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Risk management strategies and Iowa farmers: a logit analysis of the use of Federal Crop Insurance

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by

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1. INTRODUCTION

Virtually all decision-making in agricultural production is subject to risk and uncertainty. Risk is characterized as a situation where an outcome is not known but probabilities of all possible outcomes are (or can be) known. Uncertainty is defined as a situation when these probabilities cannot even be meaningfully defined (Knight,1921).

The numerous sources of risk that a farm operator faces can be grouped under the two broad headings: business risk and financial risk. The sources of risk commonly referred to as business risk include (1) production (technical) risk, (2) market (price) risk, (3) technological risk, (4) legal and social risks, and finally (5) human sources of risk. Financial risk represents an added variability of income due to fixed obligations resulting from debt financing. Financial risk embodies both solvency and liquidity risks. The trade-off between business and financial risk is a well accepted concept in economics. To put it simply, each farm has a certain risk-bearing capacity given by the type, location, and financial structure of its operation. The more business risk is assumed, the less room remains for financial risk, and vice versa.

There are several different approaches to eliminate or, more realistically, to manage the amount of risk inherent in

agricultural production. Various production, marketing, and financial strategies as well as improved decision-making can be combined in order to bring the amount of risk to some bearable level. Production strategies include region and enterprise selection, diversification, geographic dispersion of cropland, technical practices, supplemental irrigation, and substituting capital inputs for labor. Managing risk through marketing tools means selecting enterprise mix with a low expected price variability, maintaining eligibility for government programs, inventory management, using forward pricing, investing in market information and learning, spreading sales over time, and finally contracting to purchase inputs. Finally, financial responses to risk entail maintaining additional liquidity, leasing assets, or purchasing crop insurance.

Hence, crop insurance is one of the tools that can reduce business risk exposure, production risk in particular. Crop insurance works through the so called pooling effects. It reduces the uncertainty of risk of loss for an individual as well as evens out the burden of the actual loss of crops. Crop insurance distributes the risk of low crop yields over space and over time (Ray,1981).

Crop insurance can be designed to protect against a single peril (such as hail) or against multiple perils. The single peril crop insurance offered by private companies has

a long history in the United States and the industry as a whole has been quite profitable. On the other hand, attempts to provide multiple peril crop insurance through private companies has not proven very successful. Several economists have argued that public crop insurance against multiple perils has a much better chance to withstand widespread crop shortfalls. In the United States, this form of crop insurance is provided by the Federal Crop Insurance Corporation (FCIC). The FCIP has been often criticized for low participation rates and high administrative costs. Federal Crop Insurance (FCI) premiums and the availability of government disaster programs have been most frequently identified as the underlying causes of low participation. The goal of this study is to show that factors beyond FCI premiums and disaster programs influence farmers' decision to participate in the FCIP. The following section discusses the history and current issues of the Federal Crop Insurance Program (FCIP).

Federal Crop Insurance Program

The Federal Crop Insurance Program (FCIP) provides a subsidized multiple peril crop insurance available to farmers regardless of their participation in other government programs. It was introduced in 1938 and from 1948 to 1980 operated on an experimental basis. The Federal Crop Insurance Act of 1980 redesigned and extended the FCIP. The FCIP

was intended to be the primary means for disaster protection for farmers. In part this policy change was taken to eliminate arbitrary disaster payments. However, up to this date, it has proven very difficult, politically, to abandon disaster assistance completely. Because of the low number of farmers insured by FCI, widespread crop failures affecting several States at the same time usually create a strong political pressure on the government to pass disaster payment programs in that particular year. For instance, massive crop shortfalls occurred in the U.S. in 1983 and 1988. In both years, the government awarded farmers disaster payments in order to ease the negative impact of massive crop losses.

Under the current conditions, all counties with significant agricultural production and most crops are eligible for Federal Crop Insurance (FCI). In 1992, Federal Crop Insurance purchases covered 55 different crops in 48 States and over 83 million acres of agricultural land (NCIS). The FCIP is currently administered through private insurance companies that are in turn reinsured by the FCIC. The current FCIP makes several protection levels available to farmers. Farmers can choose from four coverage levels (35, 50, 65, 75 % of a base yield) as well as from different prices. The calculation of premiums is based on individual farmer's actual production history (APH) yields. Where 10 years of

actual farm data are not available, the calculation is based on county level data. Loss payments are based on an individual yield shortfall. The program can benefit participating farmers in numerous ways. Farmers willing to participate in crop insurance are required to pay insurance premiums. In return, crop insurance reduces the probability and magnitude of a possible loss. Results of several empirical studies showed that participation in FCI reduces farm income variability, increases net average after-tax income, decreases number of years with negative income, lowers need for borrowing as well as improves chances of obtaining credit. Moreover, the FCIP (although subsidized) is more efficient than free disaster relief payments.

On the other hand, FCI suffers from several problems. Some of them are common to any insurance program, namely, adverse selection and moral hazard. Adverse selection is a result of imperfect information and occurs when a farmer buying insurance has more complete knowledge about the probability of crop loss than does an insurer. The result of adverse selection are excessive premiums for farmers whose loss probabilities are lower than those of the rest of farming population. Lower risk farmers may choose not to participate in the program. As a consequence, the insurance program will experience ever increasing losses as the pool of insured farmers becomes riskier. Moral hazard, on the other

hand, refers to the risk that a farmer will change his normal farm practices after a crop has been insured so as to increase his chances of collecting an indemnity.

In addition to these two problems, the FCIP has been widely criticized for low participation rates despite the fact that premiums are subsidized by the government. According to Williams et al. (1993), a participation rate of 50% is necessary to make the FCIP actuarially sound and profitable. This rate has not been achieved. Participation rates are not uniform in all areas, however. In 1992 for example, participation was highest in North Dakota and lowest in Nevada (Table 1.1).

Participation rates also vary widely among crops (Harwood et al., 1991). They are high for crops with erratic yields where that crop is primary crop of the area. For example, barley and wheat, in semi-arid regions of the Plains, tend to have high participation rates. The same holds for specialty crops such as raisins that are vulnerable to unfavorable weather during critical times of growing season.

In addition to low participation, the FCIP is criticized for its high administrative costs, vulnerability to catastrophic losses as well as to political support of disaster relief programs.

Table 1.1 Federal Crop Insurance participation rates in 1992

State	Cropland insured	State	Cropland insured
Alabama	11.0	Nebraska	25.2
Arizona	2.7	Nevada	0.1
Arkansas	8.6	New Jersey	1.3
California	5.3	New Mexico	8.4
Colorado	9.5	New York	0.5
Connecticut	0.2	North Carolina	9.9
Delaware	9.2	North Dakota	44.1
Florida	4.1	Ohio	10.6
Georgia	15.9	Oklahoma	12.4
Idaho	6.3	Oregon	8.3
Illinois	23.4	Pennsylvania	3.0
Indiana	16.6	Rhode Island	0.5
Iowa	35.0	South Carolina	6.3
Kansas	22.7	South Dakota	23.4
Kentucky	3.4	Tennessee	2.1
Louisiana	16.2	Texas	19.6
Maine	0.3	Utah	3.6
Maryland	6.9	Vermont	0.3
Massachusetts	1.1	Virginia	6.7
Michigan	6.6	Washington	15.6
Minnesota	34.1	West Virginia	1.6
Mississippi	8.7	Wisconsin	5.6
Missouri	7.7	Wyoming	7.6
Montana	28.5		

Source: National Crop Insurance Services

All of the above difficulties contribute to high loss ratios of the FCIP. The loss ratio is the ratio of total indemnities actually paid (total losses) to total premiums charged during a specific time period, usually one year. The loss ratio is commonly expressed in percentage terms, in other words, multiplied by 100. During the 1981-1992 period, the FCIP experienced an aggregate loss ratio of 143. In contrast, the aggregate loss ratio was 64 for private crop-hail insurance companies. Although the aggregate loss ratio

of the FCIP exceeded one, considerable differences between crops and states existed. Glauber et al. (1993) showed that during the 80's a substantial portion of FCIP losses was concentrated in certain parts of the U.S. and was associated with the small number of crops. In particular, most of FCIP losses were attributable to wheat losses in Montana, soybean losses in the Delta States and the Southeast, and grain sorghum and cotton losses in the Texas High Plains. Table 1.2 presents some additional information on FCIP performance in comparison with private crop-hail insurance.

As a result of the ongoing losses experienced by the FCIC, widespread premium changes were adopted in 1990 with the aim of improving the actuarial performance of the program. Premium rates were increased for most of the counties and crops although some areas enjoyed rate decreases. Several other program changes were also introduced in 1990. These included a twenty percent limit on year-to-year rate increases, target rates for selected crops and states, and a non-standard classification system to identify high-risk producers with abnormal loss histories. Although the overall performance of the FCIP after these adjustments has yet to be evaluated, the aggregate FCI loss ratio of 121 for year 1992 suggests that the shortcomings of the program have not been resolved. In 1993, the FCIP faces enormous difficulties due to summer-long floods in the Midwest as well as dry weather

Table 1.2 The performance of the Federal Crop Insurance Program and private crop-hail insurance

	Crop-hail insurance[a]	Federal Crop Insurance[b]
All states, all crops		
Liability[c]	185,017,000	62,253,724
Premium[c]	7,009,665	3,883,816
Losses[c]	4,542,529	5,539,764
Loss ratio[d]	65	143
Average rate[e]	3.79	6.24
Loss cost[f]	2.45	8.90
Iowa, all crops		
Liability[c]	21,670,321	10,929,215
Premium[c]	664,173	462,457
Losses[c]	437,992	375,013
Loss ratio[d]	66	81
Average rate[e]	3.06	4.23
Loss cost[f]	2.02	3.43

[a] cumulative from 1948 to 1992
[b] cumulative from 1981 to 1992, excluding 1991
[c] thousands of dollars
[d] (losses / premiums) x 100
[e] dollars per acre
[f] (losses / liabilities) x 100

Source: National Crop Insurance Services

in the East. In the state of Iowa, all 99 counties have been declared a disaster area and crop and hay losses are estimated at 1.37 billion dollars (CARD).

Various solutions for the current problems of Federal Crop Insurance have been suggested. These range from free crop insurance on one hand and mandatory crop insurance on the other hand. The solution suggested probably most often is to base insurance on area rather than individual crop yield data (Barnaby and Skees, 1990; Carriker et al., 1990 and 1991; Miranda, 1991; Glauber et al., 1993). Others who researched the FCIP performance recommend using premiums reflecting relative risk of farmers (Goodwin, 1993) or using yield distribution functions with more flexible representation of skeweness (Nelson, 1990). Still others call for information collection and contract design improvements (Vandeveer, 1990). Perhaps the most fundamental change, a shift from target price to target revenue programs, was proposed by Mayer (1991). These changes attempt to reduce adverse selection and moral hazard problems, and, in some cases, also administrative costs, in order to improve the actuarial performance of the FCIP and increase the demand for this type of insurance.

Some of the proposed changes in the FCIP design may also help increase program participation rates. However, even actuarially fair premiums may not assure that every farmer

will buy FCI. As is discussed in the next chapter, there are factors other than the FCI premiums that influence farmers' decision to participate in the program. This study tries to identify those factors and their impact on the use of FCI.

Organization of the Thesis

Chapter 2 outlines the concepts of decision-making process under risk and uncertainty and risk balancing that lead to the formulation of the thesis objective. Previous empirical studies of the FCIP and their conclusions are discussed in Chapter 3. The next chapter presents discrete choice models, a logit model in particular, as well as the ways to estimate model parameters and to evaluate model fit. The sample is described in Chapter 5 along with the definitions of dependent and explanatory variables as well as models tested. Chapter 6 presents the results of empirical analysis of FCI participation. Findings and a need for further research are discussed in Chapter 7 followed by the list of cited references. Finally, the sample questionnaires are included in the Appendix.

2. CONCEPTUAL FRAMEWORK

The chapter begins with a review of risk management in agriculture. It describes typical sources of risk and discusses possible ways of dealing with those risks. Attention then turns to the economic models of decision-making under the conditions of risk and uncertainty. Then, the concept of risk balancing is discussed. The chapter concludes with the problem statement and the formulation of the objective of the study.

Risk Management in Agricultural Production

Since all decision making in agricultural production is subject to risk and uncertainty, farm management can be viewed from a risk management perspective. Crop insurance is one of the several ways farmers can manage agricultural risk. It should, therefore, be viewed in the overall context of risk management and risk balancing.

Various types of risk influence agricultural production. These include production (technical), market (price), technological, legal, and social risks, as well as human sources of risk. Production or technical risk results from random variability of agricultural production processes. Yield risk is one example of production risk. Market or price risk is

due to variations in market prices of both inputs and outputs. Technological risk stems from the fact that future technological developments may negatively effect outcomes of farmers' decisions. Changes in legal and social environment constitute another group of risks. Human factors of production and management represent the last group of risks. All of the above are commonly referred to as business risk which is exogenous to a farm operation. According to Gabriel and Baker (1980), business risk BR is defined as the total variability, or the coefficient of variation, of net operating income in the absence of debt financing

$$BR=\frac{\sigma}{E(x)}$$

where σ is the standard deviation of the expected net operating income E(x).

A second class of risks is associated with the financial structure of individual farm operations. Financial risk entails both liquidity and solvency risks. Liquidity risk represents the risk that cash generated from a farming operation will not be enough to cover current obligations. Solvency risk refers to risk that the value of total assets will not be sufficient to repay all the debt, had a farmer decided to sell his farm business. Financial risk is commonly defined as an increase in the variability of income stream due to fixed obligations resulting from debt

financing. Gabriel and Baker have shown that financial risk FR can be written as

$$FR = \frac{\sigma}{E(x)} \frac{I}{E(x) - I}$$

where I represents fixed debt servicing obligations and σ and E(x) are defined in the same way as in case of business risk.

Risk management tactics can be split into several categories. First, production responses to risk include enterprise and region selection, diversification, geographic dispersion of cropland, technical practices, supplemental irrigation, and substituting capital inputs for labor.

Market or price risk can be managed through numerous marketing risk transfer tools, such as selecting enterprises with low expected price variability, maintaining eligibility for government programs, inventory management, forward contracting and hedging, investing in market information and learning, spreading sales over time, and contracting to purchase inputs.

The farm business can also adjust its financial response to risk. Examples include maintaining additional liquidity with a structure of savings account or credit reserve, leasing assets, or using insurance. Presumably more efficient than using each of the above separately is using two or more of them as a part of an integrated strategy.

Another way of looking at the set of available risk responses is to consider whether they directly reduce the amount of risk involved in farming or whether they increase chances of the farm business to survive unfavorable circumstances (Jolly, 1983). The first strategy, managing risk exposure would, for example, include enterprise selection, marketing, government programs, and insurance. The second category, controlling risk impacts, involves the level of financial leverage, organization of business, liquidity, and efficiency.

Clearly, agricultural producers face various types of risk and have available many strategies to deal with those risks. Crop insurance is an alternative for crop growers that can be very useful, probably even more useful when used hand in hand with other risk management strategies.

Decision-Making under Risk and Uncertainty

As already mentioned, most decisions in a farming operation are subject to risk and uncertainty. Risk is a situation where the outcome of a decision is not known, but the probabilities of the occurrence of all possible outcomes are known (or at least knowable). These probabilities can be either objective, based on historical experience, or subjective, reflecting an individual's perception of chances that an event will occur (Knight,1921).

Uncertainty, on the other hand, is said to exist when it is not obvious that probabilities can be meaningfully defined, and, thus, empirically measured (Heady, 1952). In this later case, any estimate of probability would be entirely subjective. In practice, then, the distinction between risk and uncertainty diminishes since even objective probabilities are being used subjectively by a decision-maker. Therefore, the terms risk and uncertainty are used interchangeably.

Economists have developed a number of models describing decision making under uncertainty. Some of the more common are (1) decision rules employing no information on probabilities, (2) safety-first rules (lexicographic utility), and (3) expected utility maximization (Young,1984). The classical economic assumption (and the one maintained throughout this thesis) is that of the expected utility maximization.

The expected utility E(U) associated with a discrete outcomes can be represented by a weighted sum of all possible outcomes A_i (expressed in terms of income, net returns, wealth, etc.) where the weights are respective probabilities of individual outcomes $P(A_i)$

$$E(U) = \sum_{i=1}^{n} A_i . P(A_i)$$

Taking expectation of the Taylor series expansion of the utility function about mean, the expected utility can be

expressed in terms of moments of the probability distribution of the outcomes

$$E(U)=f(\mu,\sigma^2,M3,M4,\ldots)$$

Although the vector of all moments represents business risk, usually only first two moments (mean and variance) are considered in the expected utility function

$$E(U)=f(\mu,\sigma^2)$$

This is equivalent to the assumption of quadratic utility function. Factors on which the expected utility depends can then be interpreted as the expected net returns and the variance of the expected net returns.

The expected utility model provides a framework within which farmers' decisions can be evaluated. These decisions include enterprise and location selection, whether and what kind of rental arrangements to use, financial structure, participation in government programs, insurance purchases, the use of forward pricing tools, and many others.

Consider first the decision to buy crop insurance. According to the expected utility model, farmer's expected utility can be expressed as the weighted sum of his utility if a crop shortfall occurs U_L and his utility in case of no crop loss U_N

$$E(U)=U_LP_L+U_NP_N=U_LP_L+U_N(1-P_L)$$

where P_L is the probability that the crop shortfall occurs and P_N is the probability that no crop loss occurs. Insurance, in essence, gives a farmer an opportunity to achieve more even distribution of income and consumption over all possible states of nature (Ray, 1981). By giving up a small portion of income, paying the insurance premiums, the farmer reduces the likelihood and magnitude of a possible loss.

Using the assumption of the expected utility maximization the insurance decision can be examined in the familiar framework of a budget constraint and preferences. Figure 2.1 illustrates farmer's choice regarding crop insurance. The budget constraint for fair insurance B_1 is represented by a fair-odds line along which the expected monetary gain is zero. Insurance premiums are considered actuarially fair when the premium equals the probability of loss P_L, administrative costs are zero, and the insurance industry is competitive. In this special case, one can assert that a risk averse farmer will buy full insurance coverage e^a. In real life, however, this situation rarely occurs. If the FCI premium rates are perceived by farmers to be set improperly, in other words if the premiums do not reflect each individual farmer's chances of crop failure, the farmer faces the budget constraint represented by B_2. In such case, even a risk averse individual will buy less than full insurance e^b, paying the amount equal to $a-c^b{}_N$ in insurance premiums.

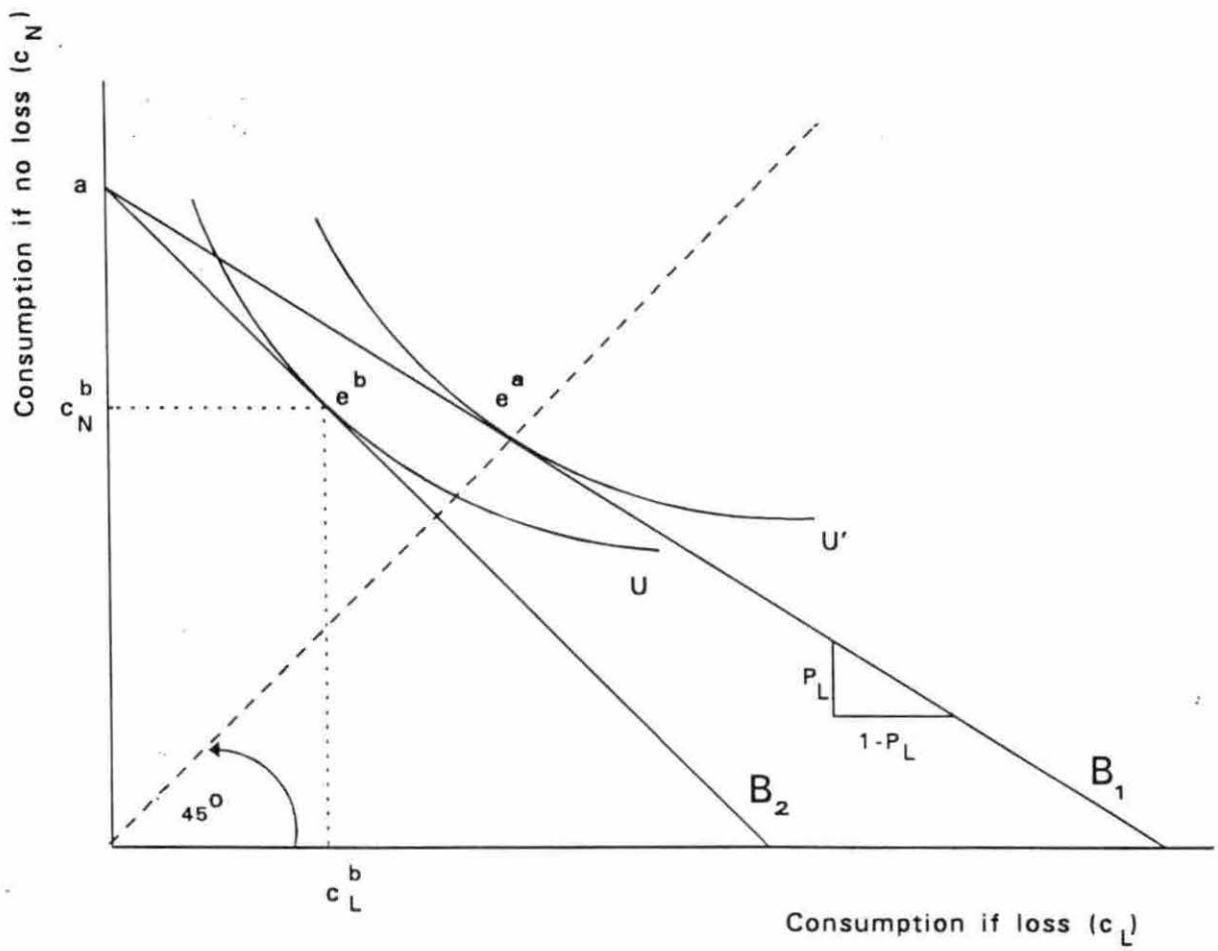

Figure 2.1 Farmer's choice of insurance coverage

The degree of farmer's risk aversion, in other words the shape of his indifference curves U, has to be known in order to determine the amount of insurance contracted for by each farmer.

