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Effects of farm characteristics and government disaster assistance on multiple-peril crop insurance purchases by Iowa crop farmers

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Effects of farm characteristics and government disaster assistance on multiple-peril crop insurance purchases by Iowa crop farmers

by

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CHAPTER 1

INTRODUCTION

Farming is generally perceived to be a risky enterprise. The major sources of risk in farming are business and financial. Business risks include production, marketing and other risks of a farming enterprise, which are independent of how it is financed. Financial risks are due to the level of debt or method of financing.

Various responses have been devised to mitigate business risk. They range from self-insurance to enterprise diversification, economies of size, adoption of new technology, hedging on the futures market, forward contracting, using agricultural commodity options and purchasing crop insurance.

Crop insurance is an instrument that can reduce the risk of a short crop. It has existed in one form or another since colonial times. Over the years, private insurance companies tried to offer a variety of protection programs, which would protect farmers against the adverse financial impacts of lower yields. While the companies' crop hail/fire protection programs have been successful, their multiple-peril coverage has not. The multiple-peril programs suffered from low participation levels and the fact that small companies did not have adequate financial strength to survive widespread losses.

In 1938, the U.S. Government became directly involved in the business of insuring farmers against crop losses by passing legislation which authorized the establishment of the Federal Crop

Insurance Corporation (FCIC). Although referred to as "all risk" insurance, the federal crop insurance program actually insured few crops against specific perils. This shortcoming contributed to the problem of low participation for both private and government crop insurance programs. The number of perils covered by federal crop insurance programs gradually increased, but the problem of low participation has not been resolved. To encourage voluntary crop insurance as a primary government program to replace government crop disaster payments, the Federal Crop Insurance (FCI) Act of 1980 tried to increase the attractiveness of crop insurance by subsidizing farmers' purchases of multiple-peril crop insurance (MPCI).

The legislative response of Congress to the drought of 1986, and more importantly the 1988 drought, brought the controversy of the subsidized MPCI program versus the disaster assistance program back to the forefront of the 1990 Farm Bill debate.

Government crop disaster payments, introduced in the 1970s, had become a significant federal expenditure by the end of the 1980s. During fiscal years 1980-1988, the total cost of agricultural disaster assistance had been estimated to be $17.6 billion (GAO, 1989). These costs were divided between three programs: crop insurance ($4.3 billion), disaster payments ($6.9 billion), and emergency loans ($6.4 billion). Despite the executive and congressional branches' repeated and concerted effort to convince farmers that Federal Disaster Relief programs would be replaced by federally subsidized crop insurance programs, the government continued to provide disaster relief payments to disaster stricken farmers as recently as for the 1991 crop year.

Beyond the budgetary concerns, arguments have been expressed that the simultaneous or potential offering of disaster assistance prevents MPCI from serving as an effective disaster relief mechanism for farmers. The concluding presumption is that one or the other of the programs should be continued, but not both. As a result, there is a need to clarify the actual impact of disaster assistance on producers' decisions and attitudes towards MPCI.

Extensive economic modeling has been done on the producers' MPCI purchase decisions. This study adds to the body of knowledge by examining a multivariate regression approach to determine the relationship between the two types of disaster relief as well as other factors that affect farmers' decisions to purchase multiple-peril crop insurance. This study is unique in that it analyzes actual producer MPCI purchase decisions after a severe crop disaster and the passage of a major disaster assistance program. Furthermore, this study avoids a major drawback of other studies that utilize the expected utility hypothesis, where the results depend heavily upon the assumed risk attitudes implied by the assumed utility function.

Because the federal government has had a long history of providing various programs and policy instruments for use by farmers, Chapter 2 will first review the historical background of the evolution of the multiple-peril crop insurance program and the recent literature concerning the crop insurance program. In Chapter

3, a conceptual relationship between a crop insurance purchase decision and various exogenous variables will be put forward. It is assumed that the various indicators and exogenous variables are the underlying reason for a farmer to make a choice to obtain crop insurance. A step function will then translate the decision making process into a probability statement. Three models, one linear and the others nonlinear, will be developed and will examine the behavior of Iowa farmers with regard to the purchase of multiple-peril crop insurance. Chapter 4 will discuss the data that was used in this study, which was available from the 1989 Iowa Farm Finance Survey. Each variable will be defined, and their possible effects on the purchase of crop insurance will be hypothesized. In Chapter 5, the empirical results of each model will be discussed and compared with one another. Finally, Chapter 6 will interpret the findings, while conclusions and suggestions for future research will be presented in Chapter 7.

CHAPTER 2.

HISTORICAL BACKGROUND AND REVIEW OF LITERATURE

2.1 Historical background

Prior to the 1930s, government assistance provided to farmers was designed to improve the efficiency of producing and marketing farm products. Congress's indirect approach to improve the farming sector took different forms, including the establishment of the United States Department of Agriculture (USDA) and the extension service, as well as land-grant colleges and agricultural experiment stations (Kramer, 1988).

However, following two serious price depressions, Congress shifted to an approach which included direct government involvement in the agricultural commodity market. In 1933, the Commodity Credit Corporation was established and was designed to help farmers with price supports for some farm products. Under this program, nonrecourse loans were made to cotton and corn farmers and provided borrowers with a price floor for their products. Later, this program was merged with the idea of some type of crop insurance which would effectively stabilize grain prices and supplies (Kramer, 1988).

Severe droughts in 1934 and 1936 generated interest in the idea of federal crop insurance. In February, 1937, President Roosevelt's Committee on Crop Insurance released a report wherein they recommended the establishment of a federal crop insurance program which would be administered by the USDA. Under this plan, farmers would insure some percentage of their average yield and the premiums would be calculated based on a weighted average of the loss experience of individual farmers as well as the county or area. Although no other country had attempted to provide this type of protection, President Roosevelt encouraged crop insurance legislation which was designed to shift much of the farmer's risk burden to the general public

On February 16, 1938, the Agricultural Adjustment Act was enacted. Title V of this Act established the Federal Crop Insurance Corporation (FCIC), which represented the government's first attempt to provide nationwide "all-risk" or multiple-peril crop insurance. Although limited crop insurance had been available through private insurers for several years, no private company had successfully offered insurance which would protect farmers from a variety of natural disasters. (Kramer, 1988).

During the first year, nearly one-third of the farmers insured by the FCIC collected indemnities, and total indemnities exceeded premiums by 2.6 million bushels. This loss was attributed to severe droughts suffered in several states, to the late completion of wheat contracts which resulted in adverse selection and to administrative problems which were believed to have underestimated the yield variability of individual farmers (FCIC, 1939).

In 1944, an amendment to the Agricultural Adjustment Act of 1938 was passed that expanded the list of insurable risks to include losses resulting from rain, snow, frost, fire, wildlife and hurricane effects. In addition, the program was expanded to cover a number of experimental programs for commodities including corn, beans, oats, barley and rye. This amendment also allowed the FCIC to refuse to sell insurance to farmers in high-risk areas (Kramer, 1988).

Between 1945 and 1949, the crop insurance program went through a number of changes, including a progressive protection plan, whereby protection increased as the crops progressed during the growing season. However, crop protection was reduced when the FCIC recognized that the insured crop was damaged or destroyed early in the growing season and it was too late to be replanted. This change was designed to eliminate the possibility of a farmer profiting more by incurring a crop loss than by harvesting a successful crop. In addition, a three-year contract was introduced in an effort to reduce the cost of selling the insurance and to avoid the problem of adverse selection, which was inherent under a one-year contract.

During the early 1950s, droughts illustrated the benefits of the crop insurance program. Beginning in 1956, the issue of overlap between federal crop insurance and other government programs was raised by the FCIC. At a time when Congress was authorizing disaster assistance in the forms of reserve programs, livestock feed assistance and emergency credit, the FCIC argued before Congress that crop insurance should be the only form of disaster assistance available to farmers. (FCIC, 1956).

Over a five-year period beginning in 1957, insurance premiums exceeded indemnities every year, which allowed the program to expand its coverage of existing crops as well as add additional crops. In 1962 and 1963, coverage was extended to a maximum of three crops per year. In the 1970s, with disaster payments supplementing older loans, as well as feed and seed programs, emphasis on relief programs shifted from loans to direct payments. This action raised the cost of drought aid and reduced the incentive for farmers to buy crop insurance (Dyson, 1988).

In 1977, the GAO proposed individualized protection as a means of increasing individual participation in the federal crop insurance program. It suggested that protection based on individual experience would be more equitable to farmers and would sharply increase participation among low-risk producers who would enjoy higher coverage and/or lower premiums. It was believed that greater participation by low-risk producers would improve the financial operations of the FCIC and reduce adverse selectivity.

In 1977, the Food and Agricultural Act was passed, effectively renewing the disaster payment programs. Although the disaster payments were popular with farmers because it was provided at no cost and covered high-risk areas where crop insurance was unavailable, this program was criticized on the grounds that it 1) encouraged farmers to plant in high-risk areas, 2) encouraged some farmers to collect payments rather than risk a crop failure when the planting conditions were less than ideal, and 3) allowed farmers to insure against losses caused by mismanagement (Kramer, 1988).

The turning point in the development of the MPCI program came in 1980 with the passage of the Federal Crop Insurance Act. This act expanded the crop insurance program by eliminating annual expansion limits, expanding the area where the crop insurance would be available and allowing farmers to reduce their FCIC premiums if they retained private hail and fire coverage through other sources (which resolved a longstanding dispute between private insurers who saw the hail and fire coverage under the federal program as an unfair form of competition [Kramer, 1988]). As a result of the 1980 legislation, most disaster payments were eliminated after 1981 and the attractiveness of crop insurance was expected to increase as 30 percent of the farmers' premiums were subsidized. However, no more than approximately 20 percent of the farmers bought crop insurance between 1980 and 1987 (Dyson, 1988).

Prior to 1985, farmers could only insure their crop yields up to a limit calculated as the mean yield for the county in which the farmer operated. This system, which was known as the Area Yield Plan resulted in adverse selection because a farmer with a historical yield less than the area yield could obtain coverage which was greater than his/her own expected yield. In contrast, farmers whose historical yield exceeded the area yield were reluctant to participate because they could only insure their yield up to the area yield.

Consequently, occurrence of adverse selection reduced the marketability of MPCI (Toland, 1988).

In 1985, in an effort to reduce the problem of adverse selection, the FCIC began using a farmer's historical yield records to determine the farmer's insurable yield. This procedure, known as Actual Production History (APH), was designed to create a direct relationship between the farmer's production history and insurance guarantees and rates (Kramer, 1988).

Despite previous efforts to eliminate disaster assistance payments, in response to the drought of 1986 Congress passed disaster payment legislation that cost $634 million. However, the 1986 disaster program was not an exception to the rule when one considers that the 1988 drought relief package cost $3.85 billion. The ad hoc government disaster relief programs have reinforced the belief that farmers can sometimes count on the government to impose disaster payments if and when serious disasters occur (Dyson, 1988).

2.2 Review of literature

One of the goals of the 1980 FCI Act was to make MPCI the primary government-subsidized crop disaster program. Accomplishing this goal required substantial participation in the MPCI program. Kramer (1983) noted that after the FCIC incurred large net indemnity losses with MPCI during 1938-1947, Congress subsequently scaled back its intention of having MPCI serve as a major farm program. General Accounting Office (GAO, 1977) and Congressional Budget Office (CBO, 1978) studies determined that limitations, which had been placed on the program, prevented MPCI from serving as an effective disaster relief mechanism for producers. For example, many producers were not able to insure their crops simply because no MPCI program was available in their county.

In addition, prior to 1980, private insurers provided limited income protection against hail and fire, whereas MPCI covered these perils as well as numerous others. However, farmers were not given the option of purchasing MPCI without hail and fire coverage (AACI, 1987). Private insurers who sold hail and fire crop insurance considered MPCI's overlapping coverage of these perils to be subsidized competition (Kramer, 1983; Kramer, 1988).

The FCI Act of 1980 responded to these shortcomings by extending MPCI's coverage to as many crops and areas as possible. In addition, the FCI Act allowed a producer to drop the hail and fire coverage from an MPCI policy, but required that he/she then purchase an equivalent dollar amount of hail and fire coverage through other sources (Toland, 1988).

The FCI Act of 1980 also established a subsidy, not to exceed 30 percent of a producer's MPCI premium, in order to encourage greater participation in the MPCI program. Gardner and Kramer (1982) estimated that a 50 percent premium subsidy was needed to attract a majority of the U.S. crop acreage into MPCI. Lemieux, Richardson and Nixon (1983) simulated MPCI use for Texas cotton and grain sorghum farms. They found that, at a 30 percent subsidy, farmers would purchase MPCI, covering 50 and 65 percent of their yield. They predicted that MPCI would not be purchased for the 75 percent yield coverage level when the 30 percent subsidy was discontinued above the 65 percent level. The need for premium subsidies was also concluded by Nieuwoudt et al. (1985), in order for the insurance system to have a sizeable impact on income stabilization.

Hojjati and Bockstael (1988) tried to explore factors that affect a farmer's decision to participate in the crop insurance program. They argued that participation in crop insurance is interrelated with other decisions. These researchers constructed a model of farmers demand for crop insurance which also considered the crop diversification (acreage allocation) choices available to the farmers. Using the concept of expected utility, with utility being a function of profit and the variance of profit, this model suggested that any changes in the FCIC policy which increases the expected profit and reduces variance of profits would increase the rate of participation in the crop insurance program. Hojjati and Bockstael (1988) also concluded that the increased participation may lead to changes in the crop mix in areas where diversification was used as a risk managing tool.

The participation of farmers in crop insurance programs, as well as other government programs, was also studied by Mapp and Jeter (1988). They used a computer simulation model developed by

Hardin (1978) and Hardin and Walker (1978) to simulate the performance of a low-equity, southwest Oklahoma farm over a ten-year period. These researchers analyzed capital investments in a stochastic environment under various assumptions regarding participation in government commodity and crop insurance programs. Among the many findings, this study suggested that, evaluated in terms of ending net worth and the coefficient of variation of ending net worth, participation in the federal crop insurance program was generally not a very attractive alternative for the Oklahoma farmer. A combination of Disaster-Deficiency payment programs achieved the highest ending net worth and lowest coefficient of variation of ending net worth. Overall, this study suggested that low participation in federal crop insurance programs in southwest Oklahoma may be partially explained by high premiums relative to indemnities (Mapp and Jeter, 1988).

Toland (1988) studied a producer's MPCI purchase decision using an Expected Utility Hypothesis (EUH) model. His model was partially based on the derivations for decision making with insurance presented by Robison and Barry (1987). Among other things, Toland found that producers' management skills could be just as important as the soil type in determining insurable yield for the purchase of MPCI. He also concluded that the group of medium yield producers would need additional incentives to participate in the MPCI program. Finally, if their initial net equity position was medium to high, producers were not predicted to buy MPCI at any mean yields. This result implied that MPCI had the potential to primarily attract producers who were in a weak financial position (Toland, 1988).

In a study of the effects of crop insurance prices on financially stressed farms, Skees and Nutt (1988) contended that studies evaluating the effects of crop insurance on the risk of farming without evaluating the farm level loss ratios (i.e., expected indemnities divided by expected premiums) were inappropriate. They argued that farm level risks were not the same for all farmers within a specified area. In addition, premium rates offered by FCIC were not structured using facts from typical farms. Instead, the rates were developed from a group of farms which were adversely selected over time (i.e., farmers in higher yield risk areas who typically purchased more crop insurance than farmers in lower yield risk areas). Skees and Nutt (1988) argued that a generalization about the effects of crop insurance, which did not consider the loss ratios, could be misleading.

As an alternative, these researchers developed loss ratios and then studied how crop insurance could provide risk protection for the sample farmers in a multi-year analysis (Skees and Nutt, 1988). By comparing measures of wealth for different risk environments, they showed that when the insurance was priced at break-even levels (i.e., expected loss ratio = 1.0), there were positive gains in the mean value of generated wealth. However, under an expected loss ratio of .8, their study suggested that in most risk environments cash flow drains from the purchase of crop insurance would lead to limited financial stress. For loss ratios of .6 and .4, their study showed reductions in generated wealth for every case where crop insurance was purchased. Skees and Nutt's (1988) study concluded that although purchasing crop insurance may periodically protect farmers from yield losses, it is possible that the expense of purchasing crop insurance, depending on how the insurance is priced, drains the farmer more than the protection provides in years of crop loss.

The use of loss ratios in determining crop insurance premiums and production guarantee levels had also been suggested by King (1984). As previously noted, in response to the shortcomings associated with Area Yield plan coverage, the FCIC established procedures using individual yields to attract more producers, especially those whose mean crop yields were greater than or equal to the area mean yield. As an alternative, King (1984) proposed the Target Loss Ratio (TLR) procedure. Under this approach, individual historical data was used to adjust premiums or production guarantees such that the expected loss ratio equaled a pre-specified target value. Although King's findings were preliminary, he concluded that premium and production guarantee level adjustments using TLR procedures should result in a crop insurance program which is more attractive to farmers than the present government program (King, 1984).

Harper, Williams and Barnaby (1989) analyzed the selection of crop insurance yield guarantee levels and indemnity prices based on risk preference for corn/soybean farmers in Northeastern Kansas. They found that some level of crop insurance will be purchased by all but the most risk-preferring producers. For risk-averse producers, the highest yield guarantee level and indemnity price are preferred. Further, the effect of the availability of disaster aid programs like those in force in 1988 was to negate the incentives to purchase crop insurance for all but the most risk-averse producers (Harper et al., 1989).

2.3 Problem statement and study objectives

A review of the literature concerning risks and crop insurance indicates that the application of the Expected Utility Hypothesis (EUH) has been a major analytical tool in many of the studies. The EUH approach has been regarded as useful and acceptable in dealing with decision making under uncertainty (Hirshleifer and Riley, 1979). Researchers found that EUH models would better predict the actual producer behavior than would the profit maximization approach (Officer and Halter, 1968; Lin, Dean and Moore, 1974; SriRamaratnam et al., 1987). However, despite its widely regarded usefulness and acceptance, there has not been universal acceptance of EUH as the basis for risk analysis. Linearity in probabilities, transitivity of preferences and subjective probability formulation were all aspects of the EUH approach, which were challenged in earlier research (Allais, 1953; Lichtenstein and Slovic, 1971; Payne and Braunstein, 1971; Kahneman and Tversky, 1979).

