indemnity payments and premiums.

The results of this study have policy implications. While the goal of federal premium subsidies is to alter behavior—specifically, to increase participation in crop and revenue insurance markets—this objective also contributes to the higher goal of providing a more comprehensive package of risk management mechanisms. If successful, the insurance program should increase the viability of agriculture and reduce the need for publicly funded ad hoc disaster assistance programs.

However, these subsidized premiums have several consequences. First, the subsidy provides not only an incentive to purchase insurance by reducing the cost of coverage to the producer, but also encourages expanded and/or more intensive production, since the producer’s expected total return increases with each insured acre. Second, because premium subsidies are based on a percentage of the total premium, and premiums are higher for production on riskier land, these subsidies may encourage production on land that might otherwise not be planted. Finally, in the absence of federal subsidies, the premium might be prohibitively expensive in high-risk areas. As higher premium rates would likely discourage participation, such areas would be less attractive markets for private companies selling policies. In this case, federal subsidies increase the likelihood of insurance delivery, and consequently encourage more intensive production in high-risk areas, such as the Great Plains region of the United States.

In short, it appears likely that subsidies have played a major role in encouraging participation in crop insurance programs. Without such subsidies, participation would likely be much more modest, as it was many years ago when premium subsidies were smaller and coverage applied only to crop yields.

Additionally, findings of this research have implications for agribusiness and extension programs. Marketing programs targeted to more educated farmers, operators of large farms, part-owners, and tenants will likely be more successful in promoting adoption of revenue insurance.
References