For Federal Crop Insurance, an additional choice is the one of a deductible. The deductible, or the coverage level, acts as co-insurance and reduces premiums charged. A deductible means that small losses are borne by the individual and large losses by the insurer. Deductibles reduce transaction costs as well as expected indemnities, therefore, they reduce the premiums. As mentioned earlier, four coverage levels are available under the current FCI program.

A similar model can be used to examine other decisions that farmers face such as the use of marketing tools. Insurance and forward pricing deal with different kinds of risk. Insurance controls yield risk while forward pricing controls price risk. When using hedging with futures markets or forward contracts, a small premium enables a farmer to get rid off unwanted risk. He protects himself from substantial losses due to unfavorable price developments, but, at the same time, looses an opportunity for above-average gains. This is illustrated in Figure 2.2.

Still another decision is the one of financial structure of a farm. Debt financing results in greater total variability of income stream. Financial risk stems from the fact

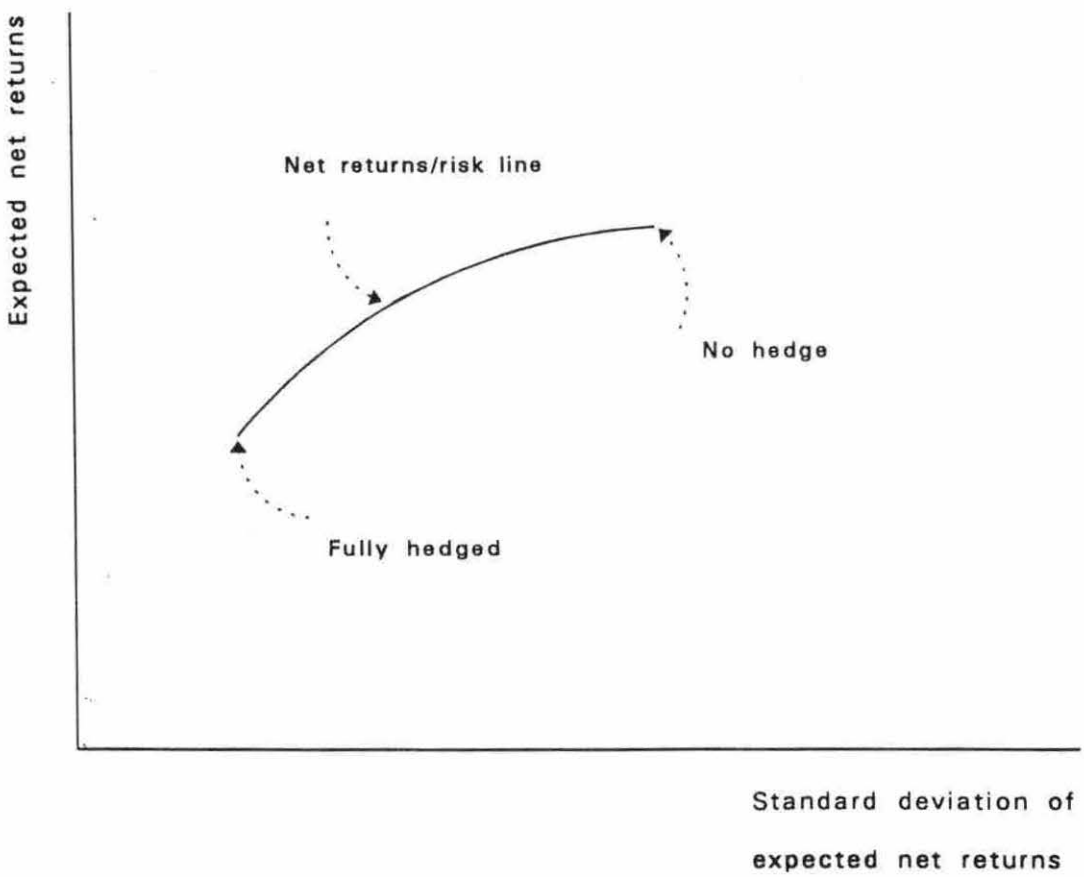

Figure 2.2 Risk - return trade-off with output hedging

that a farmer takes on fixed obligations (interest and principal payments). In a short-term, it creates a risk that cash flows generated by farm operation will not be sufficient to cover debt payments which are due. In a long-run, the value of debt can exceed the value of total assets (due to a decline in asset values), thus, causing financial difficulties.

The farm financing decision, however, is not independent of other farm related decisions. In other words, it is made simultaneously with the many production and marketing decisions so as to maintain a balance between total risk exposure and net returns.

Risk Balancing

As discussed earlier in this chapter, total farm risk consists of business risk and financial risk. In other words, total risk encompasses the variability of income stream in case of no debt financing, business risk, as well as an increase of the variability of income stream due to fixed debt servicing obligations, financial risk.

Gabriel and Baker (1980) show that risk balancing represents the adjustment of business and financial risks as a response to an exogenous shock altering the existing balance between these two components of total risk. A total risk constraint, under the assumptions that no leverage-induced

changes in business risk occur and the maximum risk tolerance level β can be identified by the decision maker, can be written

$$\frac{\sigma}{E(x)} \frac{E(x)}{E(x)-I} \leq \beta$$

where σ is the standard deviation of the expected net operating income E(x) and I is the fixed debt servicing obligation. The first element on the left-hand side of the above equation represents business risk and the second term can be interpreted as a financial risk multiplier. Hence, Gabriel and Baker have demonstrated that as a result of a decrease in business risk, financial risk should increase in order to maximally exploit the farm's total risk tolerance. Or equivalently, financial risk should decline had business risk increased. Collins (1985) have derived the same result using the framework of the expected utility maximization.

The implication of the above discussion is that the knowledge of the existing trade-off between business risk and financial risk should be used as one of the risk management tools in order to maximally exploit total risk tolerance of a farm business. In addition, consideration of financing decisions should not be omitted when modeling farm business risk decisions (Collins, 1985).

Problem Statement and Thesis Objective

Federal Crop Insurance (FCI) has been widely criticized for low participation rates and high administrative costs. In order to identify causes of low FCI participation, it is necessary to understand an individual farmer's choice to participate in the FCIP. It has been frequently argued that actaurially unfair premiums and the availability of the government disaster payments have a negative impact on farmers' participation in FCI. However, the FCI participation rates are lower than expected even in areas where the FCI premiums seem to be actuarially sound. This suggests the existence of forces beyond the FCI premiums and the government disaster programs affecting farmers' decision to participate in FCI. This study attempts to identify such factors and their impact on FCI use. Risk balancing offers a possible explanation of low FCI participation in that higher levels of business risk are allowed by lower financial risk. In addition to the trade-off between business and financial risk, the impact of human capital resources, the use of risk management strategies, as well as farm risk bearing capacity on the probability of FCI participation is investigated.

Farmers' decision to buy FCI is analyzed using the expected utility maximization framework. Although the expected utility is not evaluated explicitly, it is treated as

a driving force for a discrete choice farmers make with respect to FCI purchases.

The results of the thesis may serve in predicting the probability of FCI being purchased by farmers in Iowa under various circumstances.

3. LITERATURE REVIEW

This chapter reviews several empirical studies of crop insurance, Federal Crop Insurance in particular. The literature review is not meant to be exhaustive, but rather illustrative of the various aspects of the Federal Crop Insurance Program (FCIP). The second part of the chapter focuses on studies analyzing farmers' socioeconomic characteristics and their impact on the decision to participate in the FCIP. The chapter concludes with the outline of issues that need further consideration.

Crop Insurance Issues and Studies

Many economic researchers have analyzed the use of crop insurance and its use in combination with other risk management instruments. The most widely addressed topics related to crop insurance are (1) risk attitudes and risk reducing tools used by farmers, (2) the farm-level impact of participation in the Federal Crop Insurance Program, (3) lenders' responses to and influence on farmers' decisions to buy crop insurance, (4) crop insurance demand estimation, and finally (5) relationships between the use of FCI and the socioeconomic characteristics of farm operators.

Different risk strategies used by farmers

Studies of Miller and Trock (1979), King and Oamek (1983), Falatoonzadeh et al. (1985), Boggess et al. (1985), Wisner and Jolly (1985), Nichols (1985), Walker and Jodha (1986), and Edelman et al. (1990) have reached rather unanimous conclusions. They demonstrated that farmers would benefit from the simultaneous use of several risk management strategies. For example, they propose various combinations of risk reducing practices

- crop diversification, participation in futures markets, and the use of the FCIP;
- production management strategies and hedging; or
- the use of futures markets, cash forward contracts, and options.

The most recent studies place greater emphasis on the use of marketing alternatives such as forward contracting, futures, and options in conjunction with FCI.

The farm-level impact of the use of Federal Crop Insurance

A number of researchers have analyzed impacts of purchasing FCI on farm income stream. Most of the studies relied on simulation techniques applied to a representative farm. However, the authors' findings are not uniform. One group of studies indicates that FCI can be an attractive alternative for farmers since it decreases farm income

variability (Leatham et al., 1987), may result in higher average net after-tax income (Lemieux et al., 1982) and fewer years of negative income (Barber and Thair, 1950). It also reduces the need for borrowing and enhances the possibility of obtaining credit (Rodewald, 1960).

On the other hand, others argue that the use of crop insurance, FCI in particular, may not reduce farm income variability (Lee and Djogo, 1984; Mapp and Jeter, 1988). In one study, FCIP participation was shown to reduce the probability of survival of a high-debt hog farm when yield variability was equal to county level values (Patrick and Rao, 1989).

Lenders' response to insurance used by farmers

Lee and Djogo (1984), Binswanger (1986), Pfleuger and Barry (1986, 1988), Leatham et al. (1987, 1988), and Hughes (1990) agree that the use of crop insurance is a desirable risk management strategy from the lenders' point of view. These studies show that lenders, on aggregate, would extend more credit and/or offer lower rates to those farmers who used crop insurance. In fact, they may even require that farmers purchase crop insurance in order to obtain credit. Lenders recognize FCI to be effective in reducing loan losses. Further, FCI may facilitate credit extension to farmers

who were previously unable to qualify because of unacceptable default risk.

Pfleuger and Schmiesing (1987) indicate that suppliers of agricultural credit may not feel that crop insurance is a viable alternative for financially strong farms. Also, lenders believe that farmers are more apt to purchase hail/-fire insurance rather than multiple peril crop insurance and that they are sensitive to the cost of the latter.

Although lenders could exert significant influence on farmers' decisions regarding the use of crop insurance, the problem seems to be in poor communication between the two groups. All of the above suggests that a major source of crop insurance may in fact come from financial systems rather than from farmers themselves (Knight et al.,1989).

Demand for multiple peril crop insurance in the United States

Gardner and Kramer (1986), Hojjati (1986), Vandeveer (1990) and others show that higher premiums, lower expected indemnity and lower expected profit result in lower FCI participation rates. Farmers' risk aversion also plays important role in the decision regarding crop insurance purchases. Stronger risk aversion as well as higher vari-ability of profit increase demand for multiple peril crop insurance.

In addition, Niewuwoudt and Bullock (1986) find crop specialization, part ownership, the possibility of disaster payments, and farm size to be significant factors effecting the demand for FCI. Goodwin (1993) shows that previous-year yields, land values, and the percentage of corporations in a county influence FCI demand. In addition, he demonstrates that the elasticity of crop insurance demand differs for low-risk and high-risk producers. He, thus, confirms Miranda's conclusion (1991) that a more adversely-selected pool of insurance buyers, the pool with higher loss-risk, has lower demand elasticity. This has important implications for the FCIP in that undifferentiated rate increases would exacerbate the already existing adverse selection problem.

Characteristics of the FCIP participants

Authors of the early studies on participants and nonparticipants of FCI found interesting and rather consistent results about characteristics of the two groups of farmers. Clendenin (1942), as a part of his evaluation study of early stages of the FCIP operation, considered the characteristics of individuals who insured their crops. He surveyed wheat producers in 8 counties of 6 states and found that smaller farms, financially weak farms, and less-diversified (wheat-specialized) farms had more incentive to buy insurance. Also, the results of the study revealed that tenants were

slightly more likely to insure than owner-operators and non-farming landlords.

In another study, Jones and Larson (1965) evaluated the economic impact of FCI on farmers and other businesses related to agriculture. They interviewed farmers in 4 counties of Virginia and Montana and found that insured farmers, as a group, had less financial holdings, more and larger debts, were more specialized (in tobacco in Virginia, and wheat and barley in Montana), had less irrigation (the case of Virginia), generated lower total income, and were slightly older than uninsured farmers. The only farm characteristic for which the study revealed different results for the two states was farm size: in Virginia, smaller farms used more insurance, while in Montana, larger farms were slightly more insured.

Loftsgard (1967) summarized the results of a survey on characteristics of crop insurance participants and nonparticipants from six Great Plains states and noted that the only consistency observed was that participants were slightly older and relied more heavily on cash-grain income than nonparticipants. In similar study in North Dakota, Delvo and Loftsgard (1967) found that participants in the FCIP operated the largest farms in low- and medium-risk areas, while just the opposite was true for high-risk crop areas. Average crop yields were about the same for both groups.

Shipley (1967) examined demographic and other characteristics of participants, prior-participants, and nonparticipants in the FCIP in Northwestern Texas as a part of his study on the role and current trends of the FCIP. The results suggested no significant difference existed between the groups in age, education, number of dependents, experience, yields, or variable costs of production. However, there were significant differences in farm size as measured by cropland acres (the bigger the farm, the lower the insurance coverage), in expected total net farm income (again, negative relationship), and in contracted annual liabilities (showing the positive relationship with the use of crop insurance).

More recent studies employed either linear (Beeson, 1971) or logistic (Boggess et al., 1985; Knight et al., 1989; Olsen, 1990; and Khojasteh, 1992) models of regression analysis to test the significance of relationships between farm and farmer characteristics and the use of FCI. All of these studies were cross-sectional. The data were obtained by mailed surveys or personal interviews with randomly selected respondents. The number of respondents varied from 48 (Boggess et al.) to 920 (Knight et al.).

A qualitative dependent variable was employed in all of these studies. Beeson compared four calculated indexes of insurance management effectiveness for two data samples. One sample consisted of FCI participants, the other of nonpartic-

ipants. Boggess et al. analyzed 21 binary (0,1) dependent variables indicating the use of different risk management strategies including the use of all-risk crop insurance and hail insurance. Knight et al. tested three models with (0,1) dependent variables defined as the use of multiple-peril crop insurance, crop hail and fire insurance, and forward contracting, respectively. Olsen combined two binary variables into one qualitative variable with four categories (0,1,2,3) to account for all possible combinations of the use of multiple peril crop insurance and private hail/fire insurance. Finally, Khojasteh also specified a binary variable indicating participation and non-participation in FCI and used it in three regression models: linear, logit, and probit.

Table 3.1 summarizes all independent variables used by these authors. It also indicates whether the variable revealed significant relationship with a dependent variable defined in a particular study, and, if so, the sign of an estimated regression parameter is shown as well.

The characteristics analyzed most often were farmers' age and education, farm size measured by gross farm sales, farm enterprise mix, the debt versus equity structure of a farm, and acres owned versus rented. Variables measuring in some way financial performance or condition of farms were not used systematically. Boggess et al. relate the use of crop insurance to variables such as long-term and short-term

Table 3.1 Explanatory variables used in the selected crop insurance studies

Variable	1	2	3	4
Age		NS	NS	(-)
Education		(-)		x
Experience				x
Residence/Region		NS		
Acres irrigated (%)		NS		
Acres rented/acres owned		NS	(+)	NS
Farm size (acres operated)				(+)
Gross sales		(+)	NS	(-)
Gross sales * age				(+)
Major crop dummy		NS		
Tobacco sales ($)	NS			
Tobacco sales (% of total)	(+)			
Livestock sales ($)	NS			
Livestock sales (% of total)	(-)			
Crop sales (% of total)			(+)	x
Cattle sales (% of total)			NS	
Hog sales (% of total)			NS	
Total farm income	(-)			
Off-farm income/work		NS		x
Physical assets ($)	(-)			
Debt to asset ratio			(+)	x
Equity to asset ratio		(-)		
Net worth ($)				(-)
Long-term credit	(-)			
Short-term credit capacity	NS			
Liquid fin. reserves	NS			
ROA			NS	(+)
Financial stress dummy			NS	x

Models of: 1. Beeson, 1971
2. Knight et al., 1989
3. Olsen, 1990
4. Khojasteh, 1992

NS - variable not significant
(+) - significant variable positively associated with the use of Federal Crop Insurance
(-) - significant variable negatively associated with the use of Federal Crop Insurance
x - variable first used, but not significant, therefore later omitted from the final model

Table 3.1 (continued)

Total insurance budget	NS		
Fire ins.(% of total budget)	NS		
Automobile ins. (% of total)	NS		
Crop ins.(% of total)	NS		
Crop contracted (%)		NS	
Use of other forward tools		NS	NS

credit capacity, total value of physical assets, and liquid financial reserves. Olsen and Khojasteh used return on assets and a dummy variable for financially stressed farms. As to the results, Beeson found that total farm income and total assets were significantly higher among those who did not purchase Federal Crop Insurance. Participants obtained a higher percentage of income from tobacco, while non-participants obtained a higher percentage from livestock. Surprisingly, non-participants had a significantly larger amount of debt.

Although Boggess et al. presented some interesting results with regard to the use of certain risk management practices, they were unable to give any satisfactory explanation for the use of crop insurance. All independent variables used in their model showed insignificant relationships with the use of both all-risk crop insurance and hail insurance. A possible explanation for this result can be found by looking at their sample. It was rather small, including only 48 responses of farmers in Alabama and Florida (only one

county in each State). Also, the study covered only the use of risk management practices for a specific year.

Knight et al. concluded that Texas farmers with higher gross sales, less equity, and lower education use Federal Crop Insurance more frequently.

Olsen's insurance model results indicated that farmers who derived a greater percentage of their income from crops, those who rented a greater proportion of total acreage operated, and those with higher debt-to-asset ratios were more likely to buy crop insurance coverage. All these relationships were as hypothesized.

The results of the three models (linear, logit, and probit) tested by Khojasteh showed that younger farmers, farmers with less equity, higher return on assets (after taxes), and bigger farms (measured by acres operated) were more inclined to purchase FCI. However, farm size as measured by gross sales, rather than acres operated, seemed to reduce the FCI participation. In addition, he found that farmers who prefer decoupling of current government income support programs, those who received disaster payments in 1988, and those operating in Southern Iowa were more likely to participate in the FCIP.

Unresolved Issues

Clearly, several factors were found to play an important role in explaining farmers' decision to participate in the FCIP. Among those are farm diversification, tenancy, and the financial structure of a farm. Farmers who rely more heavily on sales from crops, rent greater proportion of land they operate, and have higher debt levels and less equity are more likely to participate in the FCIP. These conclusions are rather consistent among the studies discussed above.

However, different conclusions were reached regarding farm size. Earlier studies indicated higher probability of FCI participation for smaller farms, whereas more recent analyses suggested just the opposite.

Moreover, several variables expected to be relevant in the FCI decision did not confirm the hypothesis. Human capital variables such as age, education, and experience were mostly insignificant. Although they may not affect the insurance decision directly, demographic characteristics can have a substantial indirect effect on this decision. Differences in age, experience, and education are usually reflected in farm size, debt levels, the degree of risk aversion, and familiarity with forward pricing tools, hedging and options in particular.

More attention should also be paid to other risk management strategies such as hail insurance, participation in

government programs, rental arrangements, and forward pricing tools. The analysis of forward pricing tools such as forward contracting, hedging, and commodity options did not yield, contrary to expectations, significant results. The relevance of other risk management tools to the FCI participation decision has not yet been investigated.

Finally, the impact of the risk bearing capacity of a farm on the decision to buy FCI has not been addressed sufficiently. Higher solvency, liquidity, and efficiency improve the farm's chances for survival in case of crop failure since they increase the farm's ability to bear losses.

Based on previous studies and the conceptual model presented in Chapter 2, the decision to participate in FCI can be expressed as

$$U = f(X_1, X_2, X_3, X_4, X_5 | X_N)$$

where U is farmer's utility derived from using FCI, X_1 is a vector of demographic characteristics, X_2 is a vector of farm characteristics, X_3 represents business risk, X_4 represents financial structure of a farm, X_5 indicates the location of a farm, and finally X_N is a vector of given variables such as the FCI design attributes.

Demographic and farm characteristics directly or indirectly determine the amount of risk involved in a farm operation. Risk management tools such as hail insurance, government programs, crop share leases, and forward pricing tools

are used to manage different types of risk commonly referred to as business risk. Farm financial structure influences the level of farm financial risk. According to the risk balancing concept, business and financial risk are adjusted, following an exogenous shock to the existing balance, so as to maximally exploit total farm risk tolerance. Finally, farm location may reflect differences in soil conditions, weather patterns, or enterprise mix in different areas.