The review of literature on crop insurance also indicates that researchers often utilize the underlying theories of utility and profit (or cost) in their extreme abstract theoretical forms. For example, in using the Expected Utility Hypothesis approach, one or two independent variables (often income and variance or the coefficient of variation of income) are used to perform the analysis. Although a theory by definition requires abstraction, excluding other relevant factors from the analysis may give a distorted view of the real world. Furthermore, in the study of behavior under risk, the risk attitude by definition is measured by the bending rate of the utility function. As such, the results of these studies heavily depend upon the form of the assumed utility function.

The present federal crop insurance program has been characterized by low farmer participation and high government costs. It has been frequently argued that one of the major factors causing the poor participation rate is the continued availability of disaster relief payments, whereby the ad hoc disaster assistance programs help support producers' beliefs that a widespread natural disaster will be accompanied by government assistance.

Using a multivariate regression approach, this study intends to empirically identify factors that are relevant to farmers' decisions to participate in government crop insurance programs. In addition, this study will explore the validity of the argument that disaster assistance negates the need for crop insurance. In this study, a utility driven model is developed for the decision between purchasing or not purchasing crop insurance. However, unlike a standard EUH approach, decisions are not based on any comparison of the expected utility values. Indeed, the utility function in the models, which will be described in the next chapter, are not explicit. Finally, the results of this study will enable researchers and practitioners to predict the likelihood of Iowa farmers' participation in federal crop insurance programs under a variety of circumstances.

CHAPTER 3

METHODOLOGY

The risk attitude, along with the decision maker's perceptions (i.e., expectations) of the amount of risk, are two of the basic behavioral components of decision theory. In this study, both linear and nonlinear probability models will be used to examine possible relationships between crop insurance purchase decisions and the indicators of risk and risk preferences.

3.1 Theoretical framework

The conceptual relationship between a crop insurance purchase decision and exogenous variables influencing the decision is based on a formal, rational choice hypothesis that was proposed by Luce and Suppes (1965), among others. McFadden (1973) expanded upon the concept by applying econometric modeling.

The rational choice hypothesis asserts that if individual *i* is given a choice of selecting between two alternatives, he/she will demonstrate his/her preference over these two alternatives by selecting the most prefered option (Aldrich and Nelson, 1984). According to this approach, if we let U_{i1} indicate individual *i*'s preference for alternative one and let U_{i2} denote *i*'s preference for alternative two, then individual *i* would choose alternative one over alternative two if $U_{i1} > U_{i2}$, and would choose alternative two over one if $U_{i2} > U_{i1}$.

The U_i terms (and the Y_i^* that will be defined later) are interval level variables which are not observed or measured and in fact may not be observable because of their nature. These terms may be interpreted as utility, as was previously done by Toland (1988), Nelson and Loehman (1987) and Orazem et al. (1988).

Furthermore, preference may be assumed to be a linear function of exogenous variables (to be defined later):

$$U_{i1} = \Sigma\, a_{k1}\, X_{ik} + e_{i1}$$

and (1)

$$U_{i2} = \Sigma\, a_{k2}\, X_{ik} + e_{i2}$$

where X_{ik} for k = 1,...,k are the exogenous variables; e_i's are the disturbance terms capturing any unmeasured factors, approximation errors, and random factors; a_k's are unknown constants; and the subscripts i1 and i2 refer, respectively, to choices 1 and 2 available to individual i.

Also, let Y_i^* define the difference between the two preferences:

$$Y_i^* = U_{i1} - U_{i2} \qquad (2)$$

by substituting equation (1) for U_{i1} and U_{i2}, we will obtain:

$$Y_i^* = U_{i1} - U_{i2} = \Sigma\,(a_{k1} - a_{k2})\,X_{ik} + (e_{i1} - e_{i2}). \qquad (3)$$

We can simplify (3) by letting $b_k = (a_{k1} - a_{k2})$ and $w_i = (e_{i2} - e_{i1})$, which will result in:

$$Y_i^* = \Sigma\, b_k\, X_{ik} - w_i. \qquad (4)$$

By definition, if individual *i* chooses alternative one over alternative two, it would mean that $U_{i1} > U_{i2}$, which according to (2) would mean that $Y_i^* > 0$; and according to (4) would mean that $\Sigma\, b_k X_{ik} - w_i > 0$. In other words, alternative one is chosen when $w_i < \Sigma b_k X_{ik}$.

If a variable Y_i is defined as an observed indicator of the choice made by individual *i*, such that:

$Y_i = 1$ when alternative one is chosen, (i.e., when $Y_i^* > 0$)

$Y_i = 0$ when alternative two is chosen, (i.e., when $Y_i^* < 0$)

then, we are led to a probabilistic statement that:

$$P(Y_i = 1) = P(Y_i^* > 0) = P(w_i < \Sigma\, b_k X_{ik}) \qquad (5)$$

where $P(Y_i = 1)$ symbolizes the probability that Y_i equals one; and $P(Y_i^* > 0)$ denotes the probability that Y_i^* is greater than zero. Equation (5) suggests that to estimate $P(Y_i = 1)$, we need to know the total (or cumulative) probability that w_i is less than $\Sigma\, b_k X_{ik}$. If we further simplify the above statement by defining:

$$Z_i = \Sigma b_k X_{ik} \tag{6}$$

and assume w_i is a continuous random variable with a probability density function of f(w), then (5) could be rewritten as:

$$\begin{aligned} P(Y_i = 1) &= P(w_i < \Sigma\, b_k X_{ik}) \\ &= P(w_i < Z_i) \\ &= \int_{-\infty}^{Z_i} f(w)dw \\ &= F(Z_i) \end{aligned} \tag{7}$$

where $F(Z_i)$ is the cumulative distribution function of the random variable w_i (Aldrich and Nelson, 1984).

Thus, the probability that alternative one is chosen, $P(Y_i = 1)$, not only depends upon the magnitude of Z_i which, in turn, is a linear function of the exogenous variables, but also depends upon the distribution of w_i yet to be specified. If we assume, for example, that w_i is uniformly distributed such that the corresponding cumulative distribution function is in a simple linear functional form:

$$F(Z_i) = \begin{cases} 0 & \text{if } 0 \geq Z \\ Z & \text{if } 1 > Z > 0 \\ 1 & \text{if } Z \geq 1 \end{cases} \tag{8}$$

then the probability that alternative one is chosen, $P(Y_i = 1)$, is also a linear function of the same exogenous variables as is the variable Z_i (i.e., $P(Y_i = 1) = Z_i = \Sigma b_k X_{ik}$). Whereas, if we assume that w_i follows a logistic distribution, then the cumulative distribution function (7) will be in the form of:

$$P(Y_i = 1) = \frac{e^{Z_i}}{1 + e^{Z_i}} \qquad (9)$$

That is, the probability that alternative one is chosen is a nonlinear (logistic) function of Z_i, which, in turn, is a linear function of the exogenous variables. Finally, if we assume that w_i follows a normal distribution, we will end up with a cumulative normal function for $P(Y_i = 1)$:

$$P(Y_i = 1) = F(Z_i) = \int_{-\infty}^{Z} \frac{1}{\sqrt{2\Pi}} e^{(-w_i/2)} dw_i. \qquad (10)$$

Unfortunately, this integration cannot be carried out in closed form and is rather cumbersome to write, but suffice to say that this would yield another case where $P(Y_i = 1)$ nonlinearly depends on Z_i.

3.2 Empirical models

In this study, both linear and nonlinear probability (regression) models will be used to examine possible relationships between crop insurance purchase decisions and some exogenous factors affecting the decisions. In developing the models, the above equations (8, 9 and 10) have a practical implication: we can estimate the probability of purchasing crop insurance by using regression models with dichotomous dependent variables (i.e., variables holding values of either zero or one).

In the case of a linear regression, the model to be estimated will be in the form of:

$$Y_i = \Sigma \beta_k X_{ik} + \varepsilon_i \tag{11}$$

where $Y_i = 1$ when crop insurance is purchased , and $= 0$ when crop insurance is not purchased.

X_{ik} for $k = 1,\ldots,k$ are the exogenous or independent variables affecting Y_i.

ε_i is the deviation Y_i from its expected value, otherwise known as error or disturbance term.

β_k are the population parameters to be estimated from sample information.

The regression model (11) presumes that the means $E(Y_i)$ lies on a straight line (linear), known as the true (population) regression line:

$$E(Y_i) = \mu_i = \Sigma\beta_k X_{ik}. \tag{12}$$

In addition, the model requires some basic assumptions about the distribution of the random variable Y_i, namely, that they have the same variance for all X_i and that they are statistically independent.

Since Y_i equals either zero or one, the expected value of Y_i equals the probability that Y_i equals one:

$$E(Y_i) = 1 \times P(Y_i = 1) + 0 \times P(Y_i = 0)$$
$$= P(Y_i = 1). \qquad (13)$$

This implies that in the case of a dichotomous linear regression model where the dependent variable can assume only the values of zero or one (i.e., purchasing or not purchasing crop insurance), the model will also estimate the probability that the dependent variable will assume a value of one:

$$P(Y_i = 1) = \Sigma\beta_k X_{ik} + \varepsilon_i \qquad (14)$$

where $P(Y_i = 1)$ is the probability of purchasing crop insurance, X_{ik} for $k = 1,\dots,k$ are the exogenous variables affecting the purchasing decisions, β_k are the parameters to be estimated, and ε_i are the error terms.

In case of a nonlinear probability model, the choice hinges upon the distribution of the disturbance term w_i, as discussed earlier. However, among many well-known and not-so-well-known distributions that lead us to nonlinear probability models, logistic and normal distributions are, for a variety of reasons, the two most commonly used alternatives to the linear specification of the probability model (Aldrich and Nelson, 1984).

Analogous to the linear case, equation (13) implies that the logistic distribution function of (9) could very well be interpreted as the underlying nonlinear regression model that attributes the probability of purchasing crop insurance to some exogenous variables. In short, the nonlinear model to be estimated will be in the form of:

$$P(Y_i = 1) = [1 + e^{-\Sigma \beta k X ik}]^{-1} + \varepsilon_i \qquad (15)$$

where P, β, X, and ε are the same as defined in the linear model (14).

Finally, the normal probability distribution function (10) will be used to estimate the probability of making decisions to purchase crop insurance based on some exogenous factors, as depicted below:

$$P(Y_i = 1) = F(Z_i) = \int_{-\infty}^{Z} \frac{1}{\sqrt{2\Pi}} e^{(-w_i/2)} dw_i + \varepsilon_i \qquad (16)$$

Chapter 4 will discuss some of the explanatory variables (X's) which are believed to be relevant to the process of crop insurance purchase decisions.

3.3 Estimation procedures

As a means of analyzing the dichotomized response to the purchase of crop insurance, both least-squares regression methods and the maximum likelihood approach are utilized. While least-squares techniques are relatively easy to apply and the interpretation of the results are straight forward, the maximum likelihood method is recognized by many as the appropriate method of regressing cases with a binary dependent variable. A brief summary of the procedures that were applied in this study will be presented below.

3.3.1 Ordinary Least-Squares (OLS) procedure Least-squares procedures are used to estimate the linear probability model (14). This procedure requires some prerequisites concerning the values of the explanatory variables (X_k for k = 1,...,k) and the distribution of the error term ε_i. Namely, it is required that:

1. The values of the explanatory variables in the model (14) be fixed and measured without error.
2. The error terms are independent (from each other) random variables, all have a mean of zero, and all have the same constant variance (i.e., homoscedasticity).

These requirements, as a result, impart randomness to the dependent variable Y_i (or $P(Y_i = 1)$) and imply that it has the same distribution as does ε_i.

Due to the inherent nature of the data used in this study (as will be discussed in the next chapter), the data may not display all of the desirable characteristics outlined above. However, due to the robustness of the procedure, it is believed that the benefits of using the least-squares procedure outweighs it's shortcomings . For instance, the estimates obtained in this procedure will probably not be the best estimator (i.e., the most "efficient" estimator in the sense of having the least sampling variance), however, as will be discussed below, these estimators will still be unbiased and will produce very encouraging results in predicting the purchase of crop insurance in various senarios.

3.3.2 Weighted Least-Squares (WLS) procedure Goldberger (1964) has shown that one difficulty which arises when applying ordinary least squares, where the dependent variable is dichotomous, is that the assumption of homoscedastic disturbances is unattainable. This follows from the fact that the error term from equation (11),

$$\varepsilon_i = Y_i - \Sigma\beta_k X_{ik} \qquad (17)$$

can, in this case, only have two possible values:

$$\begin{aligned} \varepsilon_i &= 1 - \Sigma\beta_k X_{ik} \quad &\text{if } Y_i = 1 \\ &= \ \ - \Sigma\beta_k X_{ik} \quad &\text{if } Y_i = 0. \end{aligned}$$

These two possible values of the error term will occur with probabilities $P(Y_i = 1)$ and $P(Y_i = 0)$, respectively, because of the binomial distribution of the response variable $P(Y_i = 0) = 1 - P(Y_i = 1)$. As a result, it can be shown that the assumption of the error term having a mean of zero is maintained:

$$E(\varepsilon_i) = P(Y_i = 0)\,(-\Sigma\beta_k X_{ik}) + P(Y_i = 1)(1 - \Sigma\beta_k X_{ik})$$
$$= [1 - P(Y_i = 1)]\,[-\Sigma\beta_k X_{ik}] + [P(Y_i = 1)]\,[1 - \Sigma\beta_k X_{ik}]$$
$$= 0.$$

And thus, OLS estimates of β_k will be unbiased. Furthermore, the error variance can be written as:

$$E(\varepsilon_i - E(\varepsilon_i))^2 = P(Y_i = 0)\,[-\Sigma\beta_k X_{ik} - E(\varepsilon_i)]^2 + P(Y_i = 1)\,[1 - \Sigma\beta_k X_{ik} - E(\varepsilon_i)]^2$$

Since $E(\varepsilon_i) = 0$ and $P(Y_i = 0) = 1 - P(Y_i = 1)$ then:

$$E(\varepsilon_i)^2 = [1 - P(Y_i = 1)]\,[-\Sigma\beta_k X_{ik}]^2 + P(Y_i = 1)\,[1 - \Sigma\beta_k X_{ik}]^2$$
$$= (\Sigma\beta_k X_{ik})^2 + P(Y_i = 1) - 2P(Y_i = 1)(\Sigma\beta_k X_{ik}).$$

Since $P(Y_i = 1) = E(Y_i) = \Sigma\beta_k X_{ik}$, then:

$$E(\varepsilon_i)^2 = \Sigma\beta_k X_{ik} - (\Sigma\beta_k X_{ik})^2.$$

Clearly, the error variance is not a constant, but depends upon the value of the explanatory variables. The assumption of constant error variance, or homoscedasticity, is therefore violated. As a result, the OLS estimates, $\hat{\beta}_k$, although unbiased, will not be "best" in the sense of being the minimum variance estimators of all linear unbiased estimators.

To correct this problem, Goldberger (1964) proposed a two-step weighted estimation technique. By applying proper weights to the regression model, the transformed error terms would have constant variance and the estimators would not only be unbiased but "efficient" as well. The proper weights are the reciprocals of the estimated standard errors of the disturbances (Aldrich and Nelson, 1984).

3.3.3 Maximum Likelihood Estimation (MLE) In view of the probability interpretation of the $E(Y_i)$ as shown in equation (13), the predicted values generated by the estimated model (11) ($Y_i = \Sigma\hat{\beta}_k X_{ik}$ where $\hat{\beta}_k$ is the estimated parameters) are interpreted as predicted probabilities (i.e., $\hat{Y}_i = \hat{P}_i$). However, the probability is defined to lie between zero and one, and the predicted values $\Sigma\hat{\beta}_k X_{ik}$ are unbounded and may be less than zero or greater than one (Wrigley, 1976).

A number of simple solutions, however, are available to tackle this problem. Given the fact that the probability estimates, even though unbiased, are still just estimates, one should expect some values to fall out of the range of zero to one simply due to sampling error. As such, this problem is not viewed to be necessarily severe, and as a practical solution one can truncate the estimates of $\Sigma\hat{\beta}_k X_{ik}$ to values close to zero or one. For example, .001 can be substituted for negative predicted values, while .999 can be substituted for predicted values which are estimated to be greater than one (Aldrich and Nelson, 1984).

The logistic probability distribution function (9) and the subsequent logit model (15) present another alternative solution to the above problem. As can be seen by comparing the models, the logistic probability function, unlike the linear specification, automatically satisfies the 0 - 1 boundary of P. Although there are other models which automatically satisfy the condition $0 \leq P \leq 1$, logistic and normal functions are by far the most widely used.

Although logistic and normal functions are nonlinear, they can be transformed into linear models[1], where one can apply OLS to estimate the parameters. However, probit and logit parameters can be directly estimated through the method of Maximum Likelihood Estimation (MLE) without any need for transformation. It has been argued that the maximum likelihood logistic regression is preferred over the linear discriminant model because the logistic regression, unlike the linear model, is less restrictive and is applicable under a wide variety of assumptions about the explanatory variables,

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[1] The linear transformation of the logistic model (15) is in the form of:

$$\log e^{Pi/1-Pi} = \Sigma\beta_k X_{ik}.$$

Another transformation, called the Probit transformation (Finney, 1971), will result in the linear equivalent of the normal function (16). Using the Probit regression, the model can be written as:

$$\text{Probit } (P_i) = t_i = \Sigma\beta_k X_{ik}$$

where t_i equals the normal equivalent deviate (NED), such that a proportion P_i of the standard normal distribution falls to the left of NED, plus five to avoid negative values. That is: Probit $(P_i) = t_i$ = NED + 5 (Wrigley, 1976).

including the case where some or all of the independent variables are dichotomous zero-one variables (Lines and Zulauf, 1985; Halperin, et al., 1971; and Anderson, 1972).

CHAPTER 4

THE DATA

The risk attitude, along with the decision maker's perceptions (i.e., expectations) of the amount of risk, are two of the basic behavioral components of decision theory. Although all the factors influencing those components are still the subject of debate among researchers, some socio-economic variables have been found to be significantly relevant in shaping one's risk attitude and risk perceptions.

4.1 Relevant factors

The risk attitudes of individual decision makers are said to be different among people because of the shape of their utility functions with respect to wealth or other monetary outcomes. Utilizing this concept, Pratt (1964) and Arrow (1963) independently theorized a measure of ordering decision makers according to their risk attitudes. The measure, known as the Absolute Risk Aversion Coefficient (ARAC), is defined as the negative of the ratio of the second to the first derivative of the utility function evaluated at the decision maker's wealth or income level, which, in fact, reflects the bending rate of the decision maker's utility function (Robison and Berry, 1987).

Prat and Arrow believed that the ARAC was a decreasing function of wealth and income. This implies that as the decision maker moves to a higher wealth level his/her attitude towards taking risk softens and becomes less risk-avert and, thus, the decision maker demands less compensation or reward for participating in a risky investment.

The magnitude or perceptions of the amount of risk, on the other hand, is said to be determined by the investment's probability distribution, where the probabilities reflect the likelihood of occurrence for the respective outcomes. Since exact estimates of such distributions are difficult to obtain, researchers have commonly assumed that the expected value and variance of the probability distribution adequately reflects the distribution's relevant characteristics (Makowitz, 1952; Tobin, 1958; Sharpe, 1964; Linter, 1965; Fama, 1976).

As described in Chapter 3, the conceptual framework of models selected for this study can be traced to a model of behavior which is based on the rational choice of the decision maker. Therefore, the factors relevant to risk attitudes and risk perceptions would also be relevant to the probability models. In this study, the indicators of wealth and income were readily obtainable. However, the amount of risk involved in farming was assumed to be implicit in the farm operators' financial ratios. As it will be explained in the next section, financial ratios are often used to compare the status of specific farms to industry standards.

Due to the lack of theorectical work upon which one might hypothesize relationships between risk/risk attitude and other socio-economic attributes, regression methods have been used to sort out meaningful farming and decision maker characteristics, which are measurable and are suspected to be related to risk and risk attitude. Halter and Mason (1978) entered eleven farm and decision maker characteristics into a regression model with risk attitude (ARAC) as the dependent variable. They found that the variables age, education, and the percentage of land ownership, either owned separately or jointly, were significantly related to risk attitude. Wilson and Eidman (1981) also attempted to test whether the estimated risk measure was correlated with producers' socio-economic attributes. Although their study did not produce conclusive results, some associations between risk attitudes and socio-economic variables were obtained.

The following section will discuss some of the common variables that are employed in the model and are suspected to be related to risk and risk attitude.

4.2 Dependent and explanatory variables

In specifying the probability models in Chapter 3, the dependent variable was found to have a qualitative measure representing only two possible categories: presence or absence of an outcome. The independent variables, on the otherhand, are a combination of both quantitative and qualitative measures where some of the qualitative variables represent only two alternatives, while others may represent more than two categories.

4.2.1 The dependent variable ANYMPI represents a dichotomous random variable that indicates whether or not the Iowa farmers selected for the sample purchased any corn or soybean Multiple-Peril Crop Insurance in 1988 and/or 1989. The farmers who purchased crop insurance were assigned a response code of 1, while those who chose not to purchase crop insurance were given a response code of 0. As discussed earlier, ANYMPI represents a latent preference for either of the two alternatives, which are related to exogenous variables. The dependent variable can also be viewed as the probability of purchasing crop insurance, such that the probability, P_i, is a transformation of $\Sigma\beta_k X_{ik}$.

4.2.2 Independent explanatory variables The independent variables include characteristics of the farms and the decision makers (i.e., farmers) that one suspects might be related to risk and risk attitudes (Halter and Dean, 1971; Officer and Halter, 1968). Some of the explanatory variables are continuous while others are discrete. The discrete variables were used both to classify quantitative measures and to categorize qualitative characteristcs, as explained below:

AGE: (Operator age) The age of the farm operator is hypothesized to be a factor explaining the operator's risk attitude towards purchasing a crop insurance policy. Younger farmers are more likely to experience greater levels of financial risk. They they are also likely to have more education with regard to ways of transferring risks which includes the role of crop insurance, and are, therefore, more likely to purchase crop insurance to reduce their total risk.

EDUCAT: (Operator education) The education variable is a dummy variable indicating the farm operator's highest level of education. Those who attended Grade School were assigned a code of 1. Those who attended High School were given a code of 2, while those with college or vocational education were assigned a code of 3. It is reasonable to expect that with a higher level of education a farmer might be better equipped to transfer some risk associated with crop farming by simply purchasing crop insurance. However, that expectation may not be realized if the education factor interacts with other factors that influence decision making. For example, Halter and Mason (1978) concluded that college graduates became more risk averse with increasing age,while grade school-educated farmers become more risk preferring. This conclusion was reversed, however, when the age effects were held constant. They also observed that farmers who owned larger percentages of land tended to show a risk preference attitude with increasing educational levels.

YRSFARM: (Years in farming) This variable represents the number of years the operators have engaged in farming. Due to strong correlations with AGE, YRSFARM is considered as an alternative variable. It is believed that the experience gained from years of farming, rather than the age of the operator, could better explain the crop insurance purchasing decision.

GROSALES: (1987 and 1988 gross sales) The total amount of farm related income generated by a farming enterprise is an indicator of the size of the operation. As such, it indicates something about the operator's dependency on farm income. Larger farming operations are likely to earn a higher percentage of their total income from farming, while smaller farming operations tend to rely more on off-farm income. As a result, to reduce the income volatility and to ensure their ability to meet financial obligations, the larger farm operators are more likely to purchase crop insurance.

CROPS: (1987 and 1988 crop percentages of gross farm sales) The total gross sales generated by a farming operation may not, by itself, provide information regarding the extent to which a farm is diversified. A substantial portion of Iowa farms are engaged in both the production of crops and the raising of livestock. The percentage of the farmer's total gross sales, which is attributed to the production of crops, is expected to have a positive correlation with the purchase of crop insurance.

DAR: (Debt-to-asset ratio) As an indicator of a farm operator's financial risk exposure, DAR measures the proportion of owner equity the operator has in the farm; which reflects the extent to which the operator has borrowed against the farm's assets. If a farmer owes more than he/she owns, his/her debt-to-asset ratio exceeds 100 percent and the farmer is technically insolvent. This ratio is calculated as total outstanding debt divided by the farmer's estimate of the current market value of assets owned by the farming operation. In general, farms with higher debt-to-asset ratios are more vulnerable if earnings or asset values decline. Therefore, farmers with high DAR are more likely to consider purchasing crop insurance, as an alternative to secure income, to meet their financial obligations. Creditors are more likely to insist upon it as well.

ROAAT: (Return-on-assets after taxes) This variable is a ratio of after-tax cash flow to the value of assets. A higher amount of return on the same amount of assets is an indication of greater managerial skill, which allows a farmer to generate more income independent of the financing arrangement. Toland (1988) found that producers' management skills could be just as important as the soil type in determining insurable yield for the purchase of MPCI.

FINSTRCL: (Financial stress category) Four code categories have been defined to broadly describe the financial position of the farm operators. Class 1 farms are in strong financial shape. Class 2 farms are in a stable position, but may sometimes experience financial stress. Class 3 farms are in a weak condition, and may require major operating changes and/or debt and asset restructuring to stabilize the farm's financial position. Class 4 farms are severely stressed and their business survivial is unlikely if present financial conditions continue. A combination of solvency and liquidity measures for each farm was used to classify a farm operation into one of the four categories of financial position. Solvency is measured by the debt-to-asset ratio. Liquidity is measured by a ratio of cash flow to equity, where before-tax net cash flow is divided by the farm operator's net worth. One can hypothesize that those under financial stress will be more likely to use crop insurance in order to remain in business until they make major operating changes. On the other hand, it is perceivable that those in weaker financial conditions may stop purchasing crop insurance in order to reduce their total expenses. Because FINSTRCL is expected to be highly correlated with DAR and ROAAT, it will primarily be considered as a substitute for DAR and ROAAT.

FWDCONTR: (Having used some type of forward contract in pricing grain or livestock during the previous two years) As a marketing tool that can mitigate business risk, forward contracts, depending on the type of contract, can either make it possible to sell products at a future date and at a fixed price, at a price level that cannot be below some specified amount, or at a price that the farmer would specify at a later date. For this variable, those farmers who have engaged in forward contracting during the previous two years were assigned a value of 1, while those who did not engage in forward contracting were given a value of 0. Although forward contracts are useful in reducing the risk of price variability, the risk of crop failure remains unchanged. For example, if a greater amount of crops is forward contracted than is actually produced due to a short crop, the farmer must then purchase enough commodity from the market, at the prevailing price, to meet the terms of the contract. For this reason, it is expected that those who engage in forward contracting would purchase crop insurance. Forward contracting may also be viewed simply as a measure of risk aversion.

DECOUPLE: (Decoupling current income support programs) This variable indicates the farmers' belief in moving towards a market oriented policy by decoupling and phasing down income supports over several years. If a farmer favors such a policy, he/she was given a value of 1; while those who were not sure were assigned a value of 2, and those who oppose were given a value of 3. Analogous to utility function analysis where tastes and beliefs are partly responsible for explaining a certain behavior, this variable is intended to play a similar explanatory role in the mutiple regression model. It is reasonable to expect that those who support dismantling government support programs would be more likely to practice self reliance and risk management, which would include the purchase of crop insurance.

TENURCL: (Tenure class) The variable TENURCL is given a value of 1, 2 or 3 depending upon whether or not the crop land is rented, both partially rented and owned, or entirely owned, respectively. It has been argued that farmers who rent crop land may be more obligated to secure some return from their farming operation by signing up for crop insurance. On the other hand, it has been argued that renting crop land may very well constitute another method of self insurance and diversification, therefore reducing the need for MPCI.

DRGTCRDP: (Drought Assistance Act crop disaster payments) The U.S. Department of Agriculture (USDA) provides many types of assistance to farmers and other rural residents, as the result of natural disasters such as drought, fire, flood, etc... The relief programs for the drought of 1988 fell into two categories: implementation of existing legislation and the passage of the Disaster Assistance Act of 1988.

DRGTCRDP is a dichotomous variable that distinguishes those crop farmers who received, or expected to receive, assistance at the time of the survey from those who did not receive any assistance through the passage of the Disaster Assistance Act of 1988. If a farmer received or expected to receive disaster assistance, he/she was given a value of one, while those who did not or were not expecting to receive such payments were assigned a value of zero. As noted earlier, one reason for poor participation rates in the federal crop insurance program, as many suggest, is that the availability of disaster assistance supports the producers' belief that a widespread natural disaster will be accompanied by government assistance and thus reduces producers' incentive to purchase crop insurance.

CO: (Iowa counties) Historically, participation in crop insurance programs has been highest where farmers perceive the risk to be the greatest. Many farmers believe that southern Iowa counties have a higher risk of being hit by drought than do other regions in the state. They argue that southern counties have experienced more drought in recent years than have other parts of the state. Figure 1. is a map of the State of Iowa, which illustrates the 99 county boundaries within the state. As shown in Figure 1., the southern three tiers of Iowa counties were given a value of CO = 1, while the remaining counties were assigned the value of CO = 0.

GOVACT: (Likelihood of future disaster assistance) The farmers in the sample were asked to rate the likelihood of the government passing another assistance package similar to the 1988 Drought Assistance Act in the event that another drought of similar severity were to occur in the upcoming

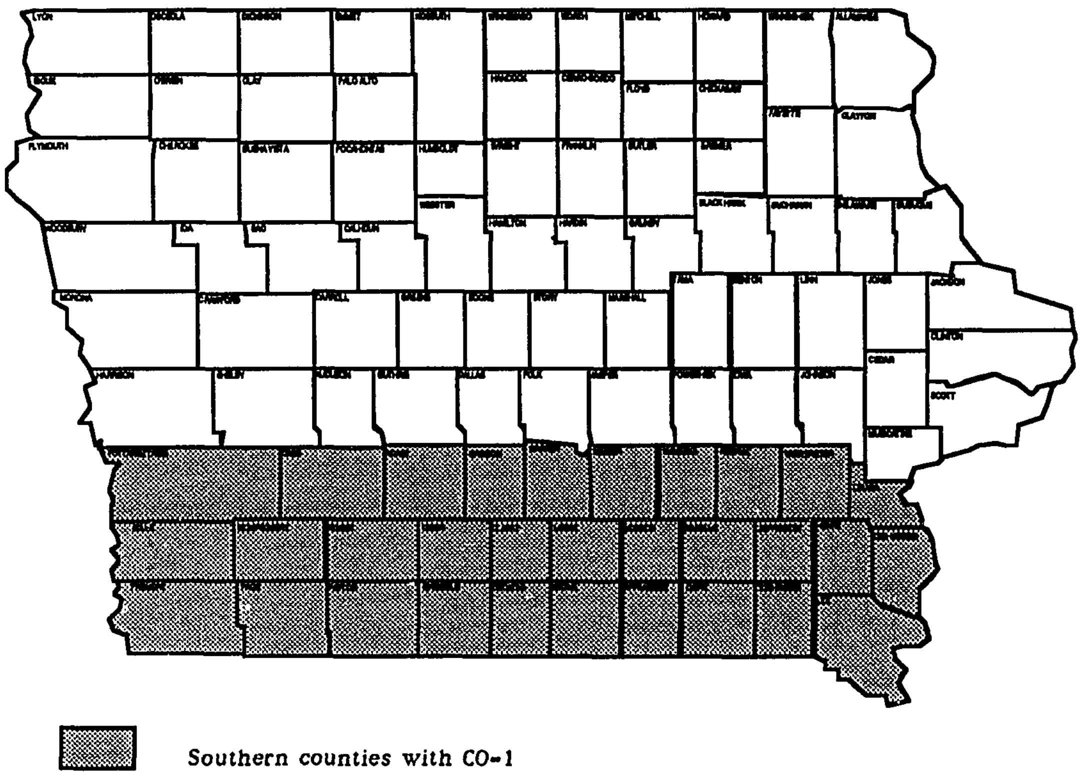

Figure 1. Map of Iowa

year. Five levels of likelihood were established to cover all possible responses. The levels included: very unlikely, somewhat unlikely, not sure, somewhat likely and very likely. The sample responses were coded with values of 0 through 4, with 0 representing the responses of very unlikely. It has been argued by many that farmers often decide against crop insurance enrollment based upon their belief that the government will grant disaster assistance in the event of a widespread disaster. If this argument is true, then one would expect to find that the likelihood of purchasing MPCI would decrease as the value of GOVACT increases.

OFFARM: (Off-farm income) An additional source of income could negate the need for purchasing crop insurance. On the other hand, the off-farm income may make the purchase of MPCI affordable to some farmers who would not have otherwise been able to purchase insurance. It is perceivable that off-farm income may affect the purchasing decision in one way or another.

ACRTOT: (Total acres of land operated) Whether the farmers own or rent the land they operate, it is reasonable to argue that the farmers will be more likely to purchase crop insurance as more acres of land are put into production. However, this argument could be dismissed on the grounds that both small and large farmers may consider insurance coverage a necessary measure to protect their financial investments against crop failure.

NW: (Net worth) Farming operations of various size may have the same debt-to-asset ratios, but may face different amounts of risk depending upon the size of their operation. For this reason, the explanatory variable NW is used to reflect the total difference between the debts and assets of a farming operation. Although Arrow (1963) and Pratt's (1964) assertion of the risk attitude being a decreasing function of wealth was challenged by some reasearchers (King and Robison, 1981; Patrick, Blake and Whitaker, 1981), it is reasonable to hypothesize that producers with large net worth have an increased financial ability to self insure. This implies that wealthy producers are more likely to consider self insurance as an alternative to purchasing MPCI.

YEAR: To distinguish the MPCI purchasing decision for 1988 from those for the 1989 crop year, the dummy variable YEAR was used in the model. Data pertaining to the 1988 crop year was identified by assigning the variable YEAR a value of 0, whereas YEAR = 1 signified the 1989 data.

4.3 Source of data

Data for estimating the models was taken from the 1989 Iowa Farm Finance Survey of farm operators conducted in March, 1989 (Edelman and Khojasteh, 1989). The survey questionnaires were mailed to a representative sample of 2,524 Iowa farm operators, and 1,316 responses were received. This survey included variables on demographic status, farm production characteristics, financial status, farm policy preferences and marketing practices (see Appendix).

Disaster assistance and crop insurance questions were a major focus of the 1989 survey. Specifically, Iowa farm operators were asked about (a) 1988 and 1989 multiple-peril crop insurance purchase decisions, (b) 1988 multiple-peril crop insurance indemnity payments, (c) 1988 disaster assistance payments, and (d) attitudes towards various public policy alternatives regarding multiple-peril crop insurance and disaster assistance. Out of the 1,316 survey responses, this analysis focused on 752 Iowa farm operators who indicated that they had planted crops and sold over $1,000 of agricultural products during 1988. The operators' age and farm-size distribution of the overall sample were similar to those in previous surveys and the Census of Agriculture (See Table 4.3), and were judged to be respresentative of commercial farm operators by the survey indicators.

Farmers receiving 1988 disaster payments for losses greater than 65 percent were required by the 1988 Disaster Assistance Act to purchase 1989 multiple-peril crop insurance. In this study, the

Table 4.3 Comparison of farm size indicators from census and 1985-1989 farm finance survey samples.