4. DISCRETE CHOICE MODELS

This chapter reviews the theoretical basis for the econometric analysis described in the subsequent chapters. First, discrete choice models and their derivation from the utility maximization concept are discussed. Then, a description of the multinomial ordered logit model follows. Estimation methods for the model as well as ways its results should be interpreted conclude the chapter.

Discrete Choice Models and Utility Maximization

Qualitative response models, also known as discrete choice, categorical, or quantal models, are models in which dependent variables are discrete rather than continuous in nature. Economists and biometricians have widely used QR models since they can capture the qualitative nature of many of problems with which these sciences deal. Binomial models, models with one exogenous variable taking two discrete values, are used most often, especially in bio-assay. Economics uses binomial models as well as more complex models, such as multinomial and multivariate.

Several authors (McFadden, 1974,1981; Amemiya, 1985) have shown the linkage between the usual economic assumption of utility maximization and discrete choice models. McFadden

(1974) was the first who derived this type of a model from the random utility concept. He showed and proved, using the axioms of independence of irrelevant alternatives, positivity, and irrelevance of alternative set effects, the derivation of the conditional logit model (CLM) from a utility maximization model. He showed the same for the multinomial logit model (MLM) and noted that they are algebraically equivalent, making appropriate substitutions. However, the economic interpretation of the two models differs. The MLM considers only effects of characteristics of an individual making a choice. The CLM, on the other hand, includes the vector of attributes of available alternatives along with the individual choice-maker's characteristics (Maddala, 1983).

Due to different specification and analysis, it is necessary to distinguish between models with ordered and unordered categorical variables. Using an ordered model when the true one is unordered leads to biases in the estimation of the probabilities. Using an unordered model when the actual model is ordered leads to the loss of efficiency rather than consistency (Maddala, 1983). Here, the attention is limited to ordered specifications since the dependent variable used in the analysis is ordered.

The Multinomial Logit Model

The multinomial logit model (MLM) is, in a sense, a simpler specification of the two models mentioned above. Assuming that a utility maximizing economic individual has a vector of measured attributes $\boldsymbol{x}_i$, and faces a set of ordered alternatives indexed j, where j=1,...,k+1 and k+1>2, one can write the i^{th} individual's utility function U_i associated with the j^{th} alternative in the form

$$U_{ij}=\beta'\boldsymbol{x}_i+\epsilon_{ij}$$

where β' is the vector of unknown parameters and ϵ_{ij} is a stochastic function of random disturbances (i.e., individual tastes). Then, the i^{th} individual will choose the alternative j only if

$$U_{ij}>U_{ik} \quad \text{for all } k\neq j$$

the utility associated with the alternative j is higher than the utilities derived from other available choices. Alternatively, one can write

$$U_{ij}=Max(U_{i1},U_{i2},\ldots,U_{ik+1})$$

In practice, utility is an unobservable, or latent variable. One can only measure some observed variable y_i reflecting this underlying latent variable and assume that

the i^{th} individual will choose the j^{th} response category, $y_i=j$, if and only if

$$\alpha_{j-1}<U_{ij}<\alpha_j \quad \text{for } j=1,\ldots,k,k+1$$

where $\alpha_1<\alpha_2<\ldots<\alpha_{k+1}$ partition the real line into successive intervals.

Assume that the error terms in the above utility function are distributed identically and independently and have the Type I extreme value (or log Weibull) cumulative distribution function. Then, for all j's, respective cumulative probabilities, i.e., the probabilities that the i^{th} individual will choose an ordered response less than or equal to j, can be evaluated in the form

$$P_{ij}=Prob(y_i\leq j)=\frac{1}{1+e^{-\alpha_j-\beta'\mathbf{x}_i}}$$

where e is the base of natural logarithm. For the last ordered category (j=k+1), this cumulative probability obviously equals one.

Using the cumulative probabilities, the empirical cumulative logits (the odds ratios) $\frac{P_{ij}}{1-P_{ij}}$ can be formed and the Taylor expansion (Zellner and Lee, 1965) can be used to show that

$$l_{ij}=\ln\frac{P_{ij}}{1-P_{ij}}=\alpha_j+\beta'\mathbf{x}_i$$

where l_{ij}'s are the respective cumulative logits for j=1,...,k. This function is the inverse of the cumulative logistic distribution function $F(x)=\frac{1}{1+e^{-x}}$ (with a zero mean and a variance equal to $\frac{\pi^2}{3}$), hence the name logit (Greene, 1993). The logit model transforms the problem of predicting probabilities within a (0,1) range to the problem of predicting the odds that the event in question will occur within the entire real line (Pindyck and Rubinfeld,1981). The curves of logistic and normal distributions agree closely, except that the former has slightly heavier tails than the later. The slope of the logistic distribution function is greatest at P=1/2 which implies that the changes in explanatory variables influence the probability of an event's occurring rather substantially at the midpoint of the distribution.

Estimation, Interpretation, and Assessing Goodness of fit of the Multinomial Logit Model

Gurland et al. (1960) suggest the estimation of the ordered logit model by either (1) minimum chi-square procedure or (2) maximum likelihood method. Both estimation

methods yield consistent asymptotically normal efficient estimates (Gurland et al.,1960; Pindyck and Rubinfeld, 1981,-1991). Still another estimation method is weighted least squares estimation. However, it results in some loss of efficiency (Cox,1970) and requires data to be grouped into sets which may be impossible to achieve when many explanatory variables are being used.

Although the minimum chi-square procedure is easier to apply, according to many authors maximum likelihood estimation is the most suitable estimation technique for the logit model. The estimation depends on (1) the concavity of the model likelihood function and on (2) the identifiability of the model (McCullagh,1980). Regarding concavity, McCullagh (1980) proves that the log likelihood function of the MLM is globally concave. The second problem, identifiability of the model, is related to the rank of the design matrix. It can be eliminated by the imposition of appropriate constraints or by the use of generalized inverse matrices.

With modern computer technology, maximum likelihood estimates are easily computed by Newton-Raphson iterative method. However, when estimating ordered models, convergence cannot be expected to be as fast as with simpler models (Haberman,1974). Non-convergence is a good practical indicator that the model being fitted is not appropriate (McCullagh, 1980). The model can be estimated using the standard-

ized SAS System, namely, using the LOGIST procedure described by Harrell (1983).

Parameters α_j are frequently referred to as "cut points" or "thresholds" on the logistic scale. They must be positive and $\alpha_1<\alpha_2<\ldots<\alpha_{k+1}$ (Maddala,1983). In practice, even without restrictions specified, maximum likelihood estimation yields positive estimates. If not, the model being estimated is not correctly specified.

The vector of regression parameters β is of much more interest since it links the log odds to the covariates $\boldsymbol{x}_i$. The parameters β do not depend on the actual response category involved, although, estimates will, in general, be affected.

Using the estimated cumulative logits evaluated at the means of the explanatory variables, the probability that the i^{th} individual will belong to the j^{th} response category can be evaluated in the following way:

$$
\begin{aligned}
Prob(y_i=j|\boldsymbol{x}_i) = \quad & F(\alpha_1+\beta'\boldsymbol{x}_i) && \text{for } j=1 \\
= \quad & F(\alpha_j+\beta'\boldsymbol{x}_i) - F(\alpha_{j-1}+\beta'\boldsymbol{x}_i) && \text{for } 1<j\leq k \\
= \quad & 1-F(\alpha_k+\beta'\boldsymbol{x}_i) && \text{for } j=k+1
\end{aligned}
$$

The interpretation of the estimated β coefficients of the logit model is not straightforward. The coefficients do not reflect changes in the explanatory variables on the

probability of an event's occurrence directly. Rather, they reflect the effect of changes in the independent variables on the log odds $\ln\frac{P_{ij}}{1-P_{ij}}$. The effect of those changes on the probability depends on the initial values of all explanatory variables and their coefficients (i.e., on the initial probability).

A more illustrative way of interpreting the estimated β coefficients is to evaluate the marginal effects of changes of independent variables on the estimated probabilities (Greene, 1993). Thus, for a continuous regression variable x_m, we write

$$\frac{\partial Prob(y_i=j|\boldsymbol{x}_i)}{\partial x_{im}} = P_{ij}(1-P_{ij})\beta_m \qquad \text{for } j=1$$

$$= \frac{\partial P_{ij}}{\partial x_{im}} - \frac{\partial P_{ij-1}}{\partial x_{im}} \qquad \text{for } 1<j\leq k$$

$$= -P_{ik}(1-P_{ik})\beta_m \qquad \text{for } j=k+1$$

In the case of a discrete explanatory variable, the marginal effect is evaluated in the form

$$ME_{ij} = Prob(y_j=j|x_{im}=z) - Prob(y_j=j|x_{im}=z-1)$$

where ME_{ij} is the marginal effect of the discrete variable

on the probability that $y_i=j$ and z-1 and z (z-1<z) are the respective levels of the discrete variable.

It is also possible to evaluate confidence limits for both the linear predictor of the cumulative probability and the predicted cumulative probability. The asymptotic (1-α)100% confidence interval for the linear predictor $\hat{l}_{ij}$ is

$$\hat{l}_{ij} \pm z_{\frac{\alpha}{2}} \hat{\sigma}(\hat{l}_{ij})$$

where $\hat{\sigma}(\hat{l}_{ij}) = \sqrt{(1, x^{j}) \widehat{Cov}(1, x^{j})^{T}}$. For the predicted cumulative probability $\hat{P}_{ij}$, the asymptotic (1-α)100% confidence interval is

$$\left(\frac{1}{1+e^{-[\hat{l}_{ij} - z_{\frac{\alpha}{2}} \hat{\sigma}(\hat{l}_{ij})]}}, \frac{1}{1+e^{-[\hat{l}_{ij} + z_{\frac{\alpha}{2}} \hat{\sigma}(\hat{l}_{ij})]}} \right)$$

Several authors proposed various measures of the goodness of fit of logit models (Judge et al.,1985, Pindyck and Rubinfeld, 1991). Among the measures they suggest are (1) the log likelihood chi-square test

$$-2[L(\beta_{r}) - L(\beta_{ur})] \sim \chi^{2}$$

where twice the difference between the maximum value of the log-likelihood of restricted and unrestricted models has an asymptotically chi-square distribution with the degrees of

freedom equal to the number of restrictions, and (2) the likelihood ratio test (a pseudo-R^2 test)

$$\rho^2 = 1 - \frac{L(\beta_{ur})}{L(\beta_r)}$$

This measure is zero when the model has no value and is one when the model is a perfect predictor.

5. EMPIRICAL DATA AND ANALYSIS

This chapter begins with a description of the two data samples used in the empirical analysis. Then, the dependent variable for the Federal Crop Insurance logistic regression is defined. Next, explanatory variables are specified and their hypothesized relationships to the use of FCI are discussed. Finally, two empirical models tested are described.

Study Design and Sample Description

The data used in the thesis were obtained from the Iowa Farm Finance Survey (FFS) conducted in 1991 and 1993. The survey was conducted by Iowa State University (Ames, IA) in cooperation with Iowa Agricultural Statistics (Des Moines, IA).[1] In both years, questionnaires were mailed to a random sample of Iowa farm operators proportionately representing all 99 counties of the State of Iowa. In 1991, 881 valid responses out of 2,142 mailed questionnaires were obtained. In 1993, a new random sample of 3,500 respondents was drawn and 1,125 valid responses were obtained. Samples of both

[1]The survey was approved by the Iowa State University Human Subjects Review Committee.

1991 and 1993 survey instruments are included in Appendices A and B, respectively.

Demographic characteristics of the 1991 and 1993 samples are shown in Table 5.1. On average, respondents of 1993 survey were younger, with fewer years of farming experience, and supported more dependents. Also, the average farm size was smaller for the 1993 sample. This fact is also reflected in lower earnings and expenses, as well as equity of an average 1993 farm. Higher average debt levels and lower average values of assets resulted in higher debt-to-asset ratio for the 1993 sample.

Table 5.1 Demographic characteristics of the sample Iowa farm operators

	January 1, 1991	January 1, 1993
Number of Observations	881	1125
Characteristic		
Age	57.7	55.4
Experience(years)	33.8	30.0
Total acres operated	439.9	381.6
Dependents	2.6	2.7
Dependents under 18	0.5	0.7
Gross income($)	127979.0	101547.0
Interest expenses($)	10328.0	7994.0
Total expenditures($)	110544.0	92797.0
Total assets($)	563350.0	510846.0
Total debt($)	101790.0	126440.0
Debt/asset(%)	18.1	24.8

Source: Iowa Farm Finance Survey, 1991 and 1993

Tables 5.2 and 5.3 present financial statements of an average survey respondent. The average Balance Sheet (Table 5.2) suggests that debt and asset structure was very similar for the two samples despite the fact that in 1993 average asset levels were lower and debt levels were higher than in 1991. The Income Statement of an average respondent (Table 5.3) shows consistency with the smaller farm size for the second sample in that higher income was derived from off-farm activities and lower from farm operation.

Finally, farm type distributions for both years (Table 5.4), based on the percentage contribution of a particular enterprise to total farm sales, show mixed grain/livestock type as the most frequent type followed by grain farm type. Farms specialized in livestock production comprised approximately one third of the samples.

In Tables 5.5 and 5.6, the operator's age and farm size distributions for the two FFS samples are compared with 1987 Iowa Census of Agriculture. The sample in 1991 under-represented farm operators younger than 45 years and over-represented those older than 55 years. The 1993 age distribution followed that of Iowa Ag Census more closely. However, farmers under 35 years of age continued to be under-represented while just the opposite was true for farmers older than 65 years. As to the farm size distribution, both FFS samples under-represented farms of less than 50 acres.

Table 5.2 Average balance sheet (dollars) for the sample Iowa farm operators

	January 1, 1991	January 1, 1993
Number of Observations	881	1125
ASSETS		
Cash	14165	15040
Financial Investments	46019	40087
Crops and Livestock Held For Sale	83635	68985
Machinery, Equipment and Breeding Stock	98906	85525
Land and Buildings	315871	287899
Other Assets	4754	13310
Total Assets	563350	510846
LIABILITIES		
Non Real Estate		
Bank	23664	29593
Farm Credit System	2182	1566
FmHA	2576	2284
Insurance Company	658	489
Individual	3915	5150
Merchant/Dealer	1664	3552
Other Loans	3454	10888
Non Real Estate Total	38113	53522
Real Estate		
Bank	17213	23005
Farm Credit System	19981	19901
FmHA	5443	4802
Insurance Company	5487	2886
Individual	14498	18245
Merchant/Dealer	166	326
Other Loans	889	3753
Real Estate Total	63677	72918
Total Debt	101790	126440
Net Worth	461560	384406

Source: Iowa Farm Finance Survey, 1991 and 1993

Table 5.3 Average income statement (dollars) for the sample Iowa farm operators

	1991	1993
Number of Observations	881	1125
Gross Income	127979	101547
+ Net Rental Income	2136	1814
+ Sale of Breeding Stock	2374	na
+ Sale of Farm Property (excl.land)	na	2370
Gross Farm Income	132489	105731
- Operating Expense	88692	73587
- Interest Expense	10328	7994
Net Cash Farm Income	33469	24150
+ Inventory Change	8752	9029
Adjusted Net Cash Income	42221	33179
- Depreciation	13563	10954
Net Farm Income	28658	22225
Wages and Salaries	8803	13851
+ Interest & Dividends	5168	3389
+ Other Income	6543	10369
Off-farm Income	20514	27609
+ Capital Gains	4332	2923
Accrual Off-farm Income	24846	30532
Net Income	53504	52757
Net Cash Income	53983	51759

na - not available

Source: Iowa Farm Finance Survey, 1991 and 1993

Table 5.4 The distribution of farm types for the sample Iowa farm operators

Farm type	1991 sample	1993 sample
Cash grain	26.9	27.3
Mixed - grain/livestock	34.2	33.0
Hog	13.1	11.7
Cattle	11.5	10.9
Other, including dairy	14.3	17.1

Source: Iowa Farm Finance Survey, 1991 and 1993

Table 5.5 Comparison of age distribution between 1987 Iowa Ag Census and the Farm Finance Survey samples

Age group	Iowa Ag Census 1987 (%)	Farm Finance Survey 1991 (%)	Farm Finance Survey 1993 (%)
Less than 35	19.3	2.7	4.6
35-44	20.2	13.4	19.1
45-54	20.7	19.4	22.1
55-64	24.0	35.8	27.6
65 up	15.8	28.7	26.6
Average age	49 years	58 years	55 years

Sources: Iowa Ag Census, 1987; Iowa Farm Finance Survey, 1991 and 1993

Table 5.6 Comparison of farm size distribution between 1987 Iowa Ag Census and the Farm Finance Survey sam ples

Farm size (acres)	Iowa Ag Census 1987 (%)	Farm Finance Survey 1991 (%)	Farm Finance Survey 1993 (%)
1-49	18.0	4.2	8.3
50-179	26.2	16.9	26.7
180-499	37.1	44.9	39.4
500-999	15.1	28.4	19.2
1,000 up	3.6	5.6	6.4
Average acres	301 acres	440 acres	382 acres

Sources: Iowa Ag Census, 1987; Iowa Farm Finance Survey, 1991 and 1993

In addition, the 1991 sample consisted of more farms larger than 500 acres than was suggested by the Census.

Dependent Variable

The same dependent variable applies to both 1991 and 1993 FFS samples. The variable represents the intensity of the use of multiple peril crop insurance (Federal Crop Insurance) by Iowa farm operators. The survey question regarding farmers' participation in Federal Crop Insurance (FCI) did not relate to any single year. Instead, the intensity of use was measured on a five-point scale (1=Never, 5=Always), thus, resulting in an ordered categorical variable CROPINS. Table 5.7 shows the distribution of the variable CROPINS for the two samples along with the mean scores.

Table 5.7 The intensity of the use of Federal Crop Insurance for the FFS samples

The intensity of use	1991 sample	1993 sample
1. Never	31.2	34.3
2. Seldom	9.2	17.2
3. Half of time	15.8	4.3
4. Most of time	11.2	12.1
5. Always	32.6	32.1
Mean Score	3.04	2.91

Source: Iowa Farm Finance Survey, 1991 and 1993

Average demographic and financial characteristics of the FFS samples as well as farm type distribution by the intensity of the use of FCI are presented in Tables 5.8 and 5.9. In order to simplify the tables, the three middle response levels of CROPINS (2, 3, 4) were grouped into one category (Sometimes). The data in Table 5.8 (demographic and financial characteristics) do not indicate major differences within each sample between the three intensity levels of FCI use. The only exceptions are total debt level, debt-to-asset ratio, and number of farmers with no outstanding farm debt for the 1991 sample. Farmers with greater debt obligations (both in absolute and relative terms) seem to use FCI more often.

Farm type distributions by the use of FCI (Table 5.9) suggest that farms with more than half of total sales coming from beef production use FCI less frequently. In addition, cash grain and grain/livestock farms indicate more intense use of multiple peril crop insurance.

The ordered discrete variable CROPINS was used to construct the empirical cumulative logits that formed the dependent variable in the logistic regression of the FCI use. Models tested are specified in the last section of this chapter. Results are presented in Chapter 6.

Data obtained in the 1993 survey permitted an alternative specification of the use of FCI and, thus, testing the

Table 5.8 Demographic and financial characteristics of the FFS samples by the use of MPCI

	January 1, 1991			January 1, 1993		
	Never	Sometimes	Always	Never	Sometimes	Always
No. of observations	274	318	284	347	339	325
Age	61.0	56.3	57.0	55.2	54.5	53.6
Acres owned	272	256	247	253	297	226
Acres operated	387	452	472	337	452	408
Dependents	2	3	3	3	3	3
Dependents under 18	0	1	1	1	1	1
Experience (years)	36.5	32.5	33.0	29.3	29.5	29.5
Gross income ($)	127,998	127,352	129,601	95,956	108,307	108,131
Interest expenses ($)	9,217	9,317	12,465	7,630	8,270	8,959
Total expenditure ($)	107,417	114,464	112,579	83,602	98,574	98,223
Total assets ($)	660,642	529,862	524,772	493,015	521,016	433,928
Total debt ($)	78,109	98,725	127,207	122,865	118,307	141,092
Debt/asset	0.15	0.19	0.26	0.33	0.30	0.36
Number of farmers with no debt	116	79	61	45	43	24

Source: Iowa Farm Finance Survey, 1991 and 1993

Table 5.9 Farm types for the FFS samples by the use of MPCI

	January 1, 1991				January 1, 1993			
	Never	Sometimes	Always	All	Never	Sometimes	Always	All
Farm type (%)								
Cash grain	25	25	31	27	24	27	31	27
Grain/livestock	32	35	35	34	26	37	40	33
Hogs	10	17	12	13	13	12	11	12
Beef	18	9	8	12	15	10	7	11
Other	15	14	14	14	22	14	11	17

Source: Iowa Farm Finance Survey, 1991 and 1993

consistency of the scale variable CROPINS. Rather than relying on this scale variable to measure the intensity of FCI use, the alternative specification measures effective coverage levels, the proportion of total expected output in 1992 covered by FCI.