Farm Size	Farm Finance Surveys					AG. Census	
(acres)	1989	1988	1987	1986	1985	1987	1982
1-49	1.4	3.1	1.7	1.7	1.1	18.0	17.2
50-179	15.3	13.2	15.8	16.5	15.2	26.2	26.8
180-499	49.5	48.5	49.9	51.9	54.0	37.1	40.1
500-999	26.6	27.2	27.1	24.4	25.0	15.1	12.9
1,000 & up	7.1	7.9	5.5	5.4	4.7	3.5	2.7
Avg.	454	463	445	424	433	301	283

Source: Edelman and Khojasteh, 1989.

farmers required to purchase MPCI in 1989 were distinquished from farmers for whom the crop insurance purchase decision was optional. After deleting the observations with missing data, and those involving farmers who were required to purchase MPCI in 1989, the regression data included 434 farmers.

There were also some assumptions that needed to be made. First, it was assumed that the reported counties, total acres in operation, tenure class of the farmers, and the farmers' political views of the U.S. agriculture policy in 1989 did not change from what they were in 1988. Second, the 1989 Iowa Farm Finance Survery asked the sample farmers to report their 1988 gross farm income from their 1988 tax records. The survey, however, did not inquire about the farmers' 1987 income which would have been the appropriate factor for 1988 crop insurance purchase decisions. Therefore, the sample farmers were assumed to have had the same amount of farm-related income in 1987 as they did in 1988. A comparison of the results from the 1988 and 1989 surveys revealed that this assumption was permissable for purposes of this study as it showed that the average farm incomes for 1988 were very similar to those in 1987, despite the impact of the 1988 drought. In fact, the net farm income for 1988 was only $600 below the record high of 1987 (see Appendix). However, it could be argued that while the income average remained approximately the same the distribution of income generated by the farmers could vary significantly between the two study years. However, because a majority of the 1988 farm income was attributed to various government payments, it was presumed that the variation of farmers' income between the two years was less volatile, perhaps, compared to other years.

CHAPTER 5

EMPIRICAL ANALYSIS

The results of the three probability models are discussed below. While the linear model is a very powerful estimation tool given the ease with which inferences can be made from the data, it's findings could be easily misleading due to misspecification of the model. Probit and logit models, though both fundamentally resting on a linear relationship between dependent variables and the exogenous variables, provide two nonlinear specifications which are more plausible in cases with limited dependent variables (i.e., variables having values between 0 and 1) as explained in Chapter 3.

5.1 Variable specifications

Since there has been little theoretical work upon which one could, with some confidence, base a relationship between the purchase of crop insurance and some explanatory indicators, all of the 18 independent variables described in the previous chapter were entered into the three probability models along with the dichotomous variable ANYMPI which served as the dependent variable. To determine the important explanatory variables, stepwise procedures were used to initially select variables that were significant at at least a 70 percent confidence level.

All 18 independent variables were also subjected to a backward elimination routine. In this procedure, all variables were initially entered into the model, including the intercept, and the least important variables were removed from the model one by one.

Judged by their statistical influence in producing the largest F value, the results of the stepwise and backward elimination procedures for each model were compared to each other. As a result of this comparison, it was determined that the variables representing years in farming (YRSFARM), crop percentage in the total gross sales (CROPS), likelihood of future disaster assistance from the government (GOVACT), debt-to-asset ratio (DAR), off-farm income (OFFARM), tenure class (TENURCL), financial stress class (FINSTRCL) and education (EDUCAT) should be removed from the models. The variables representing southern and nothern counties (CO), age of the farm operator (AGE), payments of drought assistance (DRGTCRDP), total gross sales (GROSALES), opinion on the direction of government policy (DECOUPLE), total acres operated (ACRTOT), total new worth (NW), return-on-assets after taxes (ROAAT), forward contracting (FWDCONTR), and YEAR were retained in the models.

A casual inspection of the correlation coefficients among the variables suggested that it would be necessary to perform another round of stepwise routines, which also included interaction terms among the variables. The results of this stepwise routine were found to be very unstable, the signs and significance of the coefficients changed with every slight modification in the entry/stay signficance level in the stepwise procedure, and the results, at best, were difficult to interpret. In the final analysis, it was decided that only the interaction term between AGE and GROSALES (GROSAGE) would be included in the model. The estimates of the variable coefficients retained in the model, as well as the estimates of the residuals, must then be assumed to reflect the net effect of all excluded variables and interaction terms.

5.2 Linear Probability Model (LPM)

The results of the stepwise analysis are shown in Table 5.2a. Contrary to what one might have expected, the preliminary inspection of the results indicates that the chances of a crop farmer purchasing multiple-peril crop insurance has more to do with characteristics that are not, at least directly, indicators of the financial well-being of the farming operation. For instance, debt-to-asset ratio, which was an indicator of the financial risk exposure of the farming business was omitted from the model. FINSTRCL, which was intended to describe the financial position of the farm operators, was also removed from the model. However, the variables measuring gross sales and the rate of return-on-assets were marginally retained in the model.

As discussed in Chapter 3, estimates of LPM, using ordinary least squares, are not efficient though unbiased. As a result, estimates of the sampling variances will not be correct, and any t or

Table 5.2a Results of stepwise regression using Linear Probability Model (LPM)

	DF	Sum of Squares	Mean Square	F	Prob. > F
Regression	11	23.263	2.115	9.56	0.0001
Error	740	163.694	0.221		
Total	751	186.957		$R^2 = 0.12$	

Variable	Parameter Estimate	Standard Error	t-value
Intercept	0.55676	0.13307	4.184
CO	0.12618	0.04664	2.705
AGE	-0.00659	0.00214	-3.083
DRGTCRDP	0.19093	0.05021	3.803
GROSALES	-0.01494E-4	0.00054E-3	-2.766
GROSAGE	0.31611E-7	0.00001E-3	2.951
DECOUPLE	0.08819	0.02291	3.849
ACRTOT	0.00013	0.07722E-3	1.721
NW	-0.00235E-4	0.00007E-3	-3.543
ROAAT	0.00201	0.00116	1.735
FWDCONTR	-0.03604	0.03714	-0.970
YEAR	0.09657	0.04037	2.392

F values based on these variances will not be accurate. In order to reduce the chance of committing a Type II error (i.e., erroneously excluding relevant factors), variables ACRTOT, ROAAT and FWDCONTR were retained in the model despite their lower t-values. Other variables were excluded because their t-values were too small and their inclusion would have sharply increased the risk of committing a Type I error. Furthermore, there is a good chance that the variables retained in the model would carry many of the explanatory characteristics present in the excluded variables. For example, ROAAT and GROSALES explain a good deal of the variation that would have come from DAR or FINSTRCL.

Another difficulty with the LPM model is that there is no guarantee that the predicted probabilities would be confined to the unit interval (0,1). This problem was minimal in the present case because there were only three outliers (two below 0 and one above 1), which could easily be attributed to sampling error.

Correction for heteroscedasticity may be obtained using Goldberger's (1964) Weighted Least Squares (WLS) procedure. As discussed in Chapter 3, the weights are the reciprocals of the estimated standard errors of the disturbances which are, in turn, derived from subtracting predicted values from the corresponding values of the dependent variables. In the above model, because three of the predicted values were out of the unit interval range, the weights could not be defined for three of the observations. However as a practical solution, the one predicted value that was greater than one was redefined to equal a value of 0.999, while those values (i.e., predicted probabilities) that were less than zero were redefined to equal a value of 0.001. The results of the weighted least squares regression are presented in Table 5.2b. As these results illustrate, the estimates of the coefficients are not only unbiased, but also have smaller variances.

Comparing the OLS and WLS results, it appears that the coefficient estimates from WLS are noticeably different from those of OLS. In particular, GROSALES , ACRTOT and GROSAGE lost their significance, while other variables became more significant. Moreover, the coefficient for NW changed from a negative to a positive value. Although the high R^2 from the WLS regression may

Table 5.2b Results of weighted least squares regression

	DF	Sum of Squares	Mean Square	F	Prob. > F
Regression	12	2994.005	249.500	219.72	0.0001
Error	740	840.298	1.136		
Total	752	3834.302		R^2 = 0.78	

Variable	Parameter Estimate	Standard Error	t-value
Intercept	0.59420	0.13740	4.325
CO	0.10567	0.43596E-1	2.424
AGE	-0.00861	0.20741E-2	-4.151
DRGTCRDP	0.13849	0.49780E-1	2.782
GROSALES	-0.00784E-4	0.00052E-3	-1.498
GROSAGE	0.10827E-7	0.00001E-3	1.088
DECOUPLE	0.10067	0.22823E-1	4.411
ACRTOT	0.40733E-4	0.74420E-4	0.547
NW	0.00191E-4	0.00003E-3	6.995
ROAAT	0.00259	0.42552E-3	6.082
FWDCONTR	-0.04302	0.36059E-1	-1.193
YEAR	0.14075	0.41972E-1	3.353

indicate a good fit, the markedly different coefficient estimates would suggest that the linear probability model may not be quite acceptable. Ordinarily, one would expect a higher sampling variance with OLS estimates compared with WLS, however there should be little change in the coefficient estimates. It should be noted that the high R^2 value represents the portion of the sum of squares of deviation of the "weighted" values of dependent variables that can be attributed to "weighted" independent variables. For this reason, any comparison between the OLS R^2 and the R^2 under WLS is misleading.

5.3 Logistic probability model

The linear probability model has been shown to provide reasonably accurate predictions in forecasting bankruptcy cases (Collings and Green, 1982). However, it has been criticized because there is no guarantee that the predicted probabilities fall within the unit interval (Judge et al., 1980), and as discussed above the inconsistent estimates would also invalidate any hypothesis testing (e.g., the t and F tests) or measures of fit such as R^2.

Furthermore, while correction for heteroscedasticity was possible by subjecting the regression to a proper weight using the predicted probabilities, such weights were not applicable to all observations since some of the predicted probabilities fell out of the range of zero to one. Neither Johnston (1984) or Pyndick and Rubinfeld (1981) recommend the application of the weighted least squares method. While Pyndick and Rubinfeld prefer using the OLS method in this situation, Johnston recommends using neither method.

As an alternative to the linear specifications of the probability model, a dichotomous logit model was assumed to be the correct specification of the relationship between the probability of purchasing MPCI crop insurance and other characteristics associated with Iowa crop farming. The results of the logit regression procedure are shown below in Table 5.3.

Analagous to F statistics in the linear model, the likelihood ratio statistic for overall fit can be used to test the joint hypothesis that all coefficients, except the intercept, are equal to zero in the logistic

Table 5.3 Results of logit regression model

Number of Observations	752
Log Likelihood	-469.51
Chi-Square statistic for overal fit	99.29 with 11 d.f.
Pseudo R^2 = 0.17	

Variable	Parameter Estimate	Standard Error	t-value
Intercept	0.27668	0.60157	0.460
CO	0.58372	0.21434	2.723
AGE	-0.02996	0.98734E-2	-3.034
DRGTCRDP	0.85142	0.22981	3.705
GROSALES	-0.68791E-5	0.25114E-5	-2.739
GROSAGE	0.14553E-6	0.50192E-7	2.899
DECOUPLE	0.40298	0.10507	3.835
ACRTOT	0.61328E-3	0.36033E-3	1.702
NW	-0.11077E-5	0.32649E-6	-3.393
ROAAT	0.91993E-2	0.54609E-2	1.685
FWDCONTR	-0.16393	0.16945	-0.967
YEAR	0.43326	0.18232	2.376

model. This statistic, which approximately follows a Chi-square distribution, is calculated to be 99.29 for the logit model. The probability of a null hypothesis that all coefficients are equal to zero is, therefore, less than 0.005. Furthermore, because the mean and variance of the dependent variable are not separable parameters in the models with qualitative dependent variables, one cannot report a R^2 which shows the proportion of the variation in the dependent variable that is "explained" by the independent variables. However, a pseudo-R^2 that to some degree indicates the success in fit is reported to be 17 percent for this model.

Indicators of years in farming, education, financial stress class, off-farm income, debt-to-asset ratio, the percentage of crops in the overall farming operation, the likelihood of future disaster assistance from the government and tenure class were removed from the model. Except for the variables measuring forward contracting, total acres and rate-of-return on assets, the remaining variables seemed to be significant if the significance level was set between 0.01 and 0.025. Variables reflecting the farmers' political views on agricultural policy (DECOUPLE) and Drought Assistance Act payments (DRGTCRDP) were the most significant explanatory variables, while YEAR and the rate-of-return on assests (ROAAT) were the least significant exogenous variables retained in the model. Finally, the signs on the coefficients of variables GROSALES (gross sales), AGE, NW (net worth), and FWDCONTR (forward contracting) were negative, while the remaining variables had a positive effect on the purchase of crop insurance.

5.4 Probit model

When comparing the sample farmers' actual decisions to purchase crop insurance with the predicted values from the logit model, it is evident that out of the 404 farmers who had not purchased MPCI (i.e., ANYMPI = 0) the logit model correctly identified 309 of them, while it incorrectly predicted that the remaining 95 farmers had purchased MPCI when in fact they had not. On the other hand, out of the 348 farmers who actually purchased MPCI (i.e., ANYMPI = 1), the model correctly identified 189 purchasers while it incorrectly predicted that the remaining 159 farmers had not purchased crop insurance.

A probit model, which utilizes a cumulative normal distribution function for the regression model, yields another alternative to the linear probability model that satisfies the 0-1 restriction without also constraining the predicted values. Furthermore, because a normal curve has a longer tail towards approaching zero, it might provide a better fit and reduce the possibility of incorrect predictions. However, it should be stressed that the logistic and normal curves are very similar, and in practice yield estimated choice probabilities which differ by less than 0.02, and can only be distinguished by using very large samples (Aldrich and Nelson, 1984).

Table 5.4 contains the results of the probit model, which used the same explanatory variables as were used in the logit model. The stepwise procedure had removed the variables representing years in farming, crop percentage of gross farm sales, education, likelihood of future disaster assistance, debt-to-asset ratio, and the indicators of financial stress class and tenure class from the regression model. The likelihood ratio test statistic of 98.57 indicates an overall good fit

Table 5.4 MLE results for probit model

Number of Observations	752
Log Likelihood	-469.87
Chi-Square statistic for overall fit	98.57 with 11 d.f.
Pseudo R^2 = 0.16	

Variable	Parameter Estimate	Standard Error	t-value
Intercept	0.17356	0.36842	0.471
CO	0.35127	0.12966	2.709
AGE	-0.18468E-1	0.60210E-2	-3.067
DRGTCRDP	0.51607	0.13891	3.691
GROSALES	-0.41327E-5	0.15410E-5	-2.682
GROSAGE	0.87197E-7	0.30500E-7	2.859
DECOUPLE	0.24549	0.63869E-1	3.844
ACRTOT	0.03641E-2	0.21700E-3	1.678
NW	-0.06342E-5	0.18530E-6	3.423
ROAAT	0.56295E-2	0.32710E-2	1.721
FWDCONTR	-0.10287	0.10337	-0.995
YEAR	0.26566	0.11166	2.379

that is significant beyond the .005 level. Again, with the exception of the coefficients for forward contracting, total acres, and the rate-of-return on assets, all coefficients are significant at a .025 significance level. ROAAT is significant at the .10 level. The indicators of the farmers' political views on agricultural policy (DECOUPLE) and the receipt of drought assistance payments (DRGTCRDP) remained the most significant of all coefficients in the model. GROSALES, Age, net worth (NW), and forward contracting (FWDCONTR) were the only coefficients found to have negative values.

5.5 Comparison of LPM, logit and probit estimated models

Crop insurance data was used to examine the effect of crop farming characteristics on the likelihood of Iowa farmers purchasing multiple-peril crop insurance. First, using the estimation methods of ordinary least squares (OLS) and weighted least squares (WLS), a linear probability model (LPM) was studied. Later, the method of maximum likelihood estimation (MLE) was used to derive estimates of the unknown parameters for both logit and probit models. Table 5.5a compares the LPM, logit and probit estimates.

A Chi-square statistic, using a likelihood ratio test with 11 degrees of freedom, failed to accept the null hypothesis that the parameter estimates for both logit and probit models are equal to zero. The same can be said about the linear model if the model's F value compared to the table F value. However, there are problems with the linear model, as previously explained. The linear model yielded three predicted values that were out of the 0-1 range. In addition, the sign of the coefficient to NW changed from a negative to a positive value when the weight was applied. Finally, the linear model yielded four coefficient estimates which were not significant. These problems raise questions about the appropriateness of the model as an adequate description of the crop insurance data.

Table 5.5a Comparison of LPM, logit and probit estimates.

Estimate of Variable	LPM	Logit	Probit
Intercept	0.59420	0.27668	0.17356
signf. level	.0001	NS*	NS
CO	0.10567	0.58372	0.35127
signf. level	.0156	.0065	.0067
AGE	-0.00861	-0.02996	-0.18468E-1
signf. level	0.0001	.0024	.0022
DRGTCRDP	0.13849	0.85142	0.51607
signf. level	.0055	.0002	.0002
GROSALES	-0.00784E-4	-0.68791E-5	-0.41327E-5
signf. level	NS	.0062	.0073
GROSAGE	0.10827E-7	0.14553E-6	0.87197E-7
signf. level	NS	0.037	0.043
DECOUPLE	0.10067	0.40298	0.24549
signf. level	0.0001	0.0001	0.0001
ACRTOT	0.40733E-4	0.61328E-3	0.03641E-2
signf. level	NS	0.0888	0.0936
NW	0.00191E-4	-0.11077E-5	-0.06342E-5
signf. level	0.0001	0.0007	0.0006
ROAAT	0.00259	0.9199E-2	0.56295E-2
signf. level	.0001	0.0921	0.0852
FWDCONTR	-0.04302	-0.16393	-0.10287
signf. level	NS	NS	NS
YEAR	0.14075	0.43326	0.26566
signf. level	.0008	.0175	.0174
Goodness of Fit F or χ^2	219.72	99.29	98.57
Degrees of freedom	11, ∞	11	11
Significant beyond	.0001	.005	.005
R^2	0.78	0.17**	0.17**

*NS = not significant **Cragg-Uhler R^2

However, overall the results of the three probability models, as illustrated by the signs of the coefficients, show that there is general consistency between the models.