One variable was formed for each of the two main crops in Iowa: corn (EFFCLCRN) and soybeans (EFFCLSOY). The effective coverage level for corn, EFFCLCRN, was calculated as a product of the ratio of corn acres insured by FCI in 1992 (CA_{ins}) to total corn acres planted in 1992 (CA_{plant}) and actual FCI coverage levels chosen for corn in 1992 crop year (LEVELCRN)

$$EFFCLCRN = \frac{CA_{ins}}{CA_{plant}} LEVELCRN$$

The effective coverage level for soybeans, EFFCLSOY, was calculated in the similar fashion. As mentioned earlier, there are currently four coverage levels available (35, 50, 65, and 75%) for both corn and soybeans. Clearly, EFFCLCRN and EFFCLSOY are continuous variables with values restricted within the <0,75> interval. The lower bound is behavioral. The upper bound is the result of policy limitations. Thus, the two variables represent censored variables where the two extreme values represent no FCI insurance and full FCI insurance, respectively.

Figures 5.1 and 5.2 show the distribution of the proportion of acres insured by FCI for corn and soybeans, respectively. In both cases, slightly more than a half of the respondents insured all of their cropland. The other half of farm operators had no FCI insurance in 1992. Very few farmers insured only some part of their planted corn or soybean acres. Consequently, the distributions of the actual (chosen by farmers) and effective (calculated) FCI coverage levels are almost identical (Table 5.10).

Table 5.10 Distribution of the actual and effective FCI coverage levels in 1992

Coverage level (%)	% observations	
	Corn	Soybeans
Actual		
0	54.4	59.1
35	0.1	0.3
50	2.6	1.2
65	24.1	22.1
75	18.8	17.3
Effective		
0	54.4	59.1
1-35	0.8	0.8
36-50	3.7	2.2
51-65	23.9	21.6
66-75	17.2	16.3

Source: Iowa Farm Finance Survey, 1991 and 1993

Undoubtedly, all three of the above discussed variables, i.e., the intensity of the use of FCI (CROPINS) and the 1992 FCI effective coverage levels for corn and soybeans (EFFCLCRN and EFFCLSOY) are alternative representations of the same

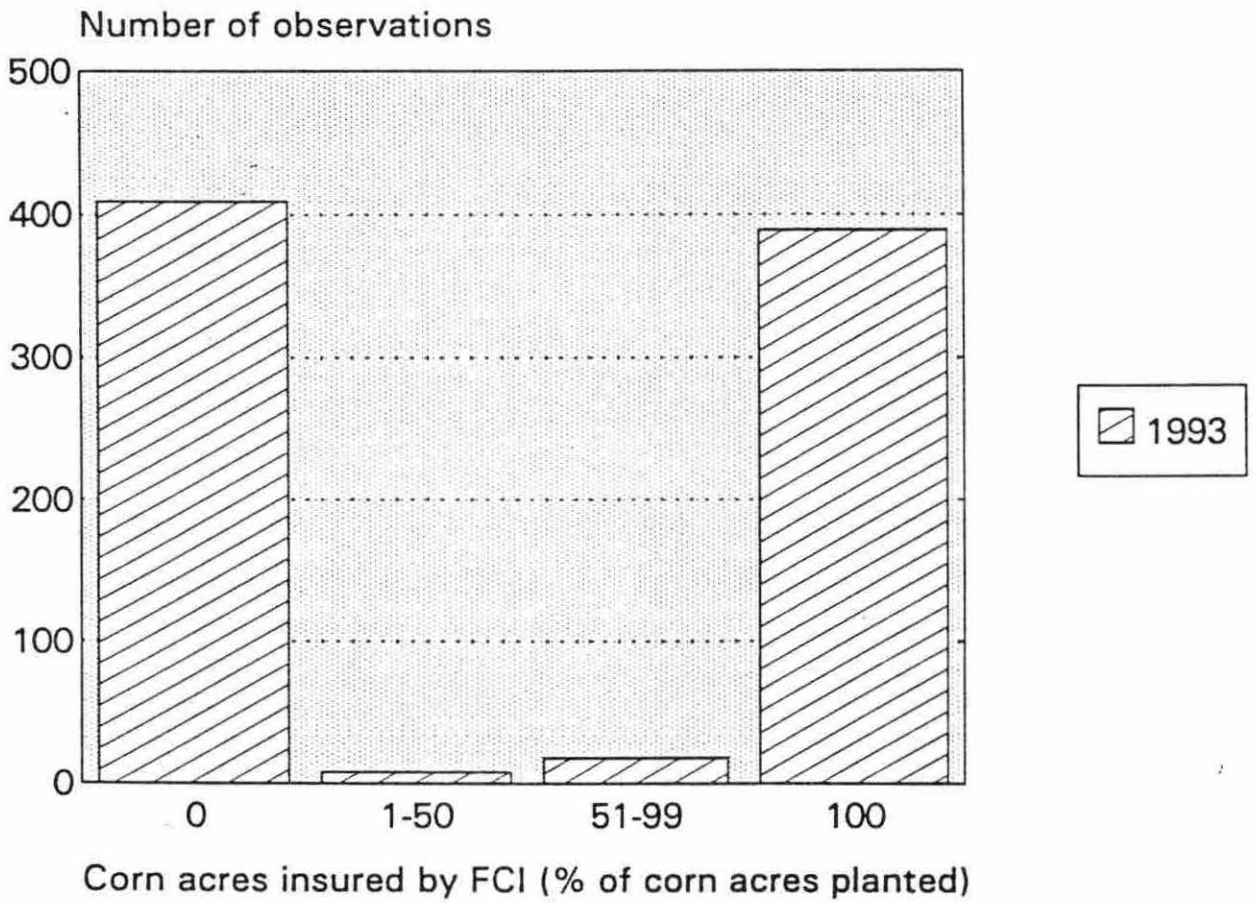

Figure 5.1 Proportion of planted corn acres insured by FCI in 1992

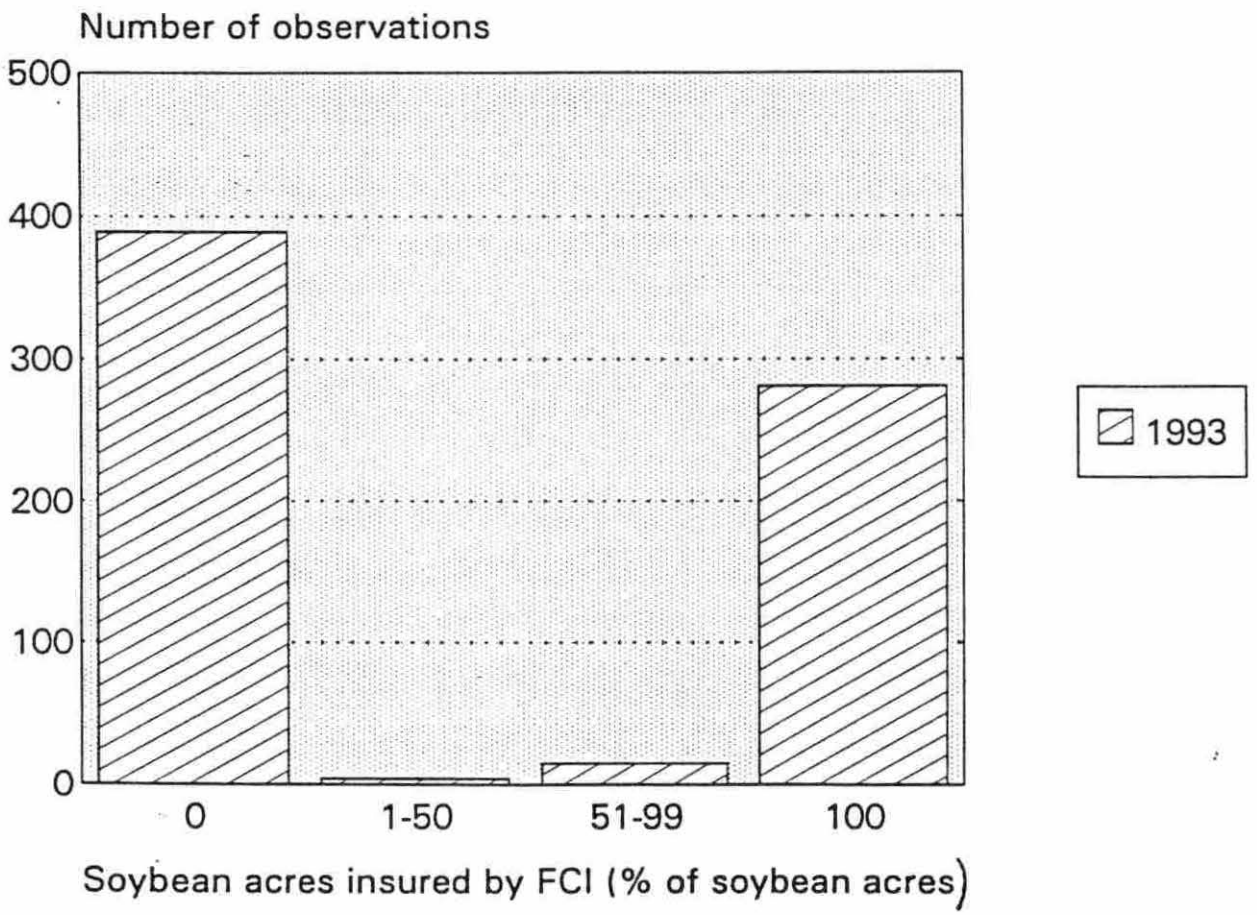

Figure 5.2 Proportion of planted acres of soybean insured by FCI in 1992

thing. The difference between them is in that CROPINS represents the typical use of FCI over several years, whereas EFFCLCRN and EFFCLSOY are relevant only to 1992 crop year. In addition, CROPINS is a scale variable, a subjective measure, while EFFCLCRN and EFFCLSOY are objective measured responses.

Since the variable CROPINS and the variables EFFCLCRN and EFFCLSOY represent the same thing, farmers' preferences for FCI revealed by these two alternative representations should be consistent. In order to see that, chi-squared tests of general association between CROPINS and the effective FCI coverage levels for corn, EFFCLCRN, and soybeans, EFFCLSOY, were conducted. Frequency distributions of the effective coverage levels by the use of FCI are shown in Table 5.11 (corn) and Table 5.12 (soybeans). Test statistics (also listed in the tables) indicate statistically significant, strong positive association between the actual FCI coverage levels in 1992 and the ordered categorical variable CROPINS (the intensity of FCI use).

This allows us to conclude that farmers' perception of the extent to which they use FCI (revealed on the 5-point scale) was consistent with the actual FCI coverage levels chosen by these farmers for 1992 crop year.

Table 5.11 Distribution of the 1992 FCI effective coverage levels for corn by the intensity of the use of FCI

Corn effective coverage level %	Intensity of the use of FCI (absolute frequencies)						
	Never	Sometimes			Always	Total	
	1	2	3	4	5		Percent
0	226	139	23	11	na	399	54.4
1-35	na	0	0	1	5	6	0.8
36-50	na	0	1	12	14	27	3.7
51-65	na	2	7	38	129	176	23.9
66-75	na	1	2	29	94	126	17.2
Total	226	142	33	91	242	734	100.0

Chi-square statistic 670.378 DF 16 P-value 0.000
Phi coefficient 0.956

na - not applicable

Source: Iowa Farm Finance Survey, 1993

Table 5.12 Distribution of the 1992 FCI effective coverage levels for soybeans by the intensity of the use of FCI

Soybean effective coverage level %	Intensity of the use of FCI (absolute frequencies)						
	Never	Sometimes			Always	Total	Percent
	1	2	3	4	5		
0	168	111	29	37	na	345	59.1
1-35	na	0	0	1	4	5	0.8
36-50	na	0	0	7	6	13	2.2
51-65	na	2	3	21	100	126	21.6
66-75	na	1	2	20	72	95	16.3
Total	168	114	34	86	182	584	100.0

Chi-square statistic 482.550 DF 16 P-value 0.000
Phi coefficient 0.909

na - not applicable

Source: Iowa Farm Finance Survey, 1993

Explanatory Variables and Hypothesized Relationships

This section presents factors relevant to the Federal Crop Insurance (FCI) participation decision that were identified in Chapter 3 in the form of explanatory variables of FCI logistic regression models. The variables are grouped into five categories defined at the end of Chapter 3. The hypothesized relationship of each variable to farmer's FCI decision is stated along with its definition and units of measurement (with the exception of unit-less variables, such as ratios). The variable names by which they are identified later in the text are listed in parenthesis.

Demographic characteristics

Age of farm operator - years (AGE)

Although it may not affect crop insurance purchases directly, a farmer's age is reflected in factors such as debt and equity levels, the proportion of land rented in total land operated, farmer's risk aversion, and familiarity with risk concepts and tools. Older farmers tend to have lower debt levels, more equity, operate smaller farms, and rent less land than younger farm operators. All of these factors would reduce the need for crop insurance. Therefore, farmer's age is expected to be negatively associated with the use of FCI.

The highest completed level of education of wife and husband -1.high school 2.community college 3.college 4.post graduate (EDW, EDH)

Education increases a person's awareness of risk issues as well as his/her understanding of possible ways of transferring risk. Farm operators with higher education are, thus, more likely to use Federal Crop Insurance as a way of reducing production risk.

Farming experience - years (YRSFARM)

Because of strong positive correlation between farmer's age and his farming experience, the latter is considered an alternative representation of the former. The variable YRSFARM is, therefore, expected to negatively influence FCI participation for the same reasons as the variable AGE.

Farm characteristics

Farm size - total acres operated (ACROPER)

Bigger farms tend to have higher total output and, thus, more value is in risk of loss for larger farm operations. In other words, bigger farm operations face larger absolute losses. Also, larger farms tend to rely more heavily on income derived from farming and have lower income from off-farm activities. For these reasons, farm size is hypothesized to have positive effect on the use of FCI.

Gross farm sales - dollars (GROSSINC)

This variable can be viewed as another measure of the size of a farm since higher sales are usually derived from larger farm operations. Thus, the same reasoning as for farm size measured by acres holds for farm size measured by gross sales. Hence, GROSSINC is hypothesized to be positively associated with the FCI use.

The proportion of acres rented from others in total acres operated (RRENTOP)

Rental arrangements (especially cash leases) increase the level of risk for a farm operator since he is obliged to make agreed-upon payments to a landlord regardless of actual crops harvested. Therefore, farmers operating the larger proportion of acreage rented are expected to use FCI more often.

The proportion of total farm sales derived from crop production (CROPS)

The ratio of crop sales to total farm sales is, in a sense, a measure of farm diversification which is one of the ways of reducing farm business risk. Farms specialized in growing crops, those with the ratio close to one, are more likely candidates for FCI than those with high livestock numbers and fewer acres of crops.

Business risk management tools

In order to illustrate farmers' use of all risk management strategies, the frequency distributions of the scale variables for FCI and the six risk management strategies discussed below are presented in Table 5.13. On the basis of the mean scores of individual strategies it can be concluded that participation in government programs, FCI, and crop-hail insurance were the strategies employed most often. On the other hand, hedging and commodity options were used only rarely. Overall, risk management practices did not differ substantially for 1991 and 1993 FFS samples.

The use of private crop-hail insurance - 1.never 2.seldom 3.half of time 4.most of time 5. always (HAILINS)

Crop-hail insurance can be viewed as a complement to multiple peril crop insurance since the two offer protection against different risks. Crop hail insures against rather isolated but possibly quite frequent losses due to hail storms, while multiple peril insures against low probability widespread crop failures due to flood, drought, and other perils. Since hail insurance deals with a different type of risk than FCI, it is expected to be positively associated with the use of FCI.

Table 5.13 The intensity of the use of risk management strategies for the FFS samples

Strategy	Year	Frequency of use					Mean Scores
		Never		Sometimes		Always	
		1	2	3	4	5	
Multiple peril	91	31.2	9.2	15.8	11.2	32.6	3.04
crop insurance	93	34.3	17.2	4.3	12.1	32.1	2.91
Crop - hail	91	38.3	5.6	7.2	6.3	42.6	3.09
insurance	93	35.5	9.5	3.8	12.2	39.0	3.10
	91	74.8	9.4	11.0	3.8	1.0	1.46
Hedging	93	73.7	16.3	6.6	2.7	0.7	1.40
	91	47.8	11.4	24.6	11.4	4.8	2.14
Forward contracting	93	45.1	22.4	17.9	11.1	3.5	2.05
	91	77.3	8.4	9.9	3.3	1.1	1.42
Commodity options	93	75.0	15.6	6.2	2.4	0.8	1.38
	91	56.4	4.7	11.5	8.1	19.3	2.20
Crop share leases	93	56.8	9.1	7.4	7.8	18.9	2.23
Participation in	91	9.1	2.4	8.1	17.0	63.4	4.20
government programs	93	9.5	5.3	4.5	23.7	57.0	4.13

Source: Iowa Farm Finance Survey, 1991 and 1993

Participation in government programs - 1.never 2.seldom 3.half of time 4.most of time 5. always (GOVTPROG)

Although it is not required for FCI eligibility, participation in government programs is expected to be positively related to the intensity of FCI purchases. The reason for that stems from the fact that most of the government programs (for example, deficiency payments and marketing loans) are designed primarily to reduce market price risk, not production risk.

The use of forward pricing tools, i.e., forward contracting, hedging, and commodity options - 1.never 2.seldom 3.half of time 4.most of time 5. always (FORCONTR, HEDGING, COMMOPT)

Forward pricing tools protect farmers against unfavorable price movements, but they do not address the problem of production risk, except, perhaps, for commodity options. Moreover, farmers who have contracted for a certain amount of their crop production for future delivery will have additional incentives to secure the output sufficient to meet contract requirements. Therefore, the three forward pricing tools are hypothesized to be positively associated with the use of FCI.

The use of crop share leases - 1.never 2.seldom 3.half of time 4.most of time 5. always (CROPSHAR)

Not all rental arrangements constitute higher risk than operating own land with own equipment. Crop share rental

agreements, for example, do not increase risk level as do cash rental arrangements. Cash renting may require rental fees to be paid in cash regardless of an actual crop harvested. Hence, the fixed obligations resulting from cash renting increase the total variability of farm income stream. On the other hand, crop share leases, as the name suggests, call for the division of the actual crop between a tenant and a landlord. Therefore, the use of crop share leases does not give farmers additional incentives to participate in FCI.

Farm financial performance

Farm net worth - dollars (NETWRTH)

Definition: Net worth = total farm assets - total farm debt.

Farms with higher net worth are hypothesized to use less FCI than those with lower equity. The reason for this lies in the fact that, for two farms of the same size (measured by total assets), more equity means less debt and, thus, less financial risk and lower pressure to control business risk. In other words, net worth represents credit reserves since it can be used as a debt collateral.

The proportion of accrued off-farm income in net farm income (OFFINCR)

Off-farm income is usually more stable than income derived from the farm operation and it serves as a cushion against high farm income variability. Therefore, the variable OFFINCR is hypothesized to be negatively associated with the use of FCI.

Total farm debt outstanding with Farmers Home Administration -dollars (FMHADEBT)

As mentioned in Chapter 3, lenders may require farmers to buy crop insurance as a condition for extending loans. Although there are no regulatory requirements that producers carry FCI, FmHA strongly encourages farmers' participation in the FCIP. In some instances, farmers may actually be required by an FmHA officer to buy FCI. Consequently, the amount of FmHA debt and the use of FCI are expected to be positively associated.

Profit margin ratio (MARGIN)

Definition: Profit margin ratio = (net farm income + interest paid - family living expenses) / total gross income. Family living expenses were calculated using data from Judd (1991,1993).

Profit margin measures the return to the capital investment per unit of output or sales. It reflects the farm operator's ability to control cost, his farm management

performance, irrespective of financing and farm size. Since more profitable farms face relatively higher absolute losses, the variable MARGIN is hypothesized to be positively associated with the use of FCI.

Asset turnover ratio (TURNOVER)

Definition: Asset turnover ratio = total gross income / value of farm assets.

Asset turnover measures the sales volume generated per dollar of investment. It is an index of the efficiency of capital utilization. The variable TURNOVER is expected to be negatively related to the use of FCI since more efficient farms have higher risk bearing capacity.

Debt-to-equity ratio (DER)

Definition: Debt-to-equity ratio = total farm debt outstanding / net worth.

The debt-to-equity ratio is a measure of farm indebtedness. In other words, it represents the level of financial risk. Farm operations with higher DER face higher financial risk and are, therefore, more likely to control total risk level through limiting the amount of business risk. Accordingly, DER is expected to have positive influence on the use of FCI.

Debt burden ratio (BURDENR)

Definition: Debt burden ratio = net cash farm income / total farm debt.

The debt burden ratio measures net cash income generated by farm operation per each dollar of outstanding farm debt. It is a measure of farm solvency, of farm's ability to repay debt. Better solvency position contributes to risk bearing capacity of a farm, thus, reducing the need for FCI.

The value of liquid assets - dollars (LIQAS)

Definition: Liquid assets = cash in checking and savings accounts + financial investments (CDs, mutual funds) + crop and livestock for sale (including CCC crops under loan).

Liquid assets are assets that can be converted into cash almost instantaneously without causing a substantial loss of their value. Therefore, they constitute financial reserves that can be used as a supplemental source of cash. Farms with high level of liquid assets are more likely to withstand unfavorable circumstances. Therefore, farm liquidity is hypothesized to be negatively associated with the use of FCI.

Gross ratio (GROSS)

Definition: Gross ratio = total farm operating expenses/ gross farm sales.

The gross ratio measures operating expenses of a farm per dollar of farm output. In other words, it is an index of farm efficiency. More efficient farm operations have lower gross ratios. With respect to FCI, farm's efficiency, or productivity, has the same effect as does its profitability. Consequently, more efficient farms are expected to use more FCI.

The location of a farm operation

Crop reporting district - 1 most of farming operation located within a crop reporting district, 0 otherwise (CRD2 - 9)

Together, there are nine crop reporting districts in the State of Iowa (one dummy variable was created for eight of them). Figure 5.3 outlines crop reporting districts on the Iowa county map. The reason for including farm location among the factors explaining FCI participation is that soil and weather conditions, as well as farm enterprise specialization are not completely uniform across the entire State of Iowa. These differences may result in different FCI participation rates in individual districts.

Models Tested

Based on the discussion of this and the previous chapters, the logistic regression model of the use of FCI can be expressed in the form

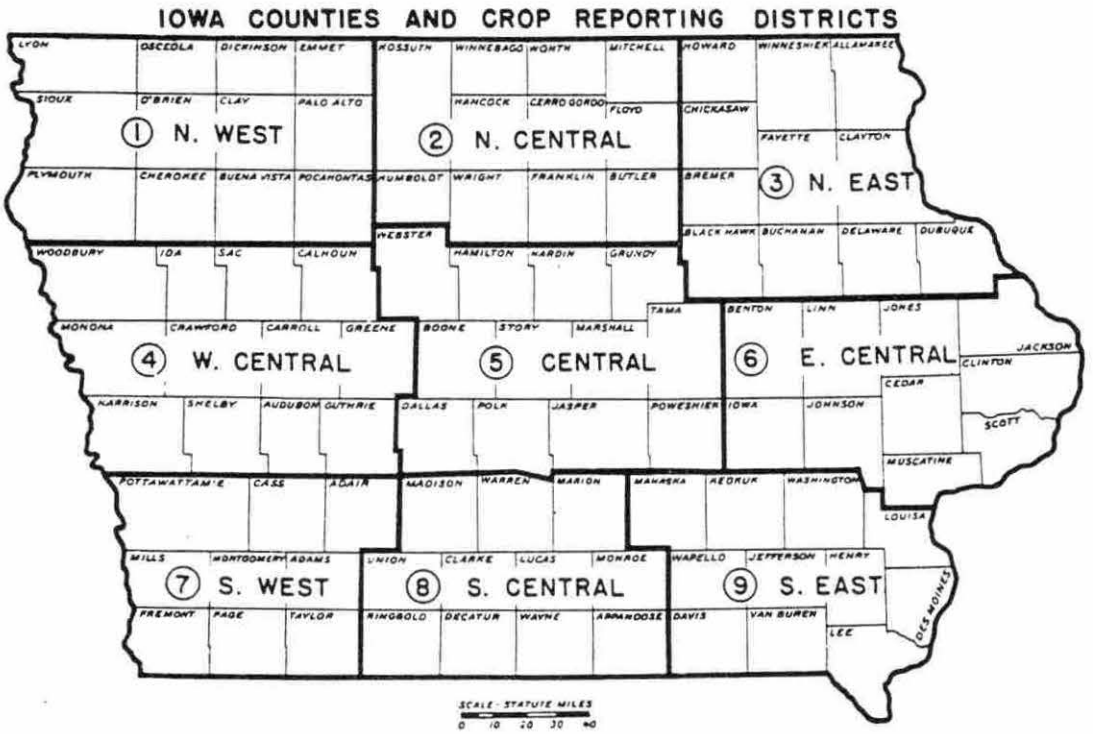

Figure 5.3 Iowa crop reporting districts 1 - 9

$$l_j = \ln \frac{P_j}{1-P_j} = \alpha_j + \beta_1' \mathbf{X}_1 + \beta_2' \mathbf{X}_2 + \beta_3' \mathbf{X}_3 + \beta_4' \mathbf{X}_4 + \beta_5' \mathbf{X}_5$$

for j=1,...,4, where l_j is the empirical cumulative logit (log odds ratio) for the j^{th} response level of the variable CROPINS, ln is a natural logarithm, and P_j is the cumulative probability, the probability that an individual will choose the CROPINS response level less than or equal to j. The right-hand side of the regression model consists of the intercept term α_j, the vectors of demographic characteristics, farm characteristics, business risk management tools, farm financial characteristics, and farm location $\mathbf{X}_1$ - $\mathbf{X}_5$, and finally, the unknown parameter vectors β_1'-β_5'.

The maximum likelihood estimation of the model yields the estimates of four intercept terms, one for each (except the last) CROPINS response level. Also, one β parameter is estimated for each explanatory variable. Using these estimates, the cumulative probabilities, P_j, are computed first. Next, from the cumulative probabilities P_j, probabilities for the individual CROPINS response levels are calculated

$$\begin{aligned} \text{Prob(CROPINS=j)} &= P_1 && \text{for j=1 Never} \\ &= P_j - P_{j-1} && \text{for j=2 Seldom, 3 Half of time,} \end{aligned}$$

and for 4 Most of time, and

$= 1 - P_4$ for j=5 Always

These probabilities are referred to as the FCI probabilities later in the text. The FCI probabilities are reported in the next chapter along with the estimated regression coefficients.

Finally, the marginal effects of the explanatory variables on the FCI probabilities Prob(CROPINS=j) are evaluated. The two logistic regression models of FCI use were estimated. They differed only in the sample analyzed. Model 1 analyzed 1991 data while Model 2 examined the 1993 sample. For both models, the same set of explanatory variables was tested. Both models were analyzed using the standard SAS package.

6. EMPIRICAL RESULTS AND DISCUSSION

This chapter presents and discusses regression analysis results. Parameter and probability estimates, marginal effects of regressors, as well as model fit for the two logistic regression models are discussed separately. Then, regression parameter estimates of the two models are compared to examine their stability over time. Finally, the results are discussed in the last section of the chapter.

Estimation Strategy

Two logistic regression models were estimated in the form outlined in the previous chapter, one for each Farm Finance Survey sample. Same set of explanatory variables, also discussed in the previous chapter, was used in the two models. Initially, all explanatory variables were included in the models. In order to identify variables that were insignificant in explaining the use of FCI and to reduce the number of regression parameters to be estimated, backward and stepwise regression methods were applied to both models.

The backward selection technique examines chi-squared univariate tests based on the maximum likelihood estimation of all regression parameters. In each step, the least significant variable among those that do not meet a specified

significance level is removed from the model. In other words, the variable with the smallest contribution to the explanatory power of the model is removed from a model. Once a variable is eliminated from the model in this way, it is not allowed to enter the model again.

In the stepwise selection, on the other hand, using the same criteria as in the backward selection, each variable can be entered and removed from the model many times. The model building process continues until all variables that already are in the model meet the specified significance level to stay in the model and none of the variables that are not in the model meets the specified entry level. A relatively high (0.50%) significance level was chosen for variable entry while a slightly lower significance level (0.40%) was specified for variables to stay in the model in order to avoid the exclusion of variables that contribute to the model but whose regression parameters are not significant. Keeping in mind possible deficiencies of the variable searching techniques, the results of both backward and stepwise regressions were carefully examined in order to identify the variables with low explanatory power.

The results show that the following variables seem to have low explanatory power with respect to farmers' decision to participate in the Federal Crop Insurance Program: farmer's age (AGE), the education of both wife and husband

(EDW, EDH), farming experience (EXPER), farm size (ACROPER, GROSSINC), the percentage of crop sales in total sales (CROPS), the use of forward contracting (FORCONTR), hedging (HEDGING), and crop share leases (CROPSHAR), asset turnover ratio (TURNOVER), and the ratio of off-farm income to total income (OFFINCR). Also, six crop reporting district dummy variables (CRD 2, 4, and 5-8) appeared to be insignificant in explaining the intensity of FCI use. Therefore, these variables were not included in the final regression models. Consequently, the final logistic regression model for both 1991 and 1993 samples involved 13 explanatory variables.

Model 1 (1991 Sample)

The first regression model analyzed the 1991 data set. The estimated regression parameters are shown in Table 6.1. At this point, an important fact that applies to both logit models estimated should be stressed. Because of the way in which the empirical logits are defined, the signs of the estimated regression coefficients are just opposite from parameter signs resulting from the usual linear regressions. For example, the parameter estimate -0.0537 for the variable RRENTOP (Table 6.1) implies that this variable (the ratio of acres rented to acres operated) has a positive impact on the probability of FCI participation. The best way to see that

Table 6.1 The estimated regression parameters for Model 1991

Variable	Parameter estimate	Standard error	Variable mean
Intercept 1	0.4962	0.6771	-
Intercept 2	1.1292*	0.6785	-
Intercept 3	1.8810***	0.6838	-
Intercept 4	2.4860***	0.6898	-
RRENTOP	-0.0537	0.3349	0.473
FMHADEBT	-2.58E-6	2.679E-6	15773
HAILINS	-0.1655**	0.0645	3.388
GOVTPROG	-0.3049***	0.1164	4.461
COMMOPT	-0.3139***	0.1186	1.658
MARGIN	-0.3201	0.2867	0.025
LIQAS	2.628E-6**	1.313E-6	118833
BURDENR	0.0295	0.0292	1.142
NETWRTH	9.451E-7*	5.314E-7	386235
DER	-0.0171	0.0238	0.916
GROSS	-0.3146	0.4824	0.675
CRD3	1.1767***	0.2991	0.171
CRD9	-0.9623*	0.4987	0.063

Number of observations: 304
*** a variable significant at 1% level
** " 5% level
* " 10% level

is to look at marginal effects of regressors on the estimated FCI probabilities.

As shown in Chapter 4, a negative β parameter reduces the probability that an individual will choose the CROPINS response level 1=Never, and, at the same time, it increases the probability that the level 5=Always will be chosen. Therefore, variables with negative regression coefficients increase the probability of FCI participation. In the case of the variable RRENTOP, then, the negative sign of the estimated regression coefficient means that farmers who rent

more land are more likely to use FCI. Other estimated regression parameters and their impact on the FCI probabilities can be interpreted in the same fashion.

For the 1991 sample, seven variables were significant in explaining FCI participation. The results suggest that the use of private hail insurance (HAILINS) and commodity options (COMMOPT), participation in government programs (GOVTPROG), and the location of a farm in the crop reporting district 9 (CRD9 -south-east) appear to increase the likelihood of FCI participation. On the other hand, liquid asset holdings (LIQAS), net worth (NETWRTH), and the fact that a farm is located in the crop reporting district 3 (CRD3 - north-east) seem to reduce the probability of FCI purchases. All of these relationships were as hypothesized.

As mentioned earlier, the sign and statistical significance of the estimated regression coefficients can be interpreted quite easily. However, that is not the case with the magnitude of the estimated parameters. The marginal effects were calculated for individual explanatory variables in order to interpret the magnitude of the influence of these variables on the estimated FCI probabilities (the probabilities with which individual CROPINS response levels are chosen). The estimated FCI probabilities as well as the marginal effects, all evaluated at the means of the

explanatory variables of the routine data set, are displayed in Table 6.2.

The first row of Table 6.2 lists the five response levels of the variable CROPINS, in other words, the five intensity levels of the use of FCI. The second row shows the predicted probabilities for each of the response levels. The probability value 0.201485 in the first column, for instance, means that there is approximately 20 % probability that a representative 1991 farmer would choose to never use FCI. A "representative farmer" refers to a hypothetical respondent whose characteristics have values equal to the means of the explanatory variables. The predicted probabilities for the five response levels are referred to as the estimated FCI probabilities.

The columns of Table 6.2 represent the marginal effects of the explanatory variables on probabilities of the respective FCI levels. For example, the probability that a farmer will never use FCI decreases by 0.026627 when the value of HAILINS increases by one. The interpretation of the marginal effect is slightly different for dummy variables. For instance, the marginal effect of CRD3 on the first CROPINS probability level is 0.229927. It means that the probability that a farmer from North-Eastern Iowa will never use FCI is by 0.229927 higher than is the same

Table 6.2 The estimated probabilities for CROPINS and the marginal effects of the explanatory variables on these probabilities for Model 1

CROPINS	1 Never	2 Seldom	3 Half of time	4 Most of time	5 Always
Probability	0.201485	0.120636	0.179819	0.146630	0.351430
RRENTOP	-8.6397E-3	-3.0862E-3	-1.6989E-3	1.1851E-3	0.012240
FMHADEBT	-4.1509E-7	-1.4827E-7	-8.1624E-8	5.6939E-8	5.8805E-7
HAILINS	-0.026627	-9.5114E-3	-5.2360E-3	3.6525E-3	0.037722
GOVTPROG	-0.049055	-0.017523	-9.6462E-3	6.7290E-3	0.069495
COMMOPT	-0.050503	-0.018040	-9.9309E-3	6.9276E-3	0.071546
MARGIN	-0.051500	-0.018396	-0.010127	7.0644E-3	0.072959
LIQAS	4.2282E-7	1.5103E-7	8.3143E-8	-5.8000E-8	-5.9899E-7
BURDENR	4.7462E-3	1.6954E-3	9.3330E-4	-6.5105E-4	-6.7238E-3
NETWRTH	1.5206E-7	5.4315E-8	2.9900E-8	-2.0858E-8	-2.1541E-7
DER	-2.7512E-3	-9.8274E-4	-5.4100E-4	3.7739E-4	3.8976E-3
GROSS	-0.050616	-0.018080	-9.9531E-3	6.9430E-3	0.071706
CRD3	0.229927	0.047803	-0.001894	-0.047092	-0.228745
CRD9	-0.118273	-0.055285	-0.053102	-0.007391	0.234052

probability for the same farmer were he operating elsewhere in Iowa.

Note that the marginal effects in the first column of Table 6.2 have the same sign as the estimated regression coefficients. On the other hand, the marginal effects in the last column have the sign opposite to that of the respective regression coefficients. This is true for all explanatory variables in both models since it follows directly from the definition of the marginal effects for the first and last response levels, respectively. The marginal effects for the three middle response levels of CROPINS, however, cannot be predicted without calculating the respective probability quantities, cf. Chapter 4 for the definitions of the marginal effects.

Note also that the marginal effects add up to zero (except for rounding errors) for each independent variable. This follows directly from the fact that the estimated FCI probabilities add up to one.

In order to assess model fit, the log-likelihood chi-squared test, the prediction rate, and the pseudo-R^2 ratio were calculated and are shown in Table 6.3. The log-likelihood test indicates that the model is statistically significant. That means, the joint hypothesis that all regression coefficients are equal to zero can be rejected. The prediction rate shows that the model correctly predicted

Table 6.3 Goodness of fit of Model 1991

- 2 LOG Likelihood	76.662
Degrees of freedom	13
P-value	0.0001
Prediction rate	70.1
Pseudo R^2	0.09

the value of the variable CROPINS for 70 % of the observations. The low pseudo-R^2, showing that only 9% of the variation of the dependent variable was explained by the model, may be due to the cross-sectional character of the data. Also, the pseudo-R^2 can be low if some factors relevant to the FCI decisions were left out of the model. This is certainly case in this analysis. The impact of the FCI premiums as well as the availability of government disaster programs on the intensity of FCI purchases have not been captured by the models. Furthermore, the data reflected the farm income situation only in the year directly preceding the year of the data collection. Also, farm financial statements reflected the situation only during the two years preceding the survey. In other words, any prior influences were omitted from the analysis.

In summary, the results of Model 1991 suggest that the location of a farm, three risk management strategies, namely, hail insurance, government programs, and commodity options, and also farm equity and farm liquid asset holdings seem to have significant influence on the probability that FCI is

used. In particular, farm equity values and liquid assets tend to reduce the probability of FCI participation. Also, the same effect has farm location in North-Eastern Iowa. On the other hand, the use of hail insurance, government programs, and commodity options tend to increase the likelihood of FCI purchases. In addition, farms located in South-Eastern Iowa seem to use FCI more often.

Model 2 (1993 Sample)

The second regression model analyzed the 1993 data. The estimated regression parameters for the explanatory variables of Model 1993 are shown in Table 6.4. Eight variables were significant at the 10% level. Accordingly, the use of private hail insurance (HAILINS), participation in government programs (GOVTPROG), profit margin (MARGIN), debt-to-equity ratio (DER), gross ratio (GROSS), and the location of a farm in South-Eastern Iowa (CRD9) seem to have a positive effect on the probability that FCI is used. On the other hand, the location of a farm in North-Eastern Iowa (CRD3) and the proportion of acres rented (RRENTOP) seem to reduce the probability of FCI participation.

These results are consistent with the original hypothesis, except for two variables. First, the ratio of acres rented to acres operated was hypothesized to have positive impact on FCI participation. Second, the gross

Table 6.4 The estimated regression parameters for Model 1993

Variable	Parameter estimate	Standard error	Variable mean
Intercept 1	3.6461***	0.8970	-
Intercept 2	4.7444***	0.9191	-
Intercept 3	5.1240***	0.9271	-
Intercept 4	5.8042***	0.9417	-
RRENTOP	0.8732**	0.4326	0.447
FMHADEBT	-4.55E-6	3.901E-6	9722
HAILINS	-0.2050**	0.0820	3.315
GOVTPROG	-0.8201***	0.1658	4.332
COMMOPT	-0.2640	0.1620	1.560
MARGIN	-0.4547**	0.1820	-0.421
LIQAS	5.333E-7	1.157E-6	134727
BURDENR	0.0605	0.0801	0.926
NETWRTH	7.775E-7	6.015E-7	371405
DER	-0.0768*	0.0406	0.830
GROSS	-1.7755***	0.6255	0.689
CRD3	2.1016***	0.4107	0.159
CRD9	-1.4794**	0.6424	0.065

Number of observations:
*** a variable significant at 1% level
** " 5% level
* " 10% level

ratio (the ratio of operating expenses to gross farm sales) was expected to be negatively associated with the use of FCI. However, the results of Model 1993 suggest just the opposite for these two variables. The results of both models are discussed in the second part of this chapter.

The estimated FCI probabilities were evaluated at the means of the explanatory variables, using the estimated regression coefficients. The estimated FCI probabilities for Model 1993 are presented in Table 6.5. Also, the marginal effects of the explanatory variables on the FCI probabilities are shown in the same table. The interpretation of Table 6.5

Table 6.5 The estimated probabilities for CROPINS and the marginal effects of the explanatory variables on these probabilities for Model 2

CROPINS	1 Never	2 Seldom	3 Half of time	4 Most of time	5 Always
Probability	0.253098	0.246870	0.097696	0.148061	0.254275
RRENTOP	0.165827	0.052438	-8.6793E-3	-0.044768	-0.164817
FMHADEBT	-8.6408E-7	-2.7324E-7	4.5225E-8	2.3327E-7	8.5882E-7
HAILINS	-0.038931	-0.012311	2.0376E-3	0.010510	0.038694
GOVTPROG	-0.155743	-0.049249	8.1515E-3	0.042046	0.154795
COMMOPT	-0.050135	-0.015854	2.6241E-3	0.013535	0.049830
MARGIN	-0.086351	-0.027306	4.5195E-3	0.023312	0.085825
LIQAS	1.0128E-7	3.2026E-8	-5.3008E-9	-2.7342E-8	-1.0066E-7
BURDENR	0.011489	3.6332E-3	-6.0135E-4	-3.1018E-3	-0.011419
NETWRTH	1.4765E-7	4.6691E-8	-7.7280E-9	-3.9862E-8	-1.4675E-7
DER	-0.014585	-4.6121E-3	7.6336E-4	3.9375E-3	0.014496
GROSS	-0.337176	-0.106624	0.017648	0.091028	0.335127
CRD3	0.470146	-0.036039	-0.053739	-0.113978	-0.266390
CRD9	-0.193624	-0.131565	-0.024031	0.009591	0.339629

is analogous to that of Table 6.2 For instance, a unit increase in the variable HAILINS reduces the probability that FCI will never be used by 0.038931, and, at the same time, it increases the probability that FCI will be used always by 0.038694. Hence, a more intense use of hail insurance increases the likelihood of FCI participation. For the discrete variable CRD 3, for example, the marginal effect value in the first column shows that the probability that FCI is not used at all is by 0.470146 higher for a representative farmer in North-Eastern Iowa than it is for the same farmer operating elsewhere in the State.

Table 6.6 presents the statistics for assessing the model fit. They indicate that the overall model is significant, with the prediction rate 78%. Again, the pseudo-R^2 test is low for the reasons discussed for Model 1991.

In summary, the results of Models 1 and 2 are in a close agreement. Farmers operating in North-Eastern Iowa seem to be less likely to participate in FCI. On the other hand, the likelihood of participation in the FCIP tends to be higher among farm operators who use other risk transfer tools, hail insurance and government programs in particular. Also, farmers who operate in South-Eastern Iowa are more likely to purchase FCI coverage for their crops. Furthermore, highly leveraged farms have higher probability of FCI use.

Table 6.6 Goodness of fit of Model 1993

- 2 LOG Likelihood	115.805
Degrees of freedom	13
P-value	0.0001
Prediction rate	78.0
Pseudo R^2	0.17

All of these relationships were as hypothesized.

However, as already mentioned, the result for the ratio of land rented to land operated does not correspond with the original expectations. Also, Model 1993 gives rather contradictive results with respect to farm efficiency and its influence on the use of FCI. The variable Profit Margin suggests that farms with higher capital utilization are more likely to buy FCI. The variable Gross Ratio, to the contrary, indicates that more efficient farms have lower probability of using FCI. All results are discussed later in this chapter.