Recalling equation (4) from Chapter 3 ($Y_i^* = \Sigma b_k X_{ik} - w_i$), it was noted that in deriving the probability models from a behavioral theory, an observable dichotomous variable Y was devised to reflect the sign of the unobservable variable Y*. Because the value of Y* cannot be observed, it's scale cannot be determined. As a result, one could multiply equation (4) by any arbitrary positive constant without changing the sign of Y*, and without effecting Y. As such, probit and logit coefficient estimates cannot directly be compared to each other because of a scale difference between the two. However, as previously noted, the parameter estimates are usually very close to each other. Furthermore, by rescaling the models to a comparable scale the difference between the two estimates becomes smaller. Madalla (1983) suggests that probit coefficients are about .551[2] (or $3^{.5}/\Pi$) times the size of its logit counterpart, while Amemyia (1981) puts this factor around .625.[3]

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[2] In a probit model, the underlying distribution function is for a normal random variable that has a mean of zero and a variance of one; whereas, in the logit model, the distribution function yields a variance of $\Pi^2/3$.

[3] Rescaling is also needed when the coefficients are compared to LPM coefficients. For example, Amemiya's approximation of .625 works as follows:

Coefficients of LPM ≈ .25 coefficients of Logit, except for the intercept.
Coefficients of LPM ≈ .4 coefficients of Probit, except for the intercept.
Intercept of LPM ≈ .25 intercept of Logit + .5.
Intercept of LPM ≈ .4 intercept of Probit + .5.

Prediction-success for the three models are presented in Table 5.5b. The results indicate similar prediction capabilities for the probit and logit models, and proved to give more accurate predictions than the LPM. For example, while the percentage of predicted purchases of crop insurance by LPM was 52.2 percent, or

Table 5.5b Prediction success table of probability models

	Predicted Purchase	Predicted No Purchase	Observed Count	Observed Share
Linear Model				
Actual Purchase	182	166	348	46.3
Actual No Purchase	117	287	404	53.7
% Correctly Predicted	60.9	63.4	62.3	---
% Predicted to Actual	52.2	71.0	62.3	---
Logit Model				
Actual Purchase	189	159	348	46.3
Actual No Purchase	95	309	404	53.7
% Correctly Predicted	66.5	66.0	66.2	---
% Predicted to Actual	54.3	76.5	66.2	---
Probit Model				
Actual Purchase	186	162	348	46.3
Actual No Purchase	95	309	404	53.7
% Correctly Predicted	66.2	65.6	65.8	---
% Predicted to Actual	53.4	76.5	65.8	---

182 out of 348; the logit model's success rate was 54.3 percent, or 189 out of 348; and the probit model's success rate was 5.34 percent, or 186 out of 348. The results of the LPM implies a larger Type I error as it predicted that 29.0 percent, or 117 out of 404, of the

sample farmers had purchased crop insurance when in fact they had not. This compares to 23.5 percent, or 95 out of 404, by either the logit or probit models. Hensher and Johnson (1981) suggested that using posterior probabilities on actual cases which were correctly predicted would be a more appropriate way to compare the prediction accuracy between models.

Accordingly, the logit and probit models would again offer more accurate predictions by correctly predicting 66.5 percent (189 out of 284) and 66.2 percent (186 out of 281), respectively, while the linear model would correctly predict 60.9 percent of the cases (182 out of 299). Overall, the results in Table 5.5b confirm that the logit and probit models would provide greater prediction accuracy, as they correctly predicted 66.2 percent and 65.8 percent of the cases, respectively, versus 62.3 percent of cases that were correctly predicted by the linear model.

CHAPTER 6

INTERPRETATION AND IMPLICATIONS

Significant association was established between the purchase of crop insurance and some of the socio-economic factors as previously explained. Although some of the findings were visably consistent with the hypotheses presented in Chapter 4, some of the variables need futher interpretation as their significance is not as readily apparent.

6.1 Interpretation of estimated crop insurance probability models

The estimation of the probability of purchasing multiple-peril crop insurance P(ANYMPI = 1) by the three models is summarized below:

I. Linear:

$$\begin{aligned} P(ANYMPI = 1) = {} & 0.59420 + (0.10567 \times CO) - (0.00861 \times AGE) + \\ & (0.13849 \times DRGTCRDP) - (0.00784E\text{-}4 \times GROSALES) + \\ & (0.10827E\text{-}7 \times GROSAGE) + (0.10067 \times DECOUPLE) + \\ & (0.40733E\text{-}4 \times ACRTOT) + (0.00191E\text{-}4 \times NW) + \\ & (0.00259 \times ROAAT) - (0.04302 \times FWDCONTR) + \\ & (0.14075 \times YEAR). \end{aligned}$$

II. Logistic:

$$P(ANYMPI = 1) = \frac{e^{Z_i}}{1 + e^{Z_i}} \quad \text{where,}$$

$$Z = 0.27668 + (0.58372 \times CO) - (0.02996 \times AGE) + (0.85142 \times DRGTCRDP) - (0.68791E\text{-}5 \times GROSALES) + (0.14553E\text{-}6 \times GROSAGE) + (0.40298 \times DECOUPLE) + (0.61328E\text{-}3 \times ACRTOT) - (0.11077E\text{-}5 \times NW) + (0.91993E\text{-}2 \times ROAAT) - (0.16393 \times FWDCONTR) + (0.43326 \times YEAR).$$

III. Probit:

$$P(ANYMPI = 1) = \int_{-\infty}^{Z} \frac{1}{\sqrt{2\pi}} e^{(-wi/2)} dw_i \quad \text{where,}$$

$$Z = 0.17356 + (0.35127 \times CO) - (0.18468E\text{-}1 \times AGE) + (0.51607 \times DRGTCRDP) - (0.41327E\text{-}5 \times GROSALES) + (0.87197E\text{-}7 \times GROSAGE) + (0.24549 \times DECOUPLE) + (0.03641E\text{-}2 \times ACRTOT) - (0.06342E\text{-}5 \times NW) + (0.56295E\text{-}2 \times ROAAT) - (0.10287 \times FWDCONTR) + (0.26566 \times YEAR).$$

where:

CO = County, it is equal to 0 if the farmer is located in a northern county, and otherwise equal to 1.

AGE = Age of the farmer.

DRGTCRDP = Whether or not the farmer received government crop disaster assistance payments. It is equal to 1 if he/she received assistance, and otherwise equal to 0.

GROSALES = Total amount of farm related income.

GROSAGE = GROSALES x AGE.

DECOUPLE = Whether or not the farmer believes in dismantling the government income support system, and moving towards market-oriented policy. If the farmer agrees with decoupling, DECOUPLE was equal to 1; if not sure, it was equal to 2; and if the farmer disagrees with this concept, it was equal to 3.

ACRTOT	=	Total acres of land in the farming operation.
NW	=	Net worth of the farming enterprise, as defined by total assets less total debt.
ROAAT	=	Return-on-assets after taxes.
FWDCONTR	=	Having used/not used some type of forward contracting. If used, FWDCONTR was equal to 1, otherwise it was equal to 0.
YEAR	=	0 to indicate drought year of 1988, and equal to 1 to indicate the 1989 crop year.

The consistency of the signs of the coefficients among the three models, and more importantly the consistency of the signs with the hypothesized effect of each exogenous variable, makes each of the models, particularly the non-linear models, a valid choice when explaining purchasing behavior. A positive sign indicates that the probability of purchasing MPCI increases with the value of the corresponding variable.

All three estimated models indicate that, under the same set of circumstances, a farmer located in a southern county would be more likely to purchase crop insurance than would his/her northern counterpart. Furthermore, a Chi-square test of independence confirms that before the 1988 drought region was a factor in deciding whether to buy crop insurance, as shown in Table 6.1. However, the severity of the 1988 drought dissolved many doubts that northern Iowa farmers had about the necessity of crop insurance for the upcoming crop year.

Age also proved to be a significant factor in purchasing crop insurance. The negative sign on the AGE coefficients in all three models implies that the probability of purchasing MPCI is greater

Table 6.1 Chi-Square test of independence between the purchase of crop insurance and region for crop years 1988 and 1989.

1988	South	North	Total
No purchase	36	238	274
Purchase	43	117	160
Total	79	355	434

Chi-squared = 12.80, d.f. = 1
significant beyond .005

1989	South	North	Total
No purchase	26	172	198
Purchase	53	183	236
Total	79	355	434

Chi-squared = 6.29, d.f. = 1
significant beyond .025

among younger farmers, and conforms with the corresponding hypothesis, as presented in Chapter 4. One reason for the negative impact of age on the purchase of MPCI could be the role of education, even though the education variable was excluded at the earlier stages of the modeling process due to its insignificant explanatory power. Younger farmers are more likely to purchase crop insurance, in part, because they are more educated and more informed about methods of reducing risk, which include the purchase of crop insurance. One could also argue that older farmers would have probably already passed the test of business survival, and would have acquired enough equity to afford the loss if they chose not to buy crop insurance.

The 1989 Iowa Farm Finance Survey showed that while the age group of 55 to 64 year old farmers had a net worth of $393,000 as of January 1, 1989, the younger farmers of age 34 or less had a net worth of $157,000. In addition, it showed that farmers between the ages of 35 and 44 tended to have the highest level of debt. Finally, the debt-to-cash flow ratios were higher for farmers in the younger age groups.

The age factor certainly appeared to have a significant role in explaining the effect gross sales has in the decision to purchase crop insurance. Gross sales (GROSALES) in all three models was accompanied by a negative coefficient, which implied that farmers with higher gross sales would be less likely to purchase MPCI. This conclusion is not consistent with the hypothesis presented in Chapter 4. However at ages above 47, the results of the logit and probit models indicated a positive relationship between the purchase of MPCI and gross sales, while the linear model displayed this positive effect for farmers with ages above 72. This positive relationship between the purchase of MPCI and gross sales is due to an interaction factor between age and gross sales (GROSAGE), which appeared to have a positive impact on the purchase of multiple-peril crop insurance.

The coefficient to drought crop disaster payment (DRGTCRDP) in all models (including many preliminary specifications that were omitted from this report) had a significant positive value, which indicated that those who received disaster payments were more likely to purchase crop insurance in the following year than were those who received no disaster assistance. This is consistent with the findings of the 1989 Farm Finance Survey (page 21), which concluded that:

> the passage of the 1988 Disaster Assistance Act has apparently not adversely affected farmers' attitudes toward the purchase of multiple-peril crop insurance as had previously been suggested. In fact, 22.6 percent of the respondents will buy more crop insurance as a result of the drought.

The result of the estimated models also revealed that, ironically, those who believe that the future direction of farm policy should move towards a market-oriented policy which includes phasing out income supports (i.e., decoupling) are less likely to purchase the MPCI. In other words, those who prefer the status quo are more likely to enroll in federal crop insurance programs than those who prefer a change towards a market-oriented farm policy. The hypothesis in Chapter 4 had predicted an opposite effect.

The coefficient to total acres (ACRTOT) was also positive and significant, which indicates that as the number of acres in production increases so will the farmer's probability of purchasing MPCI. Initially, the percent of gross sales from crop farming (CROPS) was also included in the models in order to explain the significance of the crop farming operation. However total acres, by itself, was chosen to be a better explanatory variable in part because it also reflected the size of the operation and was shown to have better explanatory power. In addition, it made the model more parsimonious by using fewer variables.

The coefficient to net worth (NW) was negative and significant in all preliminary and final model specifications. This negative sign is consistent with the role of wealth in the expected utility hypothesis theory of behavior under risk. The negative sign implies that as the farmer moves to a higher wealth level, his/her attitude towards risk-taking softens and becomes less risk-avert. In layman's terms, those who can afford the loss can and will go on farming without the purchase of crop insurance.

The coefficient to return-on-assets after taxes (ROAAT) is significant, at least at the 0.05 significance level. This variable could be used to indicate the farmer's managerial skill level, and shows how much after-tax cash flow is generated per dollar of asset. According to the results of the three models, farmers with greater managerial skill would be more likely to purchase crop insurance than those with poorer managerial skills. This finding is also consistent with the hypothesis outlined in Chapter 4.

There was a weak indication that farmers who practice forward contracting (FWDCONTR) would be less likely to purchase MPCI. This would perhaps have been consistent with the view that a decline in business risk would lead to an acceptance of greater financial risk. However, this effect was found very insignificant in all three models.

Finally, the variable YEAR coefficient was both positive and significant. The 1988 crop year was an unusual year for farmers for several reasons. First, that year was plagued by a drought, which was perhaps the second worst drought of the 20th Century. Second, preparations were underway to design the Farm Bill of 1990, which would determine the course of events for the next five years. Third, this year was especially important because it was an election year. Each of these three events could arguably affect a farmer's decision to purchase crop insurance for the upcoming year. The dummy variable YEAR played the role of a "shock indicator", which distinguished the actions taken by farmers prior to the events of 1988 from those which occurred afterward. This positive and significant coefficient reflected the hypothesis that those who were shocked by the events of 1988 would be more likely to purchase crop insurance in the following year.

6.2 Is disaster assistance an impediment to MPCI enrollment?

One of the goals of this study was to test (statistically) the validity of the argument that farmers decide against enrolling in the crop insurance program because they believe that emergency assistance will be granted in the event of a widespread disaster. The results of this study failed to reach this conclusion, and in fact the opposite result appeared.

There could be several explanations for this unexpected finding. First, the argument that government disaster payments discourage farmers from participating in crop insurance programs may have been blown out of proportion. It may very well be argued that a payment received during a disaster, such as the drought of 1988, served as a reminder for farmers to participate in the crop insurance program. Furthermore, disaster payments may be viewed as an extra incentive for those already insured to continue their participation. Under the provisions of the Drought Assistance Act of 1988, producers with crop insurance could receive both insurance and disaster payments up to 100 percent of their normal return.

Second, this study is based on observations from respondents for whom the purchase of crop insurance was not required. This included farmers whose losses were less than 65 percent. However, in this group there were no disaster payments for those who had not participated in the Basic Commodities program, or were producing nonprogram crops if their losses were less than 36 percent. Program participants with 0 to 35 percent yield loss were forgiven the repayment of any deficiency payments on lost production. For those with yield losses of between 36 to 75 percent (for this study 65 percent), the amount of disaster payments depended on the type of crop and whether or not the farmer had participated in the Basic Commodities program. For participants, the program crop price was calculated to be 65 percent of the target price; and for nonparticipants the program crop price was 65 percent of the county loan rate, which was lower than the target price. Finally, for soybean farmers and farmers planting other nonprogram crops, the price used for calculating disaster payments was 65 percent of the five-year average price, excluding the high and low years (Duffy, 1988). In short, although the disaster payments offered a substantial amount of help to drought stricken farmers, the amount of the payments were, at best, 65 percent of the farmers' normal return, which is still an undesirable return for their effort.

Finally, one should also consider the fact that in order for Congress to legislate ad hoc assistance a widespread natural disaster would have to occur, such as the drought of 1988. It is doubtful to assume that farmers expect a widespread natural disaster to occur on a yearly basis and, therefore, it is highly unlikely that farmers could afford to rely solely on government disaster payments for protection.

In view of the above arguments, it is suggested that disaster payments alone, in fact, increase the likelihood of participation in the federal crop insurance program. However, this does not mean that the receipt of disaster assistance could not have a negative effect on the farmers' attitude towards crop insurance. In fact, there is a great deal of evidence which supports the view that disaster assistance payments interact with farmers' perceptions regarding the necessity of purchasing crop insurance.

For example, Tables 6.2a and 6.2b underscore this assertion. As was previously discussed, those who favor dismantling current agricultural policy in order to move away from an income support system and towards a market oriented policy are less likely to purchase crop insurance than are those who support the current government policy. At least this was the case among 1988 and 1989 MPCI program participants in general. However, when the farmers

Tables 6.2a & 6.2b Chi-Square test of independence between purchases of crop insurance and farmers' view on changing the current agricultural policy (DECOUPLE).

6.2a MPCI vs. DECOUPLE without considering disaster payments

	1988				1989			
	AGREE	NOT SURE	DIS-AGREE	TOTAL 88	AGREE	NOT SURE	DIS-AGREE	TOTAL 89
NO PURCHASE	109	79	45	233	87	55	29	171
PURCHASE	44	62	37	143	66	86	53	205
TOTAL	153	141	82	376	153	141	82	376

Chi square = 9.44 with 2 d.f Interaction: Yes

Chi square = 13.76 with 2 d.f Interaction: Yes

6.2b MPCI vs. DECOUPLE by drought assistance payments

MPCI \ DECOUPLE	DRGTCRDP=0				DRGTCRDP=1			
	AGREE	NOT SURE	DIS-AGREE	TOTAL	AGREE	NOT SURE	DIS-AGREE	TOTAL
NO PURCHASE	63	40	17	120	24	15	12	51
PURCHASE	30	45	24	99	36	41	29	106
TOTAL	93	85	41	219	60	56	41	157

Chi square = 11.29 with 2 d.f Interaction: Yes

Chi square = 2.57 with 2 d.f Interaction: No were grouped according to whether or not they received disaster assistance payments, those who received such payments displayed no correlation between their political view on government policy changes and the purchase of crop insurance in 1989.

Similarly, according to Tables 6.2c and 6.2d, the farmers' decisions to purchase crop insurance in 1988 and 1989 seemed to be independent of how likely they thought future government disaster payments would be. However, when grouped according to whether or not they received disaster assistance payments, those who received such assistance indicated that the purchase or non-purchase of 1989 crop insurance was not independent of their opinion regarding the likelihood of future government assistance. Those who thought that future assistance was unlikely were more likely to purchase crop insurance than were those who thought that future assistance was likely. A similar reaction was not displayed among those who did not receive government disaster payments.