Comparison Between 1991 and 1993 Results

As already mentioned, the two data sets represented two different samples, but they were both drawn from the same population - the population of Iowa farmers. Thus, some additional insights to the relationship between the factors analyzed and the probability of FCI participation can be gained by looking at the comparison of the two sets of the estimated regression coefficients and the estimated FCI

probabilities. Such comparison may reveal the stability of the relationships between the explanatory variables and the use of FCI over time. However, it should not be expected that the two models will be exactly the same. The two models may reflect differences in the economic, legal, and social environment in which farmers operated, since the data were collected with the time lag of two years. Also, the differences in the models may reflect a shift in farmers' preferences for FCI as well as for other factors relevant to the FCI participation decision.

Nonetheless, the two models were compared in order to identify factors whose influence on FCI participation seemed to be important regardless of the time period during which the data were collected. For this purpose, the estimated regression coefficients are compared in Table 6.7.

The comparison of Model 1991 and Model 1993 shows that the results of the two models are very similar. The two models closely agree with each other with respect to the predicted direction of the effect of the explanatory variables on FCI. The only variable for which the regression coefficient sign differs in the two models is the ratio of acres rented to acres operated. However, the 1991 estimated regression parameter is not significantly different from zero. The magnitudes of the estimated slope coefficients of

Table 6.7 The comparison of the estimated regression parameters for Models 1 and 2

Variable	Estimated regression coefficient	
	Model 1991	Model 1993
Intercept 1	0.4962	3.6461***
Intercept 2	1.1292*	4.7444***
Intercept 3	1.8810***	5.1240***
Intercept 4	2.4860***	5.8042***
RRENTOP	-0.0537	0.8732**
FMHADEBT	-2.58E-6	-4.55E-6
HAILINS	-0.1655**	-0.2050**
GOVTPROG	-0.3049***	-0.8201***
COMMOPT	-0.3139***	-0.2640
MARGIN	-0.3201	-0.4547**
LIQAS	2.628E-6**	5.333E-7
BURDENR	0.0295	0.0605
NETWRTH	9.451E-7*	7.775E-7
DER	-0.0171	-0.0768*
GROSS	-0.3146	-1.7755***
CRD3	1.1767***	2.1016***
CRD9	-0.9623*	-1.4794**

*** a variable significant at 1% level
** " " 5% level
* " " 10% level

Model 1991 also correspond to those of the Model 1993 estimates. As is illustrated later in this chapter, the estimated coefficients of the two models result in approximately same percentage changes in the respective FCI probabilities. However, the intercept terms of the two models are considerably different. The estimated intercept terms for the 1993 model are higher than those of the 1991 model. This may be a consequence of the lower means of the explanatory variables in 1993 compared to 1991.

Another way of comparing the two regression models is to look at the estimated FCI probabilities for the five response

levels of the variable CROPINS that measures the intensity of the use of FCI (Table 6.8). As Table 6.8 suggests, Model 1993 predicts lower probabilities for the response levels 3 and 5, and higher probabilities for the levels 1, 2, and 4 than does Model 1991. In other words, it seems that the representative respondent in 1993 was less likely to participate in FCI

Table 6.8 The comparison of the estimated probabilities for Models 1 and 2

CROPINS level	The estimated probability	
	Model 1991	Model 1993
1 - Never	0.201485	0.253098
2 - Seldom	0.120636	0.246870
3 - Half of time	0.179819	0.097696
4 - Most of time	0.146630	0.148061
5 - Always	0.351430	0.254275

compared to the average 1991 respondent. This result corresponds to the fact that 1993 respondents used FCI less, on average, than 1991 respondents. The differences in the estimated FCI probabilities result not only from the differences in the estimated regression coefficients, but also from the differences in the means of the explanatory variables for the two models. Compared to 1991, an average 1993 respondent had lower FmHA debt, used risk management strategies less often, experienced considerably lower profitability and higher liquidity, and also had lower

relative debt level. According to the original hypothesis, such differences suggest less intense use of FCI in 1993 compared to 1991. Thus, the lower predicted probability of the FCI use in 1993 appears to be consistent with the hypothesis. However, there is also some evidence contradicting the expectations in that the average 1993 farmer experienced lower solvency and had lower value of farm equity than the average farm in 1991. This would suggest higher need for FCI in 1993. It appears, however, that the impact of lower solvency and lower net worth on the FCI probabilities was outweighed by the influence of the other factors just described.

Discussion

This analysis attempted to answer the question which factors, beyond insurance premiums and the availability of government disaster payments, influence farmers' decision to participate in the FCIP. In order to do that, the relationship between the intensity of the use of FCI and several socio-economic factors was analyzed. The variables hypothesized to be relevant to the FCI participation decision were grouped into the five categories. The first was the group of farmers' demographic characteristics, such as age, education, and experience. The second set of variables represented farm size and enterprise mix. Next, the group of

variables reflecting farmers risk management practices included six business risk transfer tools dealing with both yield and price risk. The fourth category of the variables illustrated financial structure and conditions of farm operations. Finally, the set of dummy variables indicated farm location within the State of Iowa. The results for each of the five groups of variables are discussed individually.

Demographic characteristics

In the initial models, the following demographic characteristics were considered: the age of a farm operator, the education of both husband and wife, and finally operator's experience in farming. All four demographic variables were insignificant in both models. Hence, the analysis leads to the conclusion that farmer's age, education, and experience do not seem to exert significant influence on farmers' decisions regarding FCI. However, it is possible that these factors influence the FCI participation decision indirectly, through the influence of other variables. For instance, younger farmers tend to rent more land, have higher financial leverage and lower equity values than older farm operators. Also, differences in education can be reflected in farmers' risk awareness and knowledge of risk management strategies.

Farm characteristics

The following farm characteristics were included in the original models: total acres operated, gross farm income, the ratio of crop sales to total sales, and the ratio of acres rented to acres operated. The results of the two regression models suggest that farm size and the proportion of crop sales in total farm sales seem to have an insignificant impact on the probability that FCI is used.

The last of the farm characteristics, however, seems to influence FCI purchases. The 1991 results imply that farmers who rent relatively more land are more likely to participate in the FCIP, although not significantly so. This result confirms the hypothesis. Farmers who operate relatively more rented land face higher risk due to their obligation to make payments to their landlords. Therefore, they may be more interested in controlling yield risk by using crop insurance.

The results of the 1993 model, however, do not support the hypothesis. The 1993 results suggest that farmers with relatively less rented land are more likely to buy FCI. A possible explanation for this contradiction is that the variable representing acres rented relative to acres operated includes the influence of one or more variables not included in the model. One of the variables possibly missing from the model is the use of crop share leases. The data show that crop share leases become more important as the relative

amount of rented land rises (Table 6.9). Since crop share rental arrangements also entail risk sharing between a farmer and a landlord, farmers who rent relatively more land, that is, those who use crop share rental agreements more often, may need FCI less.

Farmers' risk management practices

Altogether, the influence of six risk management strategies on the use of FCI was considered. The analysis showed three of them to play a significant role in FCI decisions. The predicted probability of the use of FCI was higher for those farmers who used hail insurance, government programs, and also commodity options (the 1991 model only) more often. Thus, the three business risk tools seem to be complements, rather than substitutes, to FCI. These results agree with the expectations about the relationship between FCI and the three business risk management strategies.

One reason why business risk management strategies may be complements is that their use may be a reflection of farmers' attitudes toward risk in general. Those farm operators who dislike business risk may choose to use more than one strategy and use risk management tools more often in order to reduce business risk exposure of their farms. On the other hand, farmers less concerned with business risk may choose to use risk management tools less often.

Table 6.9 The use of crop share leases by the relative amount of land rented by sample Iowa farmers in 1993

Proportion of land rented	Number of obs.	Use of crop share leases					
		Relative frequencies					Mean Scores
		Never	Seldom	Half of time	Most of time	Always	
< 0.34	118	61.0	10.2	4.2	11.0	13.6	1.59
0.34-1.00	332	36.4	13.9	11.8	10.2	27.7	2.79
1.00-1.50	68	44.0	7.5	5.9	8.8	33.8	4.50

Source: Iowa Farm Finance Survey, 1993

Another reason why individual business risk strategies can be complements, rather than substitutes, is the fact that they protect those who use them against different types of business risk. For instance, government programs and commodity options protect farmers primarily against unfavorable price developments. On the other hand, Federal Crop Insurance and private crop-hail insurance deal with yield risk. In addition, the difference multiple peril and hail insurance is in that they protect farmers against different kinds of yield risk. FCI is very useful in situations of a substantial crop failure due to flood, drought, crop diseases, and other perils. However, such situations usually do not happen every year. On the other hand, crop-hail insurance is more important in case of crop damage due to hail storms that are usually rather isolated and occur virtually every year. Since government programs, commodity options, hail insurance, and FCI target different types of business risk, they may well be perceived as complements by risk averse farmers.

In order to evaluate the magnitude of the impact of the use of government programs, hail insurance, and commodity options on the probability of FCI purchases, the marginal effects presented in Tables 6.2 and 6.5 were analyzed in more details. As discussed earlier, the marginal effects of explanatory variables represent changes in the FCI

probabilities, that is, in the probability that FCI is used Never, Seldom, Half of time, Most of time, or Always, resulting from unit changes in the explanatory variables.

An increase in an explanatory variable with a negative regression coefficient reduces the probability that FCI is never used. At the same time, an equal increase in the value of that variable increases the probability that FCI is always used. This is always true regardless of the signs of the other estimated regression coefficients and regardless of the means of the explanatory variables included in the model.

On the other hand, the probabilities of the three middle response levels, FCI used Seldom, Half of time, and Most of time, can change in either direction, as the marginal effect definition of Chapter 4 suggests. Therefore, the best way to illustrate the changes in the FCI probabilities resulting from the changes in the explanatory variables is to look at the changes in the probabilities of the two extreme response levels of the variable CROPINS: Never and Always.

This approach is used to illustrate how the probabilities that FCI is never used and FCI is always used depend on different levels of the use of the three risk management strategies, hail insurance, government programs, and commodity options.

Figure 6.1 depicts the changes in the predicted FCI probabilities associated with the changes of the variable

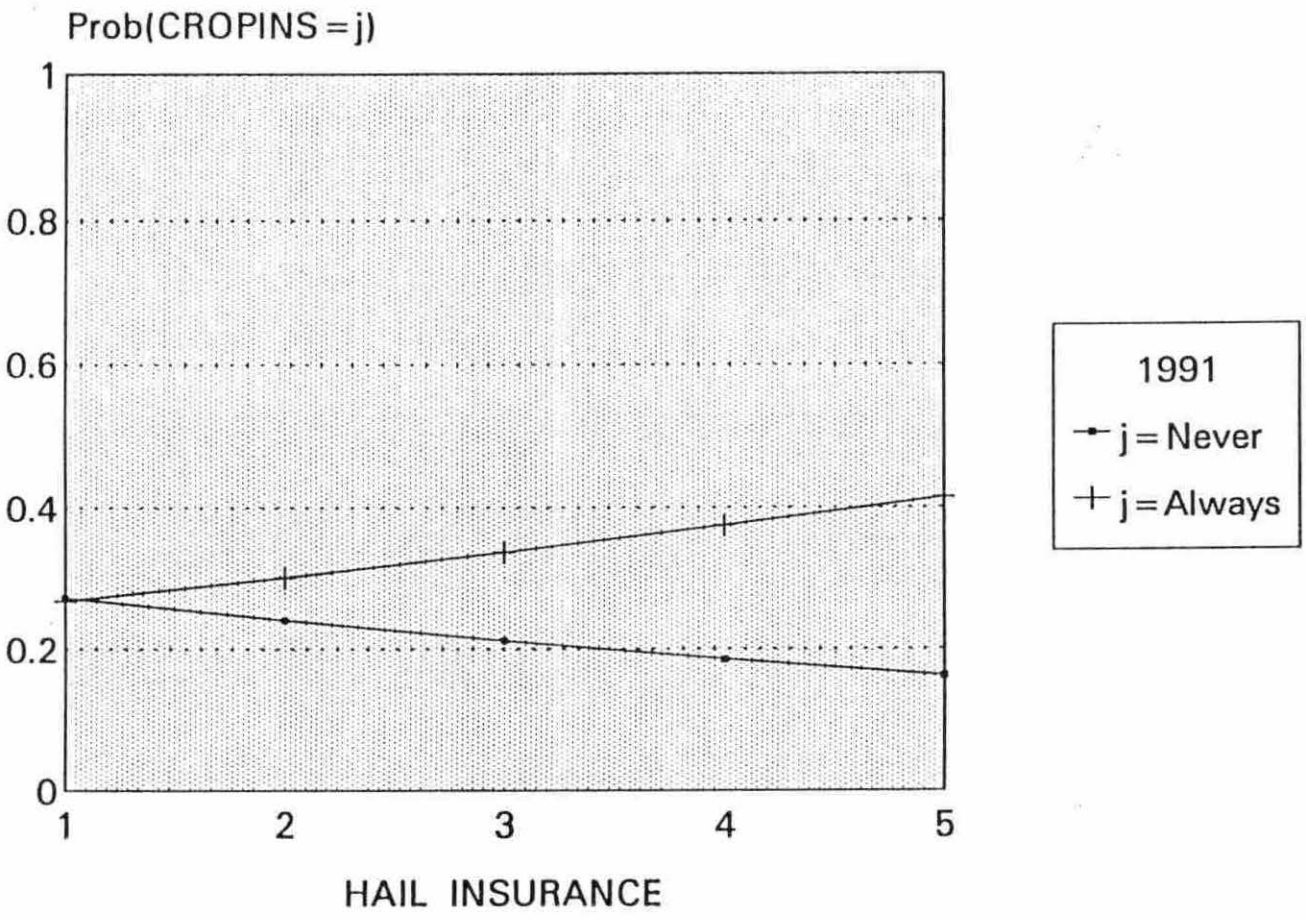

Figure 6.1 The predicted FCI probabilities as a function of farmers' use of hail insurance

a. 1991

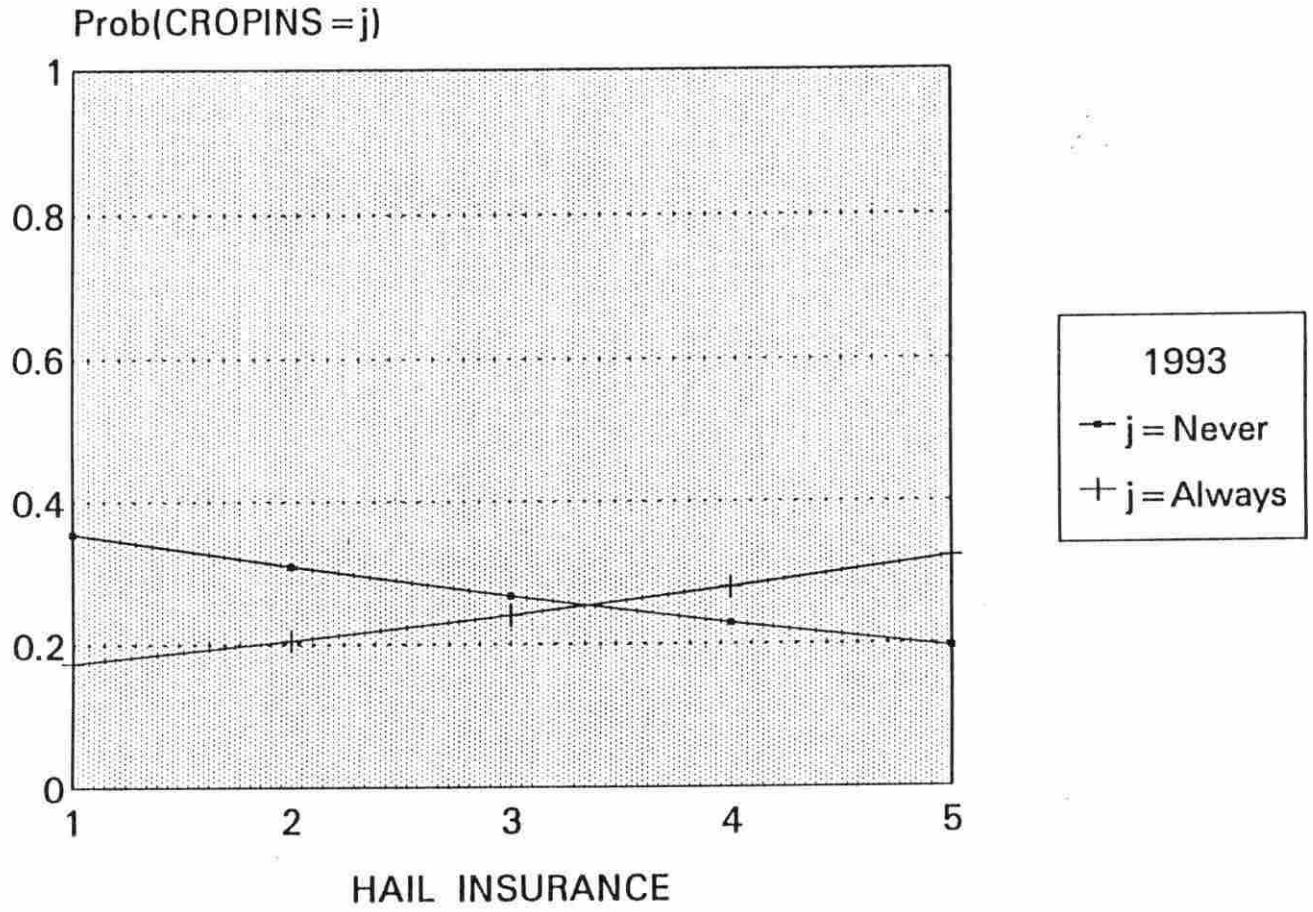

Figure 6.1 (continued)
b. 1993

HAILINS. As the value of HAILINS increases, in other words, as farmers use crop-hail insurance more often, the probability that FCI is never used decreases. At the same time, the probability that FCI is always used increases. Therefore, more frequent use of hail insurance increases the likelihood of FCI participation.

Similarly, the results of both 1991 and 1993 models suggest that farmer's participation in government programs increases the chances that the farmer will also participate in the FCIP (Figure 6.2).

Finally, for the 1991 model, farmers who use commodity options more often seem to buy FCI more often (Figure 6.3). In other words, hail insurance, government programs, and commodity options appear to be complements to FCI.

As mentioned earlier, three other risk management tools were initially included in the analysis, but they did not show a significant influence on the FCI probabilities. Among such variables were forward contracting and hedging. Since these two forward pricing tools do not seem to have significant impact on the use of FCI, it may be a little surprising that another forward pricing tool, commodity options, was found to have a substantial impact on the FCI probabilities in Model 1991. It is possible, however, that the variable representing the use of commodity options reflected not only the impact of the use of this marketing

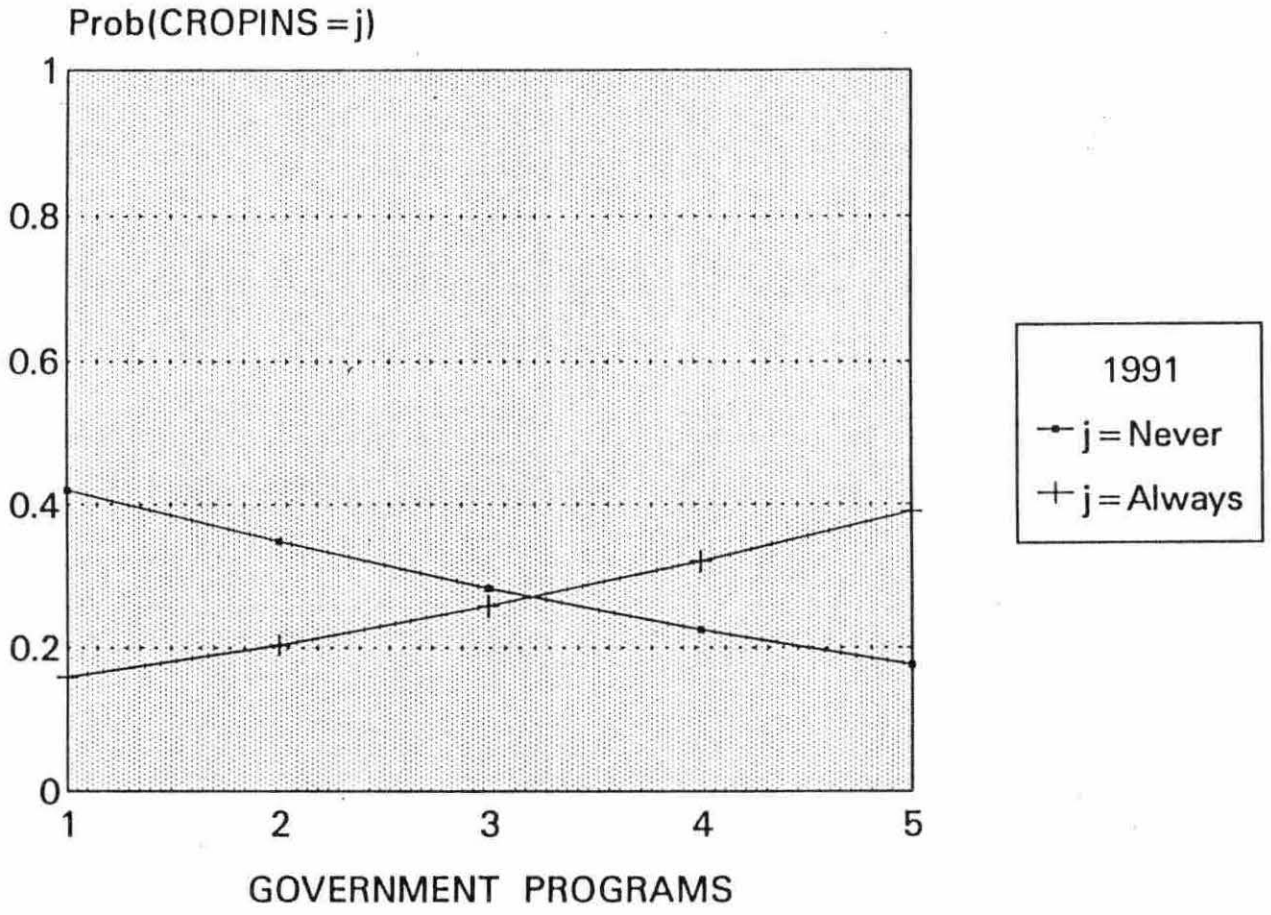

Figure 6.2 The predicted FCI probabilities as a function of farmers' participation in government programs
a. 1991

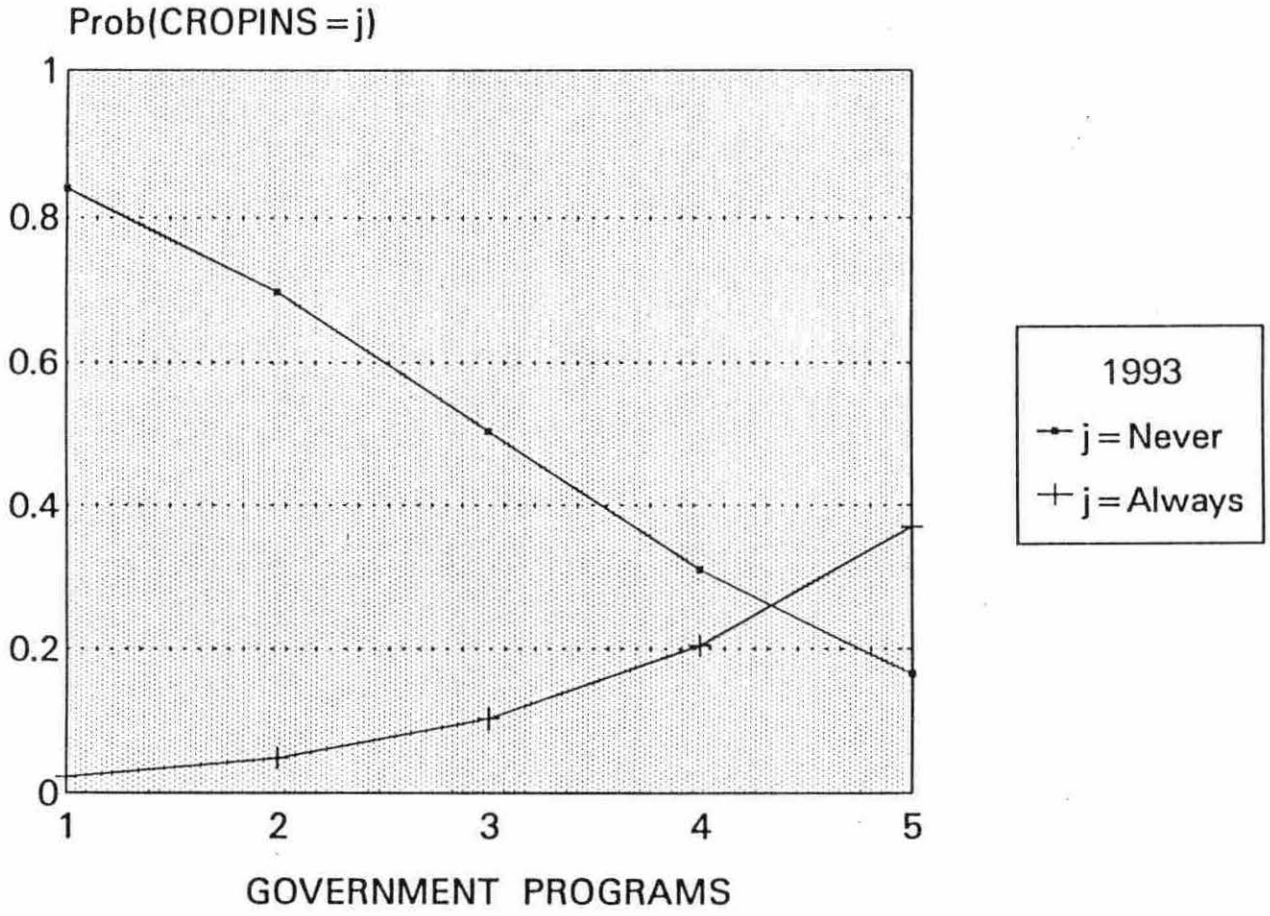

Figure 6.2 (continued)
b. 1993

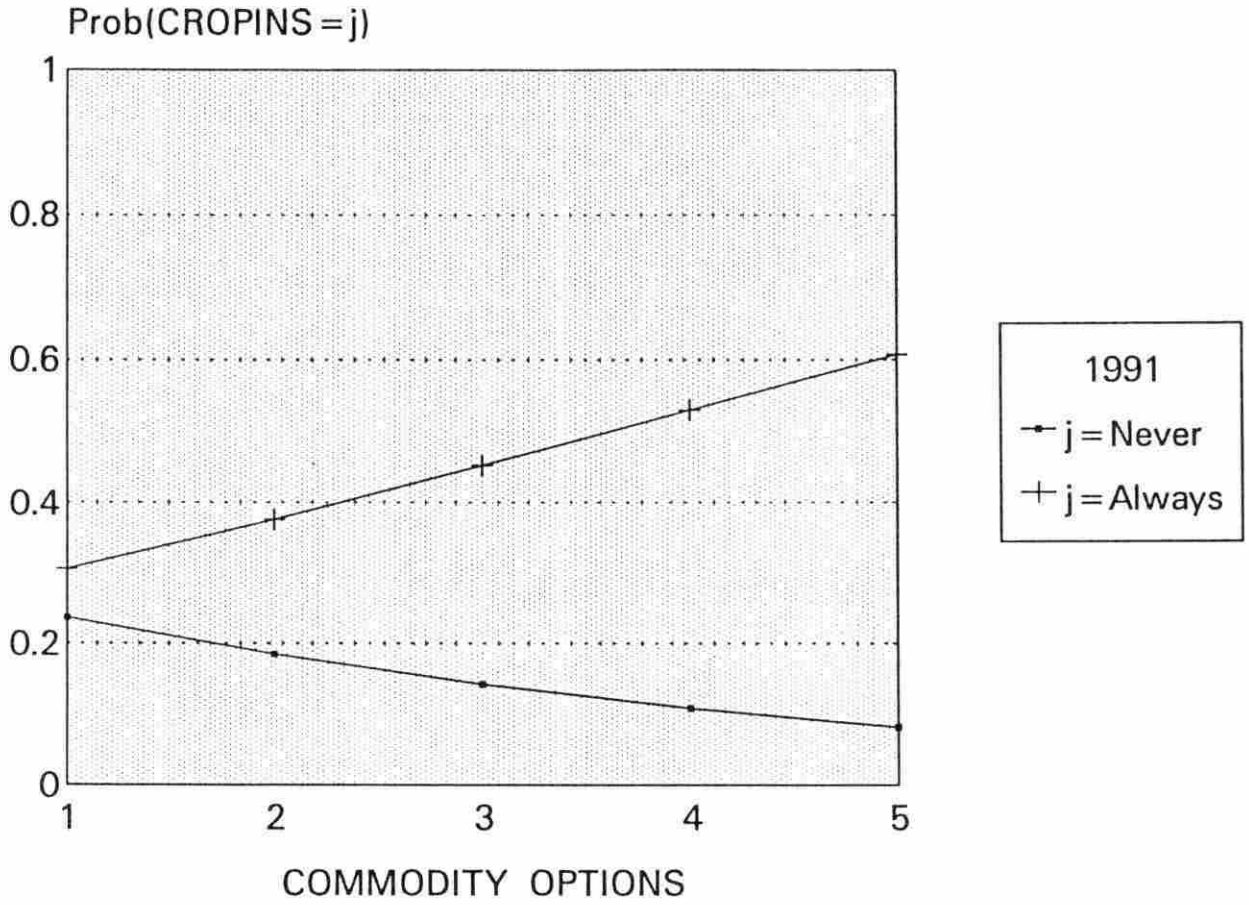

Figure 6.3 The predicted 1991 FCI probabilities as a function of farmers' use of commodity options

tool, but also an impact of some other variable, such as farm size. For the 1991 data set, larger farm operations used commodity options approximately 38 % more often than smaller farms (Table 6.10). Hence, the evidence from the data supports the above reasoning about the impact of the use of commodity options on FCI.

Still another risk management strategy initially included in the regression models was the use of crop share rental arrangements. This variable did not seem to exert a significant influence on the FCI probabilities. Nonetheless, its influence might have been revealed indirectly through another variable, such as the relative amount of land rented discussed earlier in this chapter.

In summary, the results indicate that the use of hail insurance, commodity options, and government programs had a positive impact on the use of FCI. That means, these three business risk management tools seem to be complements, rather than substitutes, to FCI. On the other hand, forward contracting and hedging do not seem to have a considerable influence on the probabilities of FCI participation. Also, the use of crop share leases does not seem to play a significant role in FCI decisions, at least not directly.

Table 6.10 The use of commodity options by farm size by sample Iowa farmers in 1991

Gross sales ($)	Number of obs.	Use of commodity options					
		Relative frequency					Mean scores
		Never	Seldom	Half of time	Most of time	Always	
≤ 250,000	561	77.5	8.9	10.5	2.5	0.5	1.40
> 250,000	75	54.7	13.3	18.7	10.7	2.7	1.93

Source: Iowa Farm Finance Survey, 1991

Financial characteristics

A total of nine measures of financial structure and performance of farm operations were considered in the analysis. Due to their low explanatory power, the proportion of off-farm income in total income and the asset turnover ratio were not included in the final models. Also, the amount of debt with Farmers Home Administration and farm solvency, measured by the debt burden ratio, did not seem to play a significant role in farmers' decision to buy FCI. The remaining five variables measuring financial condition of farms seem to have a significant impact on the probability of FCI participation.

According to the results of Model 1991, farm net worth reduces the FCI probabilities. In other words, farmers with higher net worth seem to use FCI less frequently than farmers with lower equity values. This result supported the original hypothesis. Farm equity serves as a cushion against unfavorable circumstances. Had a farmer experienced substantial crop shortfall threatening his ability to meet all financial obligations, equity could be used as a collateral for existing or additional loans. In other words, the greater the net worth, the larger the credit reserve. Consequently, the farmer has a better chance to withstand difficulties resulting from crop failure. Thus, the same likelihood of crop loss represents higher risk to farmers

with lower equity values, even if their relative financial leverage was the same as that of farmers with high net worth. According to the risk balancing concept discussed in Chapter 2, farmers with higher financial risk will tend to control their business risk exposure. Hence, they are expected to use FCI more often. The results seem to support this business - financial risk trade-off.

The magnitude of the impact of changes in equity values on the predicted 1991 FCI probabilities are depicted in Figure 6.4. The marginal effects of changes in farm equity values, presented earlier in this chapter, on the FCI probabilities are very small, generally of the order 10^{-7}. Clearly, a one dollar change in net worth can hardly be expected to have a profound impact on farmers decisions in general, and on FCI decisions in particular. However, a ten thousand dollar change in equity may be enough to effect the FCI decisions. In fact, as the calculated marginal effects of the two models imply, each ten thousand dollar change in equity changes the FCI probabilities by approximately 0.7%. Accordingly, a one hundred thousand dollar change in equity values would be required to change the FCI probabilities in a more observable way (Figure 6.4). In particular, each hundred thousand dollar change in net worth would increase the probability that FCI is never used by approximately 7%. On

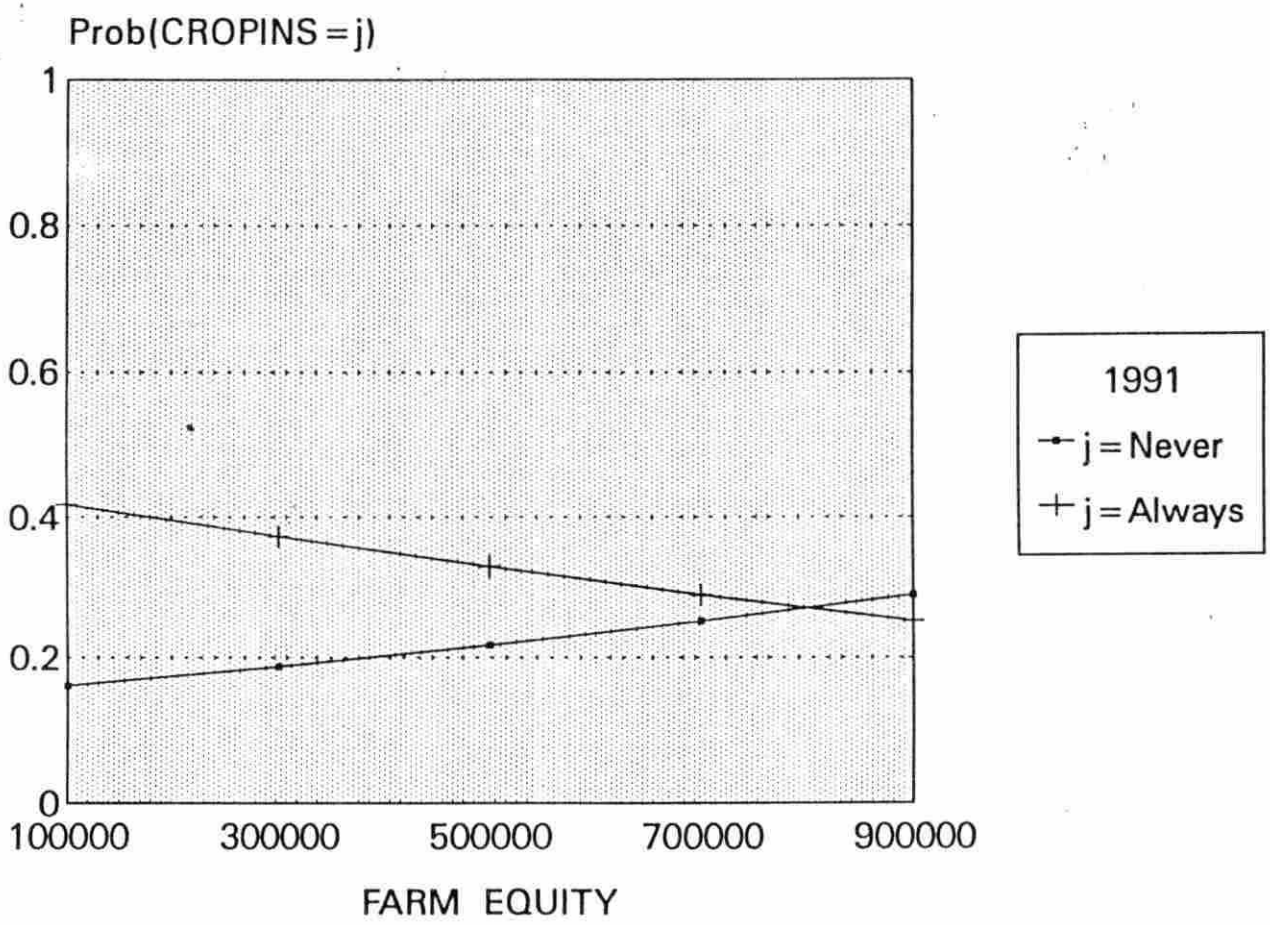

Figure 6.4 The predicted 1991 FCI probabilities as a function of farm equity values

the other hand, the same change in net worth would reduce the probability that FCI is always used by 5%. The results are consistent with the expectations that farmers with higher equity values use FCI less.

The statistical significance of the variable measuring farm liquidity also supports the hypothesis about the trade-off between business and financial risk. The results of Model 1991 indicate that farmers enjoying better liquidity are less likely to buy FCI. Liquid assets (money in bank accounts, CDs, mutual funds, and crops and livestock ready for sale) constitute the financial reserves of a farm. In case of crop failure, suchreserves can be rapidly liquidated to meet farmers' financial obligations resulting from farming as well as to pay for family living expenses. Consequently, farmers with a higher value of liquid assets are better prepared to withstand difficulties resulting from lost crop and, thus, lost income. Higher liquidity, then, allows lower FCI coverage. Figure 6.5 illustrates the effects of changes in farm liquidity on the FCI probabilities. For instance, a twenty thousand dollar change in liquid asset values results in approximately a 4% change in the FCI probabilities. In other words, increased farm liquidity reduces the probability that FCI is always used and increases the probability that it is not used at all. Therefore, farmers with higher liquidity seem to be less inclined to buy FCI.

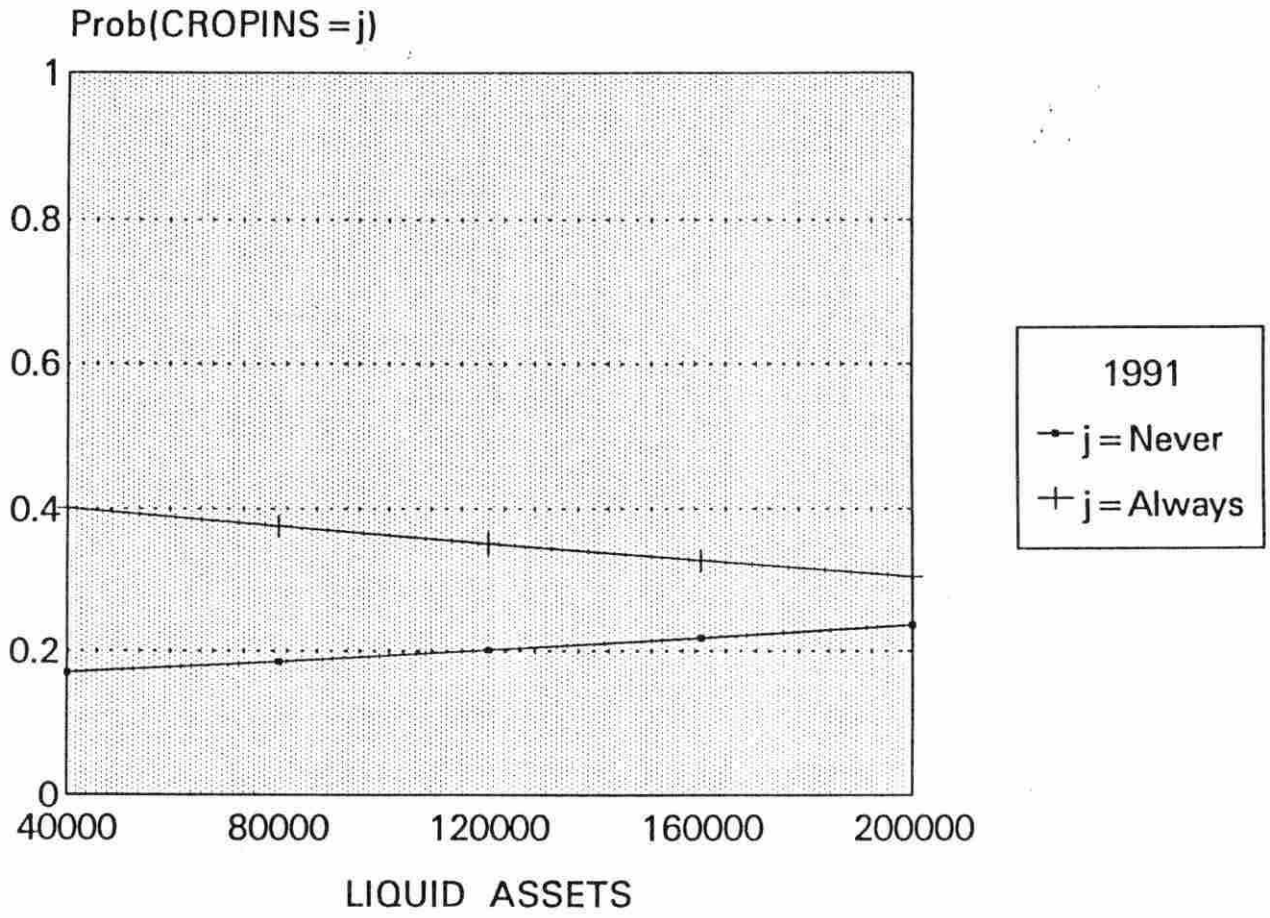

Figure 6.5 The predicted 1991 FCI probabilities as a function of farm liquidity

Model 1993 also offers some evidence supporting the trade-off between business and financial risk. The results indicate that risk bearing capacity of a farm is also an important factor influencing the FCI participation decision. Farms with higher total risk tolerance are less likely to buy FCI. Higher risk bearing capacity results from lower financial leverage and higher farm efficiency and reduces the negative impact of crop shortfall and resulting income losses on a farm business. Less debt financing and higher efficiency may, therefore, reduce the need to control farm risk exposure itself. In other words, lower financial leverage and higher farm efficiency may result in less intense use of crop insurance.

The impact of changes in farm financial leverage is illustrated in Figure 6.6. Consider an example of a farmer who takes out a new loan which results in an increase in the farm debt-to-equity ratio from, say, 0.20 to 0.40. According to the results of Model 1993, the probability that the farmer will always buy FCI for his crops rises only by 0.01%. Hence, the impact of farm financial leverage on the FCI probabilities is quite small.