Although the data confirmed the existence of this correlation, the question remains whether or not the negative impact of disaster assistance payments could convince farmers not to participate in the MPCI program. The answer to this question depends on a number of other factors, including, and in particular, whether or not the farmers have previously participated in the program. Through the further breakdown of the data (not presented here), it seems that the negative effect is more evident among farmers who had not previously purchased crop insurance and, thus, may not know the advantages of having crop insurance. This finding has serious implications for the future of the federal crop insurance program, especially as it relates to Iowa farmers.

Tables 6.2c & 6.2d Chi-Square test of independence between the 1988 & 1989 purchases of crop insurance and attitudes toward the likelihood of future disaster payments (GOVACT).

6.2c 1988 & 1989 MPCI vs. GOVACT without considering disaster payments.

MPCI vs.	1988						1989					
GOVACT:	0	1	2	3	4	Total	0	1	2	3	4	Total
NO PURCHASE	38	61	53	48	33	223	20	41	41	38	27	171
PURCHASE	23	32	33	38	14	143	37	52	45	48	23	205
TOTAL	61	93	86	86	50	376	61	93	86	86	50	376

1988: Chi square = 2.25 with 4 d.f
Interaction: No

1989: Chi square = 2.69 with 4 d.f
Interaction: No

6.2d 1989 MPCI vs. GOVACT by drought assistance payments.

MPCI 89 vs.	DRGTCRDP=0						DRGTCRDP=1					
GOVACT	0	1	2	3	4	Total	0	1	2	3	4	Total
NO PURCHASE	19	27	32	26	16	120	5	14	9	12	11	51
PURCHASE	11	23	23	28	14	99	26	29	22	20	9	106
TOTAL	30	50	55	54	30	219	31	43	31	32	20	157

DRGTCRDP=0: Chi square = No with 4 d.f
Interaction: No

DRGTCRDP=1: Chi square = 8.94 with 4 d.f
Interaction: Yes

GOVACT = 0 Very unlikely
GOVACT = 1 somwhat unlikely
GOVACT = 2 Not sure
GOVACT = 3 Somewhat likely
GOVACT = 4 Very likely

CHAPTER 7

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The purpose of this study was to develop and empirically estimate probability models that could explain Iowa farmers' behavior regarding the purchase of multiple-peril crop insurance. The models under study included both linear and nonlinear single-equations. While components of decision theory under risk have been woven into the models, the focus was shifted away from the selection of a utility function and towards the selection of indicators of risk attitude and the amount of risk.

Using socio-economic measures from a sample of Iowa farmers as the exogenous variables, the study examined the purchasing behavior of the sample farmers during a period of time when one of the largest government disaster assistance programs was underway. The intent of this study was to research, among other things, the effect of government disaster assistance payments on farmers' participation in the multiple-peril crop insurance program.

While, as hypothesized, significant association was established between the purchase of MPCI and some socio-economic factors, not all indicators were found to be relevant.

7.1 Conclusions and implications

Using data from the 1988 and 1989 crop years, this study found that the county of operation, age of the farm operator, receipt of government disaster assistance payments, total acres under operation, total gross sales and net worth of the farming operation, rate-of-return on assets after taxes, and the farmer's political view about the course of change in government policy were significant factors in determining which farmers will decide to purchase crop insurance.

This study has further explained the role of goverment disaster payments in the purchase of crop insurance, and concluded that the receipt of such payments, given at the time of a disaster, encouraged farmers to participate in the federal crop insurance program. However, it may also create false expectations of future government disaster payments, which may have a negative impact on the likelihood of farmers' participation in the federal crop insurance program. This negative impact is possibly more detrimental, in terms of future enrollment, for farmers who have not previously participated in MPCI.

One could translate this hypothesis into another set of probability models, which would include a variable indicating the farmers' previous participation in MPCI. After modifying the models described in Chapter 5 to include the variable which indicated MPCI purchases in 1988 (i.e., ANYMPI88), several stepwise procedures were conducted. In the final analysis, the independent variables ANYMPI88, AGE, DRGTCRDP, GOVACT, DECOUPLE, ROAAT, and FWDCONTR were found to be most significant, as presented in Table 7.1a The variables AGE, GOVACT and FWDCONTR carry negative signs, which implies their negative impact on the probability of purchasing crop insurance.

Table 7.1a Comparison of LPM, logit and probit estimates.

Estimate of Variable	LPM	Logit	Probit
Intercept	.313941	0.33133	0.18035
signf. level	.0001	.NS*	.NS
AGE	-0.15090E-2	-0.36461E-1	-0.21297E-1
signf. level	.0464	.0231	.0226
DRGTCRDP	0.060149	1.50644	0.83171
signf. level	.0235	.0001	.0001
GOVACT	-0.22330E-2	-0.25333	-0.14435
signf. level	.NS	.0496	.0530
DECOUPLE	0.66830E-2	0.43388	0.26705
signf. level	.4873	.0434	.0339
ANYMPI88	0.69989	4.93285	2.69826
signf. level	.0001	.0001	.0001
ROAAT	0.19690E-2	0.17202E-1	0.99533E-2
signf. level	.0086	NS	NS
FWDCONTR	-0.64537E-1	-0.753228	-0.44915
signf. level	.0001	.0341	NS
Goodness of Fit			
F or Chi-square	2336.09	248.57	247.21
Degrees of freedom	7, ∞	7	7
Significant beyond	.0001	.005	.005
Psuedo R^2	0.98	0.65	0.64

*NS = not significant

In these models, the linear probability model (LPM) had an overall prediction success rate of 81 percent, whereas the logit and probit models both had success rates of over 84 percent. Although all three models presented valid choices for probability determination, the results of the logit model were used to illustrate some of the possible implications that drought disaster payments and the likelihood of future assistance had on farmers' crop insurance purchase decisions.

For example, the average age of farmers, according to the 1989 Iowa Farm Finance Survey, was 55 years of age. Also according to the survey results, the average after-tax rate of return on assets was 8.9 percent. Table 7.1b presents several scenarios using the estimated coefficients. In column one of this table, is a case of an average Iowa farmer who previously purchased crop insurance, received drought disaster payments, is not sure about the likelihood of future disaster

Table 7.1b Probability table of crop insurance purchase decisions under various scenarios.

Case	1	2	3	4	5	6
Previous Purchase	Yes	No	No	No	No	No
AGE	55	55	30	30	30	30
DRGTCRD	Yes	Yes	No	No	Yes	Yes
GOVACT	3	3	0	4	4	0
DECOUPLE	2	2	3	3	3	3
ROAAT	8.9	8.9	8.9	8.9	8.9	8.9
FWDCONTR	Yes	Yes	No	No	No	No
PROBABILITY	94%	10%	66%	42%	77%	90%
FUTURE MPCI PURCHASE	Yes	No	Yes	No	Yes	Yes

GOVACT = 0 Very unlikely
GOVACT = 1 somwhat unlikely
GOVACT = 2 Not sure
GOVACT = 3 Somewhat likely
GOVACT = 4 Very likely

Decouple = 1 Supports decoupling
Decouple = 2 Not sure
Decouple = 3 Does not support decoupling

assistance payments (GOVACT = 3), is not sure about the need for future changes in the agricultural policy (DECOUPLE = 2), and was engaged in forward contracting. In this scenario, the likelihood of the farmer's future participation in MPCI is estimated to be 94 percent. If the same farmer had not previously participated in the crop insurance program, as shown in column two, his/her likelihood of future participation in the program would be 10 percent. Columns three through six of Table 7.1b provide other examples where it is perceivable that farmers would be expected to participate in the MPCI program even though they have not purchased crop insurance in the past.

The findings of this study may provide an empirical basis for several policy recommendations to improve participation rates of farmers in the multiple-peril crop insurance program. For example, one way to increase the participation is to target promotion and/or subsidies to farmers who have not previously participated in the program, especially the younger farmers who are more likely to make purchases based on model indicators. One may also consider redirecting the government subsidy to reduce premiums for the younger farmers who are more likely to experience greater levels of financial risk. In pursuing this policy, perhaps the current government goal of rate setting on an actuarially sound basis should be temporarily abandoned in favor of enhancing the support net for young farmers entering the farming business.

7.2 Suggestions for future research

Low participation rates as well as the high costs of the federal crop insurance program and disaster assistance programs are major issues concerning the future status of federal crop insurance. This study examined some socio-economic factors that are believed to effect farmers' decisions to purchase multiple-peril crop insurance. In addition, this study investigated the relationship between crop insurance and disaster assistance payments.

However, it is believed that the producers' dissatisfaction with the insurance program is another major factor which could effect the program participation rates. Producers often complain that premiums are excessive when compared to the amount of coverage they receive. In the future, this study could be expanded by including factors that are more directly related to the purchases of crop insurance, which could include producers recent or historical yield, yield coverage level, and the indemnity crop price.

Although this study only considered farmers for whom the purchase of crop insurance was optional (not required), many more farmers are required by either banks and other financial institutions or by the federal government to obtain crop insurance for a variety of reasons. Additional research is needed to examine the effect that these requirements have on the farmers' decisions regarding crop insurance, and on the overall MPCI participation rate.

Finally, the effect of other government programs on the MPCI purchase decision was not considered in this study. It could be argued that government income-support policies reduce the overall risks (business and financial) faced by farmers and may lead to the assumption of additional business risk, including self insurance.

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APPENDIX

1989 IOWA FARM FINANCE SURVEY

1989 IOWA FARM FINANCE SURVEY

This survey was conducted by the Iowa State University Cooperative Extension Service and Agricultural Experiment Station with assistance of the Iowa Office of Agricultural Statistics. Iowa farm operators were asked for income tax return and balance sheet data to determine financial conditions as of January 1, 1989. This is the sixth survey since 1984. The purpose is to provide accurate research-based information on the financial performance of agriculture to farmers, policymakers and others with an interest in Iowa agriculture.

I. SAMPLE CHARACTERISTICS

The 1989 surveys were mailed to a representatives sample of 2,524 Iowa farm operators. Responses from 1316 were returned. The financial analysis is based on 752 returns containing complete financial data. The revised sampling methods yielded a higher response than previous years.

The strength of a mail survey depends upon how well the respondents represent characteristics of the total farm operator population. Similar to the previous surveys, 1989 respondents are under-represented by younger farmers and smaller farms. So, the results are more representative of established commercial farms.

TABLE 1. Comparison of Farm Size Indicators from Census and 1985-89 Farm Finance Survey Samples.

Farm Size	Farm Finance Surveys					Ag. Census	
(acres)	1989	1988	1987	1986	1985	1987	1982
	percent						
1-49	1.4	3.1	1.7	1.7	1.1	18.0	17.6
50-179	15.3	13.2	15.8	16.5	15.2	26.2	26.8
180-499	49.5	48.5	49.9	51.9	54.0	37.1	40.1
500-999	26.6	27.2	27.1	24.4	25.0	15.1	12.9
1,000 up	7.1	7.9	5.5	5.4	4.7	3.5	2.7
Avg.	454	463	445	424	433	301	283

Source: Iowa Farm Finance Survey, 1989; 1988; 1987; 1986; 1985; and Iowa Census of Agriculture, 1982; 1987.

The 1989 Iowa Farm Finance Survey was prepared by Dr. Mark A. Edelman and Khosrow Khojasteh, Associate Professor and Graduate Assistant; Department of Economics, Iowa State University, PA #84, June 6, 1989.

TABLE 2. Comparison of Age Indicators from Census and 1985-89 Farm Finance Survey Samples.

Age Group	Farm Finance Survey 1989	1988	1987	1986	1985	Ag. Census 1987	1982
	percent						
< 35	4.0	6.0	5.4	7.3	5.8	N.A.	22.5
35-44	14.8	15.6	14.5	17.4	16.3	N.A.	19.5
45-54	23.9	26.4	25.1	23.9	26.6	N.A.	22.6
55-64	38.3	33.8	38.1	37.5	37.7	N.A.	23.9
65 up	19.1	18.2	16.8	13.8	13.7	N.A.	11.5
Avg.	55	54	54	53	54	N.A.	48

N.A.= Not Available at Publication.
Source: Iowa Farm Finance Survey, 1989; 1988; 1987; 1986; 1985; and Iowa Census of Agriculture, 1982; 1987.

II. 1989 AVERAGE FINANCIAL INDICATORS COMPARED TO PREVIOUS YEARS

The January 1, 1989 balance sheet indicators list total assets at $453,000 and total debt at $113,000 per farm. These results show that the overall reduction in farm debt has slowed and many respondents are modestly increasing debt. In addition, total assets increased again this year, partially reflecting the recent rise in land values. As a result, average net worth per farm grew by $30,000 to $340,000 per farm in 1988.

Net farm income for 1988 remained strong and near the 1987 record levels despite the impacts of the most severe drought since the 1930s. Net farm income for 1988 averaged $30,000--only $600 lower than the record high $30,600 for 1987.

However, net farm incomes for 1988 and 1987 are significantly higher than the previous years during the farm finance crisis. Net farm income before taxes averaged $17,300 in 1986, $1,000 in 1985 and $8,300 in 1984. These numbers describe the variability in farm income and the dramatic climb out of the farm crisis for many--but not all--farmers.

Financial ratios are often used to compare the status of specific farms to industry standards. Most of the ratios used in this report reflect a good year for 1988, but not as strong as 1987.

TABLE 3. Comparison of Financial Characteristics For Samples of Iowa Farm Operators on January 1, 1989, 1988, 1987, 1986 and 1985.

FINANCIAL CHARACTERISTICS	1989 SURVEY	1988 SURVEY	1987 SURVEY	1986 SURVEY	1985 SURVEY
OPERATORS (%)	100%	100%	100%	100%	100%
Average Age	55	54	54	53	54
Average Acres	454	463	445	424	433
BALANCE SHEET ($000)					
Total Assets	453	420	366	382	501
Non-Real Estate	173	174	145	142	165
Real Estate	280	246	221	240	336
Val/Acre	1087	974	892	1026	N.A.
Total Debts	113	110	114	123	159
Non-Real Estate	41	39	38	45	59
Real Estate	72	71	76	78	100
Net Worth	340	310	252	259	342
FINANCIAL STATEMENT ($000)					
Gross Farm Income	140.2	136.6	127.2	115.5	112.0
- Operating Expense	87.8	86.1	80.1	76.1	70.2
- Interest Expense	10.5	11.2	13.1	15.3	17.6
Net Cash Farm Income	41.9	39.3	34.0	24.1	24.2
+ Inventory Change	2.4	7.3	0.4	(4.1)	3.4
Adj Net Cash Farm Income	44.5	46.6	34.4	20.0	27.6
- Depreciation	14.5	16.0	17.1	19.0	19.3
NET FARM INCOME (bef tax)	30.0	30.6	17.3	1.0	8.3
+ Off-Farm Income	11.3	11.1	10.6	8.1	6.5
Income Before Taxes	41.3	41.7	27.9	9.1	14.8
- Estimated Tax	10.9	10.4	8.0	4.3	4.0
NET INCOME (aft tax)	30.4	31.3	19.9	4.8	10.8
- Est. Family Living	16.0	16.2	16.3	16.5	16.3
Earned Net Worth	14.4	15.1	3.6	(11.7)	(5.5)
+ Depreciation	14.5	16.0	17.1	19.0	19.3
- Inventory Change	2.4	7.3	0.4	(4.1)	3.4
NET CASH FLOW (aft tax)	26.5	23.8	20.3	11.4	10.4
FINANCIAL RISK INDICATORS (%)					
Debt/Asset Ratio	24.9	26.2	31.1	32.2	31.7
Non-Real Est Assets/Debt	422	446	382	316	280
Interest/Gross Income	7.5	8.2	10.3	13.2	15.7
Return on Assets (bef int)	8.9	9.9	8.3	4.3	5.2
Return on Equity (aft int)	8.8	9.9	6.9	0.4	2.4
Earned Net Worth Ratio	4.2	4.9	1.4	(4.5)	(1.6)
Debt/Net Cash Flow Ratio (yrs)	4	5	6	11	15

Source: Iowa Farm Finance Survey Data, 1989; 1988; 1987; 1986; and 1985.

TABLE 4. Farm Financial Analysis Ratios And Risk Indicators.

1. WHAT IS YOUR DEBT LEVEL?		
Debt to Asset Ratio:	Superior	under 10%
	Good	10% - 40%
Total Liabilities	Close Watch	40% - 55%
/ Total Assets	Weak	55% - 70%
	Inferior	over 70%
2. CAN YOU COVER CURRENT OBLIGATIONS?		
Non-Real Estate Asset to Debt Ratio:	Superior	over 500%
	Good	400% - 500%
Non-Real Estate Assets	Close Watch	300% - 400%
/ Non-Real Estate Liabilities	Weak	200% - 300%
	Inferior	under 200%
Note: Non-Real Estate Asset to Debt Ratio Standards are approximately two to three times commonly used standards for Current Ratios.		
3. WHAT IS YOUR INTEREST EXPOSURE?		
Interest to Gross Income Ratio:	Superior	under 10%
	Good	10% - 15%
Interest Expense	Close Watch	15% - 20%
/ Gross Income	Weak	20% - 25%
	Inferior	over 25%
4. WHAT'S THE PROFITABILITY OF THE WHOLE FARM?		
Return on Assets Ratio (bef int):	Superior	over 12%
	Good	8% - 12%
Net Farm Income (bef tax)	Close Watch	4% - 8%
+ Interest Expense	Weak	0% - 4%
/ Total Assets	Inferior	under 0%
5. WHAT'S THE PROFITABILITY OF YOUR EQUITY INVESTMENT?		
Return on Equity Ratio (aft int):	Superior	over 10%
	Good	6% - 10%
Net Farm Income (bef tax)	Close Watch	2% - 6%
/ Net Worth	Weak	(2%) - 2%
	Inferior	under (2%)
6. IS YOUR FIRM GROWING OR DECLINING?		
Earned Net Worth Ratio:	Superior	over 8%
	Good	4% - 8%
Earned Growth in Net Worth	Close Watch	0% - 4%
/ Net Worth	Weak	(4%) - 0%
	Inferior	under (4%)
7. HOW MANY YEARS OF CASH FLOW WOULD IT TAKE TO PAY OFF YOUR DEBT?		
Debt to Net Cash Flow (aft tax):	Superior	under 5
	Good	5 - 15
Total Debt	Close Watch	15 - 30
/ Net Cash Flow (aft tax)	Weak	30 over
	Inferior	Negative

Source: Iowa Farm Finance Surveys, 1985-89 and professional judgment.

III. FINANCIAL POSITION DEFINED BY DEBT LEVEL AND CASH FLOW

In this report, four categories are defined to broadly describe the financial position of farm operators. Class 1 farms are in strong financial shape. Class 2 farms are in stable position but may sometimes experience stress. Class 3 farms are in weak condition and may require major operating changes and/or debt and asset restructuring to stabilize the farm's financial position. Class 4 farms are severely stressed and survival of the business is unlikely if present conditions continue.

The classification scoring system in this report uses a combination of solvency and liquidity measures for each farm. Solvency is measured by the debt to asset ratio on January 1, 1989. For example, a debt to asset ratio of 40 percent means the farmer owes $40 in debt for each $100 of assets owned. If a farmer owes more than is owned, the debt to asset ratio exceeds 100 percent and the farmer is technically insolvent. In general, farms with higher debt to asset ratios are more vulnerable if earnings or asset values decline.

Liquidity is measured by a cash flow to equity ratio. For this ratio, before-tax net cash flow is divided by the farm operator's net worth. In this study, before-tax net cash flow equals total cash sales for 1988 reported on IRS Form 1040F, plus sales of breeding stock and off-farm income, less cash production expenses, interest, and estimated family living expenses. Net worth is defined as the difference between the farm operator's assets and its debts as of January 1, 1989.

If before-tax net cash flow is positive, funds may be used to pay taxes, replace equipment, retire debt or expand the operation. If the cash flow is negative, the farm will require additional borrowing or liquidation of assets to offset the cash flow shortfall. For example, a ratio of minus 20 percent indicates the farm lost a cash equivalent to

20 percent of its current net worth. If this loss level continues, the farmer would become insolvent within a few years. In contrast, a positive 20 percent ratio means strong earnings-to-investment capacity.

The combinations of liquidity and solvency measures used to define the financial positions in this report are listed below. Severe stress is experienced by farms in the upper left and financial position improves as we move toward the lower right. The parentheses show the percent of all respondents with each combination.

TABLE 5. Financial Positions Defined by Debt Level and Cash Flow.

DEBT/ASSET RATIO	CASH FLOW/EQUITY RATIO					
	Insolvent	Less than -20%	-20 to -5%	-5 to 5%	5 to 20%	Greater than 20%
Insolvent	4 (3)	-	-	-	-	-
70-100%	-	4 (+)	4 (+)	3 (0)	3 (1)	3 (3)
40-70%	-	4 (1)	4 (1)	3 (3)	2 (8)	2 (4)
10-40%	-	3 (1)	3 (1)	2 (10)	1 (17)	1 (2)
0-10%	-	3 (1)	3 (4)	2 (20)	1 (18)	1 (2)

Top number is the financial class assigned to each respondent.
Bottom number in ( ) is the percent of total respondents.
(+) Indicates greater than zero but less than 0.5 percent.
Source: 1989 Iowa Farm Finance Survey.

IV. CHANGE IN DISTRIBUTION OF FARM OPERATORS BY FINANCIAL POSITION

The results of the 1989 Farm Finance Survey reveals that a majority of farms remain in stable or strong financial status in spite of the 1988 drought. Forty-two percent of the respondents are now in stable condition compared to 31 percent in the 1988 survey. However, only 39 percent are considered financially strong compared to 48 percent last year. This means that a greater proportion are now classified as stable rather than strong. Disaster Assistance, higher grain prices and farm program payments are among the apparent reasons for income stability. Also, rising land values contributed to improved balance sheet solvency.

However in spite of three years of improved agricultural income conditions since the depths of the farm finance crisis, 19 percent of Iowa farm operators remain under weak or severe financial stress. While this is lower than the 31 percent in severe stress in the 1986 survey, it signifies that some restructuring will likely continue in the future.

TABLE 6. Changes In Distribution of Iowa Farmers and Characteristics by Financial Position 1989, 1988, 1987, 1986, and 1985.

FINANCIAL CHARACTERISTICS	FINANCIAL POSITION STRONG	STABLE	WEAK	SEVERE	TOTAL
DISTRIBUTION OF OPERATORS (%)					
January 1, 1989	39	42	14	5	100
January 1, 1988	48	31	15	6	100
January 1, 1987	45	29	15	11	100
January 1, 1986	32	37	18	13	100
January 1, 1985	28	42	18	12	100
ASSET DISTRIBUTION (%)					
January 1, 1989	43	44	10	3	100
January 1, 1988	50	34	12	4	100
January 1, 1987	47	32	13	8	100
January 1, 1986	33	40	16	11	100
January 1, 1985	27	45	18	10	100
DEBT DISTRIBUTION (%)					
January 1, 1989	24	43	21	12	100
January 1, 1988	25	35	25	15	100
January 1, 1987	20	31	25	24	100
January 1, 1986	14	30	27	29	100
January 1, 1985	12	35	29	24	100
FARM GROSS SALES DIST (%)					
January 1, 1989	46	37	11	6	100
January 1, 1988	53	30	12	5	100
January 1, 1987	47	31	13	9	100
January 1, 1986	34	36	17	13	100
January 1, 1985	31	39	19	11	100

Sources: Iowa Farm Finance Survey, 1989; 1988; 1987; 1986; and 1985.

The 1989 Farm Finance Survey shows that a higher proportion of farm assets are now held by those with stable financial status rather than strong financial position. This reflects an erosion of financial status for many farmers as a result of the drought.

Compared to last year, a higher proportion of the farm debt is now held by those in stable and strong financial positions and the proportion of the farm debt held by those classified as weak or severely stressed has declined.

V. GEOGRAPHIC DISTRIBUTION OF FARM OPERATORS BY FINANCIAL POSITION

The 1987 and 1988 surveys indicated a higher incidence of financial stress in Southern Iowa. While a pattern of regional differences appears to remain in the 1989 survey, the differences are not as apparent as in the 1988 survey.

TABLE 7. Geographic Distribution of Iowa Farm Operators By Financial Position, January 1, 1989.

		FINANCIAL POSITION				
CHARACTERISTICS	(N)	STRONG	STABLE	WEAK	SEVERE	TOTAL
STATE TOTAL	(723)	39	42	14	5	100
Northwest	(185)	43	41	12	4	100
Central	(191)	45	37	15	3	100
Northeast	(185)	32	48	16	4	100
Southern	(162)	37	42	15	6	100

Source: 1989 Iowa Farm Finance Survey.

VI. FINANCIAL INDICATORS BY FINANCIAL POSITION

A major purpose of the Farm Finance Survey is to annually provide standard financial indicators by financial position that may be used as a tool or basis for comparison by farmers and others in making financial management and policy decisions. The 1989 Farm Finance Survey includes balance sheet, income statement and risk indicators by financial status.

TABLE 8. Comparison of Financial Characteristics For a Sample of Iowa Farm Operators by Financial Position, January 1, 1989.

FINANCIAL CHARACTERISTICS	1989 FINANCIAL POSITION STRONG	STABLE	WEAK	SEVERE	1989 SAMPLE
OPERATORS (%)	39	42	14	5	100
Average Age	55	57	56	46	55
Average Acres Operated	496	433	391	370	454
BALANCE SHEET ($000)					
Total Assets	498	475	322	243	453
Non-Real Estate	195	171	142	117	173
Real Estate	303	304	180	126	280
Total Debts	70	117	164	270	113
Non-Real Estate	22	39	67	114	41
Real Estate	48	78	97	156	72
Net Worth	428	358	158	(27)	340
FINANCIAL STATEMENT ($000)					
Gross Farm Income	164.2	121.8	104.8	105.5	140.2
- Operating Expense	96.0	78.2	79.1	79.3	87.8
- Interest Expense	7.1	11.3	14.7	17.3	10.5
Net Cash Farm Income	61.1	32.3	11.0	8.9	41.9
+ Inventory Change	3.4	0.6	6.9	1.7	2.4
Adj Net Cash Farm Income	64.5	32.9	17.9	10.6	44.5
- Depreciation	19.0	12.3	8.8	9.1	14.5
NET FARM INCOME (bef tax)	45.5	20.6	9.1	1.5	30.0
+ Off-Farm Income	14.9	8.5	8.5	9.8	11.3
Income Before Taxes	60.4	29.1	17.6	11.3	41.3
- Estimated Tax	16.3	7.0	3.4	4.7	10.9
NET INCOME (aft tax)	44.1	22.1	14.2	6.6	30.4
- Est. Family Living	16.2	15.8	16.5	17.4	16.0
Earned Net Worth	27.9	6.3	(2.3)	(10.8)	14.4
+ Depreciation	19.0	12.3	8.8	9.1	14.5
- Inventory Change	3.4	0.6	6.9	1.7	2.4
NET CASH FLOW (aft tax)	43.5	18.0	(0.4)	(3.4)	26.5
FINANCIAL RISK INDICATORS (%)					
Debt/Asset Ratio	14.1	24.6	50.9	111.1	24.9
Non-Real Est Assets/Debt	886	438	212	103	422
Interest/Gross Income	4.3	9.3	14.0	16.4	7.5
Return on Assets (bef int)	10.6	6.7	7.4	7.7	8.9
Return on Equity (aft int)	10.6	5.8	5.8	( )	8.8
Earned Net Worth Ratio	6.5	1.8	(1.5)	( )	4.2
Debt/Net Cash Flow Ratio	2	7	( )	( )	4

Source: 1989 Iowa Farm Finance Survey.

VII. FARM OPERATOR CHARACTERISTICS BY FINANCIAL POSITION

Several farm characteristics help to explain the differences in financial indicators across the various financial positions. Those with severe financial stress tend to be younger with more dependents and they rent a higher proportion of acres operated. They have higher living expenses, more education, and earn greater off-farm wages than farms in stable or weak position. Low 1989 returns for pork are also reflected in the enterprise mix indicators.

TABLE 9. Operator Characteristics for a Sample of Iowa Farm Operators by Financial Position, Comparisons with 1989; 1988.

OPERATOR CHARACTERISTICS	FINANCIAL POSITION				SAMPLE TOTAL	
	STRONG	STABLE	WEAK	SEVERE	1989	1988
OPERATORS (%)	39	42	14	5	100	100
FAMILY CHARACTERISTICS						
Average Age	55	57	56	46	55	54
Years in Farming	31	33	32	21	32	30
Total Dependents	2.9	2.5	3.1	3.8	2.8	2.9
Dependents Under Age 18	0.7	0.5	0.9	1.6	0.7	0.8
Husband Education *	2.4	2.3	2.2	2.6	2.3	2.4
Wife Education *	2.5	2.4	2.2	2.5	2.4	2.5
OFF-FARM INCOME						
Off-Farm Income ($000)	14.9	8.5	8.5	9.8	11.3	11.1
Wage Income ($000)	10.1	5.8	7.0	9.3	7.9	7.6
SOURCES OF GROSS FARM INCOME						
Crops	61	58	54	57	58	57
Pork	17	15	18	23	17	17
Beef	15	19	17	18	17	16
Dairy	3	2	5	0	3	4
Other	4	6	6	2	5	6
Total	100	100	100	100	100	100
LAND TENURE CHARACTERISTICS						
Total Acres Operated	496	432	391	369	454	463
Acres Owned	255	281	183	150	258	254
Percent Owning All Land	25	39	39	27	33	36
Percent of Acres Rented	49	35	53	59	43	45
Percent Renting All Land	14	9	14	17	12	13
Jan. 1, 1989 Land Value/A	1188	1081	986	843	1087	974

* Highest educational institution attended: 1 = grade school, 2 = high school, and 3 = college or vocational school.

Source: Iowa Farm Finance Survey, 1989; 1988.

VIII. FINANCIAL INDICATORS BY AGE OF IOWA FARM OPERATORS

Although farmers in all age groups can and have experienced financial stress, higher proportions of younger farmers have tended to experience financial stress during the 1980s. The financial characteristics of Iowa farmers by age groups provides an interesting analysis of farm income capabilities by age during 1987.

First, net worth typically tends to grow until age 65 as retirement is phased in. Second, peak income years occur between the age of 35 and 64. Third, farmers between the age of 35 to 44 tend to have the highest debt level. Return on assets and return on equity are highest for respondents who are less than 45 years old. Finally, the debt to cash flow ratios are higher for younger age groups.

TABLE 10. Comparison of Financial Characteristics For a Sample of Iowa Farm Operators by Age of Farm Operator, January 1, 1989.

FINANCIAL CHARACTERISTICS	FARM OPERATOR AGE GROUPS ≤ 34	35-44	45-54	55-64	≥ 65	1989 SURVEY
OPERATORS (%)	4.0	14.8	24.5	38.2	18.5	100
Average Age	32	40	50	60	70	55
Average Acres Operated	413	553	481	478	302	454
BALANCE SHEET ($000)						
Total Assets	265	412	501	511	354	453
Non-Real Estate	178	216	202	182	92	173
Real Estate	87	196	299	329	262	280
Total Debts	108	178	130	118	36	113
Non-Real Estate	56	71	50	37	12	41
Real Estate	52	107	80	81	24	72
Net Worth	157	234	371	393	318	340
FINANCIAL STATEMENT ($000)						
Gross Farm Income	128.4	181.6	146.4	156.2	71.1	140.2
- Operating Expense	89.7	119.9	93.3	93.0	45.4	87.8
- Interest Expense	8.8	13.5	11.7	12.3	3.7	10.5
Net Cash Farm Income	29.9	48.2	41.4	50.9	22.0	41.9
+ Inventory Change	3.8	7.1	4.1	2.3	(2.5)	2.4
Adj Net Cash Farm Income	33.7	55.3	45.5	53.2	19.5	44.5
- Depreciation	13.5	18.8	16.5	15.1	7.8	14.5
NET FARM INCOME (bef tax)	20.2	36.5	29.0	38.1	11.7	30.0
+ Off-Farm Income	11.1	11.5	11.4	11.0	11.6	11.3
Income Before Taxes	31.3	48.0	40.4	49.1	23.3	41.3
- Estimated Tax	6.7	10.4	10.3	14.0	6.4	10.9
NET INCOME (aft tax)	24.6	27.6	30.1	35.1	16.9	30.4
- Est. Family Living	17.7	17.9	16.5	15.5	15.4	16.0
Earned Net Worth	6.9	9.7	13.6	19.6	1.5	14.4
+ Depreciation	13.5	18.8	16.5	15.1	7.8	14.5
- Inventory Change	3.8	7.1	4.1	2.3	(2.5)	2.4
NET CASH FLOW (aft tax)	16.6	21.4	26.0	32.4	11.8	26.5
FINANCIAL RISK INDICATORS (%)						
Debt/Asset Ratio	40.8	43.2	25.9	23.1	10.2	24.9
Non-Real Est Assets/Debt	318	304	404	492	767	422
Interest/Gross Income	6.9	7.4	8.0	7.9	5.2	7.5
Ret. on Assets (bef int)	10.9	12.1	8.1	9.9	4.4	8.9
Ret. on Equity (aft int)	12.9	15.6	7.8	9.7	3.7	8.8
Earned Net Worth Ratio	4.4	4.1	3.7	5.0	0.5	4.2
Debt/Net Cash Flow Ratio	7	8	5	4	3	4

Source: 1989 Iowa Farm Finance Survey.

IX. FINANCIAL INDICATORS BY SIZE OF FARM (ACRES) IN IOWA

The financial indicators show that assets and net worth PER ACRE decline as acres operated increase. This is to be expected because larger farms rent more acres and spread their machinery costs over more acres. Thus, smaller farms utilize more investment per acre.

Surprisingly, the range in net farm income is only a $28 per acre among the farm size groups. This indicates that no farm size group is significantly more profitable per acre than the other farm size groups. However, that is not the whole story. If we add off-farm income and subtract taxes and family living expenses, earned net worth and cash flow per acre are significantly less for the small farm group. Living expenses and taxes are spread over fewer acres in the small farm group.

Even though many analysts argue over the presence of economies of size in farming, the more dramatic competitive effects are likely due to the shear differences in volume of production. Ignoring variation in profits per acre, the net farm income per farm for the small farms average $7,000 compared to $110,900 for the farms with over 1000 acres. Including off-farm income and deducting taxes, we also find that after-tax income is $13,800 for small farms and $85,700 for the large farms.

Three important risk indicators significantly increase as farm size increases: earned net worth, return on assets and return on equity. Earned net worth is net income after family living expense which is available for principal payments and net investments above depreciation. The results indicate that while production economies per acre are similar across farm size groups, the financial competitiveness of the large farms can clearly overshadow the whole farm competitiveness of the small farms. Similar conclusions were found in the 1988 survey.

TABLE 11. Comparison of Financial Characteristics PER ACRE For a Sample of Iowa Farm Operators by Farm Size (Acres), January 1, 1989.

FINANCIAL CHARACTERISTICS	FARM SIZE GROUPS (ACRES) ≤ 179	180-499	500-999	≥ 1000	1989 SURVEY
OPERATORS (%)	16.3	50.4	26.5	6.8	100
Average Age	61	55	53	52	54
Average Acres	123	322	679	1308	454
BALANCE SHEET ($/A)					
Total Assets	1593	1093	954	818	991
Non-Real Estate	479	404	387	333	377
Real Estate	1114	689	567	485	614
Total Debts	187	220	268	282	244
Non-Real Estate	65	77	99	106	88
Real Estate	122	143	169	176	156
Net Worth	1406	873	686	536	747
FINANCIAL STATEMENT ($/A)					
Gross Farm Income	311	322	288	339	306
- Operating Expense	203	202	182	206	192
- Interest Expense	18	20	24	28	23
Net Cash Farm Income	90	100	82	105	91
+ Inventory Change	(3)	(1)	10	9	5
Adj Net Cash Farm Income	87	99	92	114	96
- Depreciation	30	32	33	30	31
NET FARM INCOME (bef tax)	57	67	59	85	65
+ Off-Farm Income	87	34	16	11	24
Income Before Taxes	144	101	75	96	89
- Estimated Tax	32	26	19	30	24
NET INCOME (aft tax)	112	75	56	66	65
- Est. Family Living	128	50	24	13	35
Earned Net Worth	(16)	25	32	53	30
+ Depreciation	30	32	33	30	31
- Inventory Change	(3)	(1)	10	9	5
NET CASH FLOW (aft tax)	17	58	55	74	56

Source: 1989 Iowa Farm Finance Survey.

TABLE 12. Comparison of Financial Characteristics For a Sample of Iowa Farm Operators by Farm Size (Acres), January 1, 1989.

FINANCIAL CHARACTERISTICS	FARM SIZE GROUPS (ACRES) ≤ 179	180-499	500-999	≥ 1000	1989 SURVEY
OPERATORS (%)	16.3	50.4	26.5	6.8	100
Average Age	61	55	53	52	55
Average Acres	123	322	679	1308	454
BALANCE SHEET ($000)					
Total Assets	196	352	648	1070	453
Non-Real Estate	59	130	263	435	173
Real Estate	137	222	385	635	280
Total Debts	23	71	182	369	113
Non-Real Estate	8	25	67	139	41
Real Estate	15	46	115	230	72
Net Worth	173	280	466	701	340
FINANCIAL STATEMENT ($000)					
Gross Farm Income	38.3	103.7	195.5	442.9	140.2
- Operating Expense	24.9	65.2	123.4	269.0	87.8
- Interest Expense	2.3	6.5	16.6	36.4	10.5
Net Cash Farm Income	11.1	32.0	55.5	137.5	41.9
+ Inventory Change	(0.4)	(0.2)	7.2	12.3	2.4
Adj Net Cash Farm Income	10.7	31.8	62.7	149.8	44.5
- Depreciation	3.7	10.4	22.7	38.9	14.5
NET FARM INCOME (bef tax)	7.0	21.4	40.0	110.9	30.0
+ Off-Farm Income	10.7	11.0	10.6	14.1	11.3
Income Before Taxes	17.8	32.4	50.6	125.0	41.3
- Estimated Tax	4.0	8.4	12.6	39.3	10.9
NET INCOME (aft tax)	13.8	24.0	38.0	85.7	30.4
- Est. Family Living	15.8	16.1	16.4	16.6	16.0
Earned Net Worth	(2.0)	7.9	21.6	69.1	14.4
+ Depreciation	3.7	10.4	22.7	38.9	14.5
- Inventory Change	(0.4)	(0.2)	7.2	12.3	2.4
NET CASH FLOW (aft tax)	1.3	18.5	37.1	95.7	16.5
FINANCIAL RISK INDICATORS (%)					
Debt/Asset Ratio	11.7	20.2	28.1	34.5	24.9
Non-Real Est Assets/Debt	737	520	393	312	422
Interest/Gross Income	6.0	6.3	8.5	8.2	7.5
Return on Assets (bef int)	4.7	7.9	8.7	13.8	8.9
Return on Equity (aft int)	4.0	7.6	8.6	15.8	8.8
Earned Net Worth Ratio	(1.1)	2.8	4.6	9.9	4.2
Debt/Net Cash Flow Ratio	18	4	2	4	4

Source: 1989 Iowa Farm Finance Survey.

X. CHANGE IN FARM DEBT BY DEBT POSITION

The 1989 Farm Finance Survey asked respondents for January 1, 1988 and 1989 balance sheet data. This allows direct comparison of the changes in debt level that occurred during the 1988 calendar year. While most producers remained in the same debt class during 1988, 12 percent of the 752 respondents show a reduction in their 1989 debt class level compared to 1988. On the other hand, 6 percent of the respondents show a higher debt class in 1989 compared to 1988.

The rise in debt to asset ratios for those with higher debt levels may indicate an eroding financial position. However, those with rising debt ratios and lower debt levels may be incurring more debt as they purchase real estate and/or expand operations.

TABLE 13. Change in Debt to Asset Ratio Classes For the 1989 Farm Finance Survey Sample of Iowa Farm Operators: January 1, 1989 and 1988.

1988 Debt/ Asset Ratio Class (%)	1989 Debt/Asset Ratio Class					1988 Total Dist.
	0-10%	10-40%	40-70%	70-100%	Insolvent	
0-10%	92%	7%	1%	0%	0%	45%
10-40%	13	82	5			29
40-70%	2	23	71	3	1	17
70-100%	4	2	45	49	0	6
Insolvent			5	19	76	3
1989 Total Distribution	46%	31%	17%	4%	2%	100%

( ) The number underlined indicates the percentage of operators in this 1988 debt class who are in the same debt class in 1989.

EXAMPLE: Of the respondents who had a 0-10 percent debt to asset ratio January 1, 1988, 92 percent had 0-10 percent debt to asset ratios on January 1, 1989, while ratios for 7 percent rose to the 10-40 percent level and ratios for 1 percent rose above 40 percent.

Source: 1989 Iowa Farm Finance Survey.

XI. FARM DEBT BY FINANCIAL POSITION HELD BY EACH LENDER

Generally, the distribution of farm debt by borrower's financial position appeared to be mixed for the lenders during 1989. The portfolio of farm debt by financial position appeared to weaken slightly for banks. However, the distribution of debt appears to improve for the Farm Credit System and the FmHA.

TABLE 14. Distribution of Farm Debt by Lender and Financial Position A Comparison of 1989 and 1988 Farm Finance Surveys.

LENDERS	(N)	FINANCIAL POSITION STRONG	STABLE	WEAK	SEVERE	TOTAL SAMPLE
COMMERCIAL BANKS						
January 1, 1989	(344)	23	41	23	13	100
January 1, 1988		33	34	22	11	100
FARM CREDIT SYSTEM						
January 1, 1989	(148)	14	56	22	8	100
January 1, 1988		26	32	28	14	100
FARMERS HOME ADMINISTRATION						
January 1, 1989	(83)	3	39	32	26	100
January 1, 1988		5	27	38	30	100
INSURANCE COMPANIES						
January 1, 1989	(69)	20	44	24	12	100
January 1, 1988		NA	NA	NA	NA	100
INDIVIDUALS						
January 1, 1989	(231)	21	40	23	16	100
January 1, 1988		27	35	24	14	100
OTHERS						
January 1, 1989	(153)	19	46	22	14	100
January 1, 1988		27	37	28	8	100
TOTAL SAMPLE						
January 1, 1989	(505)	24	43	21	12	100
January 1, 1988		25	35	25	15	100

NA - Not Available, inconsistencies in data prevent publication.
Sources: Iowa Farm Finance Survey, 1989; 1988.

XII. DISTRIBUTION OF FARM FINANCIAL STRESS AMONG LENDERS

Based on the 1989 Iowa Farm Finance Survey, the banks presently hold the largest portion (34 percent) of the farm debt that is classified as severely stressed. The Farmers Home Administration holds 24 percent. Individuals and the Farm Credit System hold 17 percent and 13 percent, respectively.

Private banks also hold the largest portion (43 percent) of farm debt borrowed by farmers with a strong financial position. Individuals hold 27 percent of this debt. The Farm Credit System holds 13 percent.

As expected, the debt indicators by borrowers' financial position for the Farmers Home Administration reflect FmHA's role as a government "lender of last resort." The percentages of debt by financial status increase as the financial stress increases.

TABLE 15. Distribution of Farm Debt Across Lenders by Financial Position For a Sample of Iowa Farm Operators, Comparisons 1989.

LENDERS	FINANCIAL POSITION				TOTAL SAMPLE
	STRONG	STABLE	WEAK	SEVERE	
COMMERCIAL BANKS	43	29	26	34	35
FARM CREDIT SYSTEM	13	29	22	13	21
FARMERS HOME ADMIN	2	10	18	24	11
INSURANCE COMPANIES	7	6	3	5	5
INDIVIDUALS	27	18	23	17	20
OTHERS	8	8	8	7	8
TOTAL SAMPLE	100	100	100	100	100

Source: 1989 Iowa Farm Finance Survey.

XIII. SELECTED FINANCIAL MANAGEMENT STRATEGIES

In spite of improved financial conditions during 1988, 9.2 percent of those seeking operating credit expect difficulty in receiving credit. This is down from 11.0 percent in 1988 and 14.6 percent in 1987.

While only 6.5 percent of the respondents sold land during the past three years, 32.5 percent of those who sold land claimed that they did so due in part to financial stress. And, similar to 1988 and 1987 responses, there are more than twice as many respondents who sold equipment or breeding stock due to financial stress than who sold land due to financial stress.

Finally, between 2.5 and 8 percent of the respondents indicate renegotiation of land contracts, principal and interest write-down and FmHA loan guarantees during the last three years. These responses are similar to those in 1988 and 1987.

TABLE 16. Comparisons of Iowa Farm Finance Practices, 1989; 1988, 1987.

SURVEY QUESTION PERCENT YES RESPONSES	1989	1988	1987
a. Will you seek operating credit during this year?	42.8%	38.8%	42.4%
b. If yes, do you expect difficulty acquiring credit?	9.2	11.0	14.6
c. If you have not declared bankruptcy, are you contemplating bankruptcy in the future?	0.7	2.6	4.2
d. During the last 3 years, have you sold land?	6.5	5.3	5.1
e. If yes, was this sale due to financial stress?	32.5	55.6	57.7
f. During the last 3 years, have you sold equipment or breeding livestock?	29.4	31.6	35.1
g. If yes, was this sale due to financial stress?	21.4	21.7	27.7
During the last 3 years:			
h. Have you given back land purchased on contract?	2.9	3.0	3.0
i. Have you renegotiated a land contract?	7.7	7.1	6.9
j. Have you voluntarily turned assets back to lender?	2.5	3.2	3.5
k. Have you received a write-down in principal owed?	4.1	4.3	4.6
l. Have you received a write-down in interest owed?	5.2	5.6	6.8
m. Have you received a FmHA loan guarantee?	6.3	6.0	6.2

Source: Iowa Farm Finance Survey, 1989; 1988; and 1987.

XIV. MARKETING AND RISK MANAGEMENT STRATEGIES OF IOWA FARM OPERATORS

Similar to the 1988 Farm Finance Survey, the 1989 Survey asked questions about the marketing management strategies of Iowa farmers. The impacts of the drought and alleged wrong doing by some commodity exchanges appear to have influenced 1989 farmer preferences on the use of futures. On the other hand, the use of options continues to grow.

Many respondents showed interest in forward contracting insurance which could be used to limit contract penalties from a short crop. In the 1988 survey, 39.4 percent of farmers who forward contracted crops would consider using this insurance product. In 1989, 55.9 percent of those who forward contracted crops would consider using such a product. Forward contracting insurance has been introduced in other states, but not Iowa. This survey indicates a viable market may potentially exist.

TABLE 17. Marketing Management Practices of Iowa Farmers, 1989; 1988.

1. Which of the following market tools have you used during the last 2 years?	Grain 1989	Grain 1988	Hogs 1989	Hogs 1988	Fed Cat 1989	Fed Cat 1988
a. Cash marketing or government loans	54.0	42.3	77.0	71.2	78.4	80.1
b. Forward cash contracts	40.3	41.2	7.4	11.4	6.3	3.6
c. Futures market for hedging	12.2	11.2	15.3	17.8	14.2	15.7
f. Agricultural commodity options	12.4	11.5	9.8	7.8	10.8	8.4

2. Identify the most important factors why you would not use forward marketing tools?	Very Important 1989	Very Important 1988	Somewhat Important 1989	Somewhat Important 1988	Not a Factor 1989	Not a Factor 1988
a. Conditions favor other strategies	22.3	31.6	47.5	36.3	30.2	32.1
b. Fear or lack of knowledge	27.1	23.2	35.4	30.3	37.5	46.5
c. Fear of bad weather and short crop	56.8	N.A.	32.8	N.A.	10.4	N.A.
d. Too much speculation and manipulation	52.5	42.1	27.9	25.9	19.6	32.0
e. Morally wrong to use such tools	8.6	5.3	10.9	6.9	80.5	87.8

3. Would you consider forward pricing a larger portion of your sales if insurance was available to limit losses during a short crop?

38.8% Yes 30.6% No 30.6% Do Not forward Price Crops.

Source: Iowa Farm Finance Survey 1989; 1988.

XV. FARM PROGRAM IMPACTS.

Nearly 90 percent of the survey respondents indicated participation in government farm programs. The respondents estimated government payments to represent 17.9 percent of their gross farm income. Based on the 1989 Farm Finance Survey financial summary data, farm program payments represented 83.8 percent of 1989 net farm income. The percent of net farm income is higher than expected based on other sources.

TABLE 18. Farm Program Impacts on Iowa Farm Operators, 1989.

Item	Percent
a. Farm Program Participation	89.3 *
b. Estimated Payments /Gross Farm Income	17.9 *
c. Estimated Payments /Net Farm Income	83.8 **

* Direct survey response.
** Compiled from item "b" and survey financial data.
Source: Iowa Farm Finance Survey, 1989.

XVI. DISASTER ASSISTANCE AND CROP INSURANCE POLICY PREFERENCES

The 1989 Farm Finance Survey included a number of questions regarding the impacts of the drought, crop insurance and the 1988 Disaster Assistance Act. The results show a significant increase in the purchase of multiple peril crop insurance for corn and soybeans in 1989 compared to 1988. In addition, some farmers shifted their coverage from private hail and fire to multiple peril coverage.

Nearly half of the respondents received (or expected to receive) forgiveness of deficiency payments and crop disaster assistance payments. Less than five percent received livestock feed assistance. More than one in five received (or expected to receive) crop insurance indemnity payments for 1988 drought losses.

The passage of the 1988 Disaster Assistance Act has apparently not adversely affected farmers' attitudes towards the purchase of multiple peril crop insurance as had previously been suggested. In fact, 22.6 percent of the respondents will buy more crop insurance as a result of the drought. Less than one percent indicated that they would buy less crop insurance due to the 1988 Drought Assistance Act.

By a two-to-one margin, the repondents favor having voluntary multiple peril crop insurance as the only disaster relief during drought years. However, respondents were more evenly split as to whether the government should provide disaster assistance in place of crop insurance. The respondents also were evenly split as to whether they thought the government would pass another drought assistance act if another drought occurs in 1989.

Farmers favor mandatory purchase of crop insurance for FmHA borrowers. Since FmHA accounts for only 11 percent of the farm debt, most of those who favor this requirement are not FmHA borrowers. On the other hand, 89 percent of the respondents participated in government payments, but the respondents were opposed to requiring mandatory crop insurance for farm program participants by a two-to-one margin.

When asked about the provisions of the 1988 Disaster Assistance Act, nearly two-thirds of the respondents believed the minimum losses required to qualify for assistance and payment rates were about right.

Twenty-three percent of the respondents are required to purchase crop insurance in 1989 due to the provisions of the 1988 Disaster Assistance Act. Over half of the respondents believed that farmers who purchased crop insurance should be allowed to be eligible for both crop insurance and disaster assistance if another Act is subsequently passed after the purchase in the future.

TABLE 19. Disaster Assistance and Crop Insurance Strategies, 1989.

A. Crop Insurance Purchases Did you (will you) buy	Corn 1989	Corn 1988	Soybeans 1989	Soybeans 1988	Neither 1989	Neither 1988
	(%)		(%)		(%)	
Multiple peril crop insurance?	58.8	34.4	42.6	26.4	39.6	64.0
Private hail/fire crop insurance?	42.4	44.9	40.4	42.4	52.3	50.2

B. 1988 Disaster and Crop Insurance Receipts Did you (or do you expect to) receive	Percent	Avg Paymt/ Claimant
Disaster forgiveness of Deficiency Payments?	47.1%	$2415
Drought Assistance Act Crop Disaster Assistance?	49.4	6597
Livestock Feed Assistance Payments?	4.7	5593
Payments from 1988 Multiple Peril Crop Insurance?	22.3	8498

C. Has the 1988 Drought Assistance Act affected 1989 crop insurance decisions? Not Applicable 11.4%	Percent
I will buy more crop insurance in 1989 as a result.	22.6%
I will buy less crop insurance in 1989 as a result.	0.2
No, it will not affect my crop insurance decisions.	65.7

D. If another severe drought occurs in 1989, how likely is the government to pass another Drought Assistance Act?

Very Likely	16.5%	Very Unlikely	16.2%	Not Sure	28.0%
Somewhat Likely	22.3%	Somewhat Unlikely	17.1%		

E. What should be our national policy to deal with farm production risks and natural disasters?	Agree	Not Sure	Disagree
	(percent)		
Voluntary multiple peril crop insurance should be the only disaster relief during drought years.	45.8	30.1	24.1
Government should provide disaster assistance for a severe disaster in place of crop insurance.	31.3	33.2	35.5
Multiple peril crop insurance should be required for farmers receiving FmHA loans.	70.7	17.7	11.6
Multiple peril crop insurance should be required for all farm program participants.	24.3	26.7	49.1

F. What do you think about the provisions of the 1988 Disaster Assistance Act?	Too High	About Right	Too Low	Not Sure
Minimum losses to receive assistance were:	11.6%	65.0%	10.8%	12.5%
The payment rates for corn were:	8.1	67.2	12.6	12.1

G. Crop Insurance Requirements and Eligiblility	Yes	No	Not Sure
Should farmers with crop insurance be eligible for both crop insurance and disaster assistance?	56.6%	30.6%	12.7%
Are you required to buy multiple peril crop insurance due to 1988 Disaster Assistance Act?	23.2%	76.8%	-

Source. Iowa Farm Finance Survey, 1989.

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