As to the impact of farm efficiency on the FCI probabilities, the analysis does not provide conclusive results. The farm gross ratio, the ratio of operating expenses to gross farm sales, suggests that less efficient

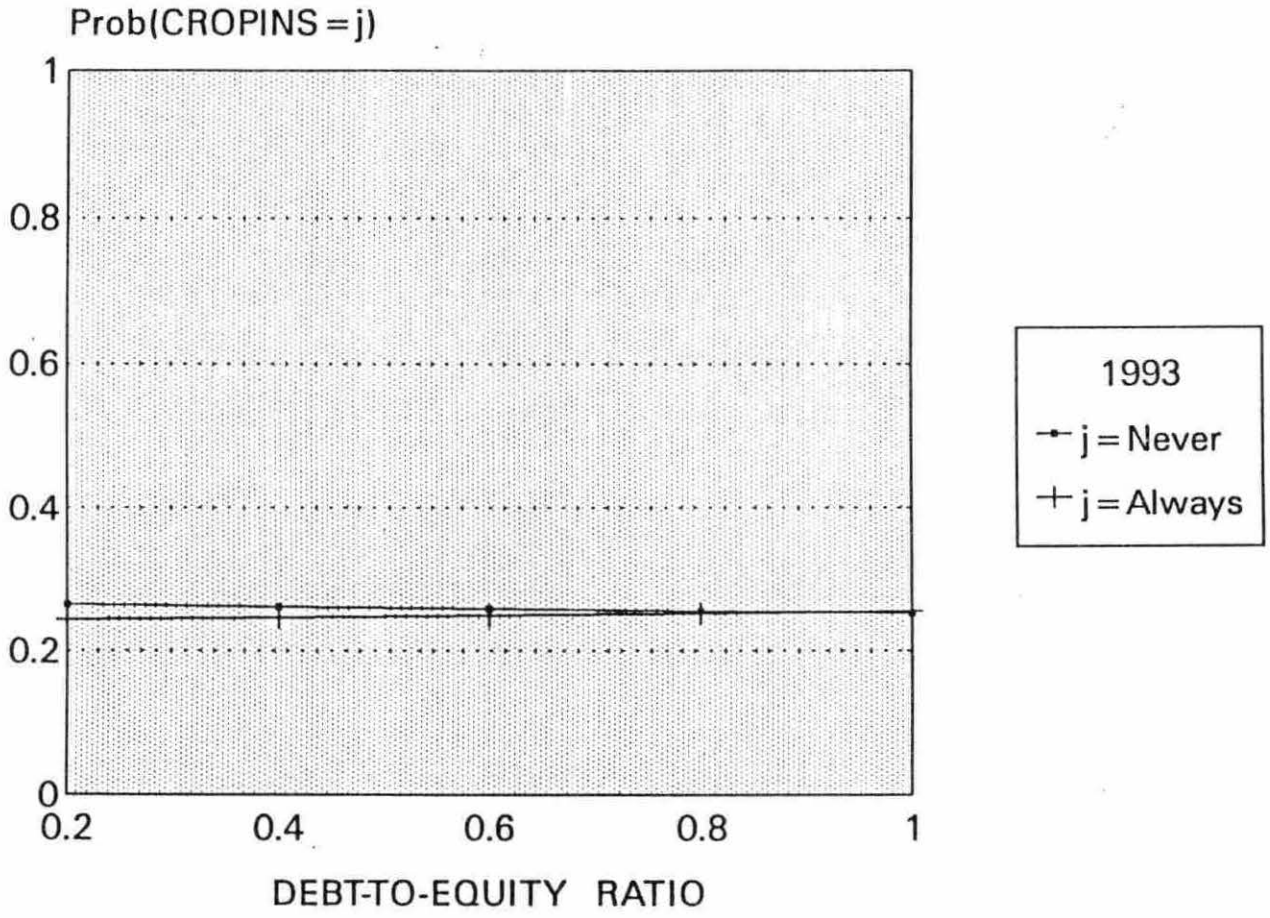

Figure 6.6 The predicted 1993 FCI probabilities as a function of farm financial leverage

farms tend to use FCI more often. This is illustrated in Figure 6.7. For instance, if, say, a 10% increase in operating expenses does not result in higher farm sales, in other words, if it results in 10% lower farm efficiency, the probability that a farmer will always buy FCI rises by approximately 12%.

To the contrary, farm profit margin, the ratio of net income to farm gross sales, indicates more intense use of FCI by more capital efficient farm operations. Figure 6.8 depicts the changes in the predicted FCI probabilities resulting from changes in farm efficiency measured by the profit margin ratio. For farms with the higher profit margin ratio, the more efficient farms, the probability that FCI is never used is lower and the probability that FCI is always used is higher. In other words, higher farm efficiency seems to increase the likelihood of FCI participation, although this effect is only moderate.

In summary, the analysis showed that lower values of farm equity are likely to encourage FCI participation. Also, farm financial performance, and, consequently, farm risk bearing capacity seem to play an important role in FCI decisions. In particular, farmers experiencing lower liquidity and higher relative debt levels are more likely to use FCI as a way of controlling their business risk exposure.

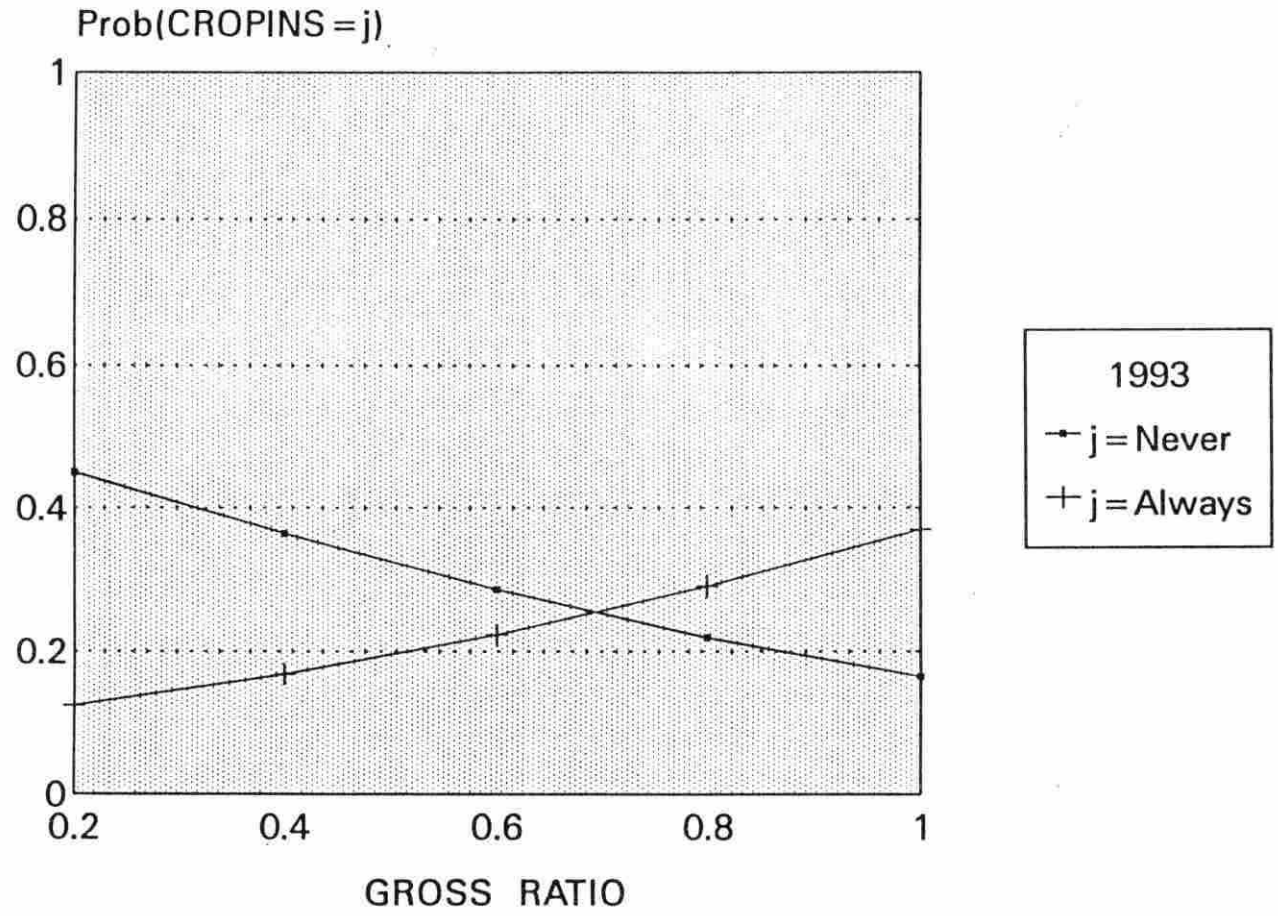

Figure 6.7 The predicted 1993 FCI probabilities as a function of farm efficiency

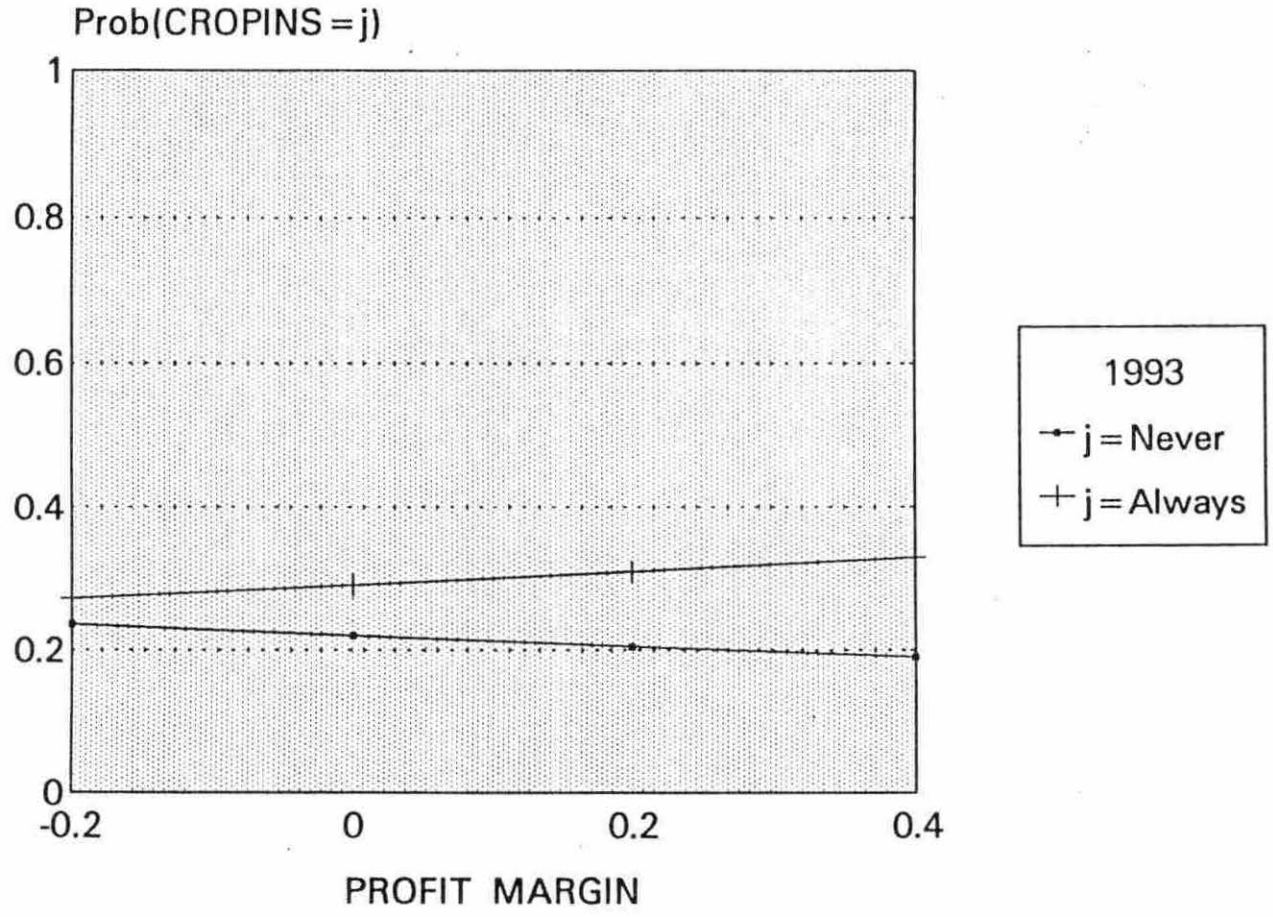

Figure 6.8 The predicted 1993 FCI probabilities as a function of farm profitability

However, the results are inconclusive as to the impact of farm efficiency on the use of FCI.

The location of a farm operation

The last set of the explanatory variables reflected farm location. Out of eight crop reporting district dummy variables (CRD), only two were significant: a dummy for the location of a farm in the third crop reporting district (north-east) and the dummy for the ninth crop reporting district (south-east).

However, the impact on FCI is not the same for the two regions. The results of both models suggest that farmers whose farming operations are in North-Eastern Iowa are less likely to participate in the FCIP. To the contrary, farmers operating in South-Eastern Iowa seem to buy FCI more often.

The location dummy variables may reflect a number of factors such as differences in soil types and conditions, weather patterns, enterprise mix, and ethnic group. Still other factors possibly picked up by the location dummies are farmers' risk aversion or past FCI experience. Of course, many other attributes of individual production areas that increase the risk of crop shortfall may also be captured by the crop reporting district dummy variables.

Consider first North-Eastern part of Iowa. Farms in that area tend to be smaller compared to Iowa average farm

size. In addition, they are heavily specialized in dairy production. Hence, the result that farmers in North-Eastern Iowa tend to use FCI less often seems to match these facts. On the other hand, South-Eastern Iowa is a part of the southern pasture area. Also, many farmers argue that Southern Iowa experiences droughts more often than other parts of the State (Khojasteh, 1992). In fact, past FCI experience shows that this may well be true. The average FCIP loss ratios during the 80's for both corn and soybeans exceeded one for the southern and south-eastern parts of Iowa (Glauber, 1993). On the other hand, as shown in Table 1.2, average FCIP loss ratios for the rest of the Iowa were below one during the same time period. A loss ratio higher than one indicates that the premiums paid were lower than the indemnities received for a given time period. This suggests that buying FCI is, on average, a profitable option for farmers in south-eastern parts of Iowa.

Figure 6.9 compares the differences in the FCI probabilities (for all five intensity levels of FCI use, in this case) predicted by Model 1991 for a farm located in North-Eastern Iowa and for a farm located elsewhere. Figure 6.10 shows the same comparison for Model 1993.

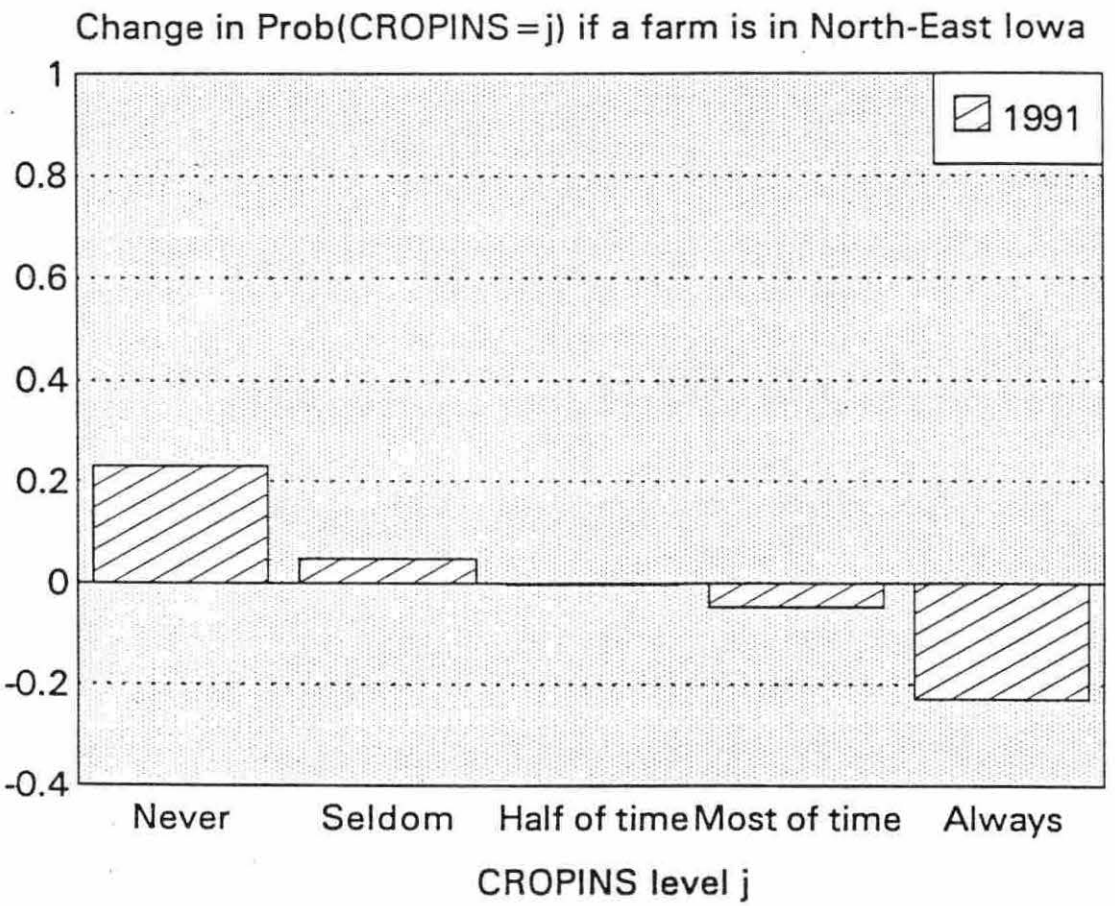

Figure 6.9 The difference in the predicted 1991 FCI probabilities for a farm located in North-Eastern Iowa and a farm located elsewhere

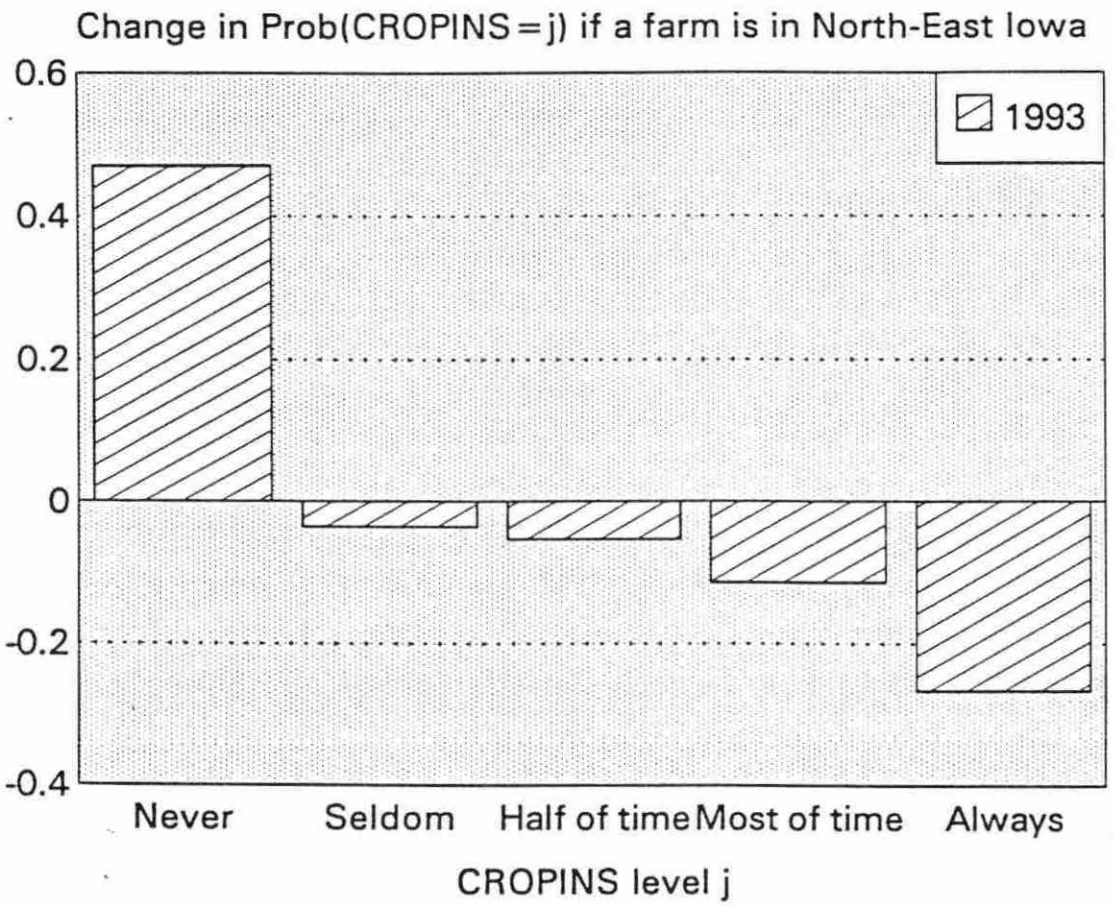

Figure 6.10 The difference in the predicted 1993 FCI probabilities for a farm located in North-Eastern Iowa and a farm located elsewhere

Similarly, Figures 6.11 and 6.12 depict the differences in the predicted FCI probabilities for South-Eastern Iowa.

In summary, the results indicate that farm location is an important factor influencing the intensity of the use of FCI. Farmers producing in North-Eastern Iowa are less likely to buy FCI, whereas the opposite is true for farmers in South-Eastern Iowa.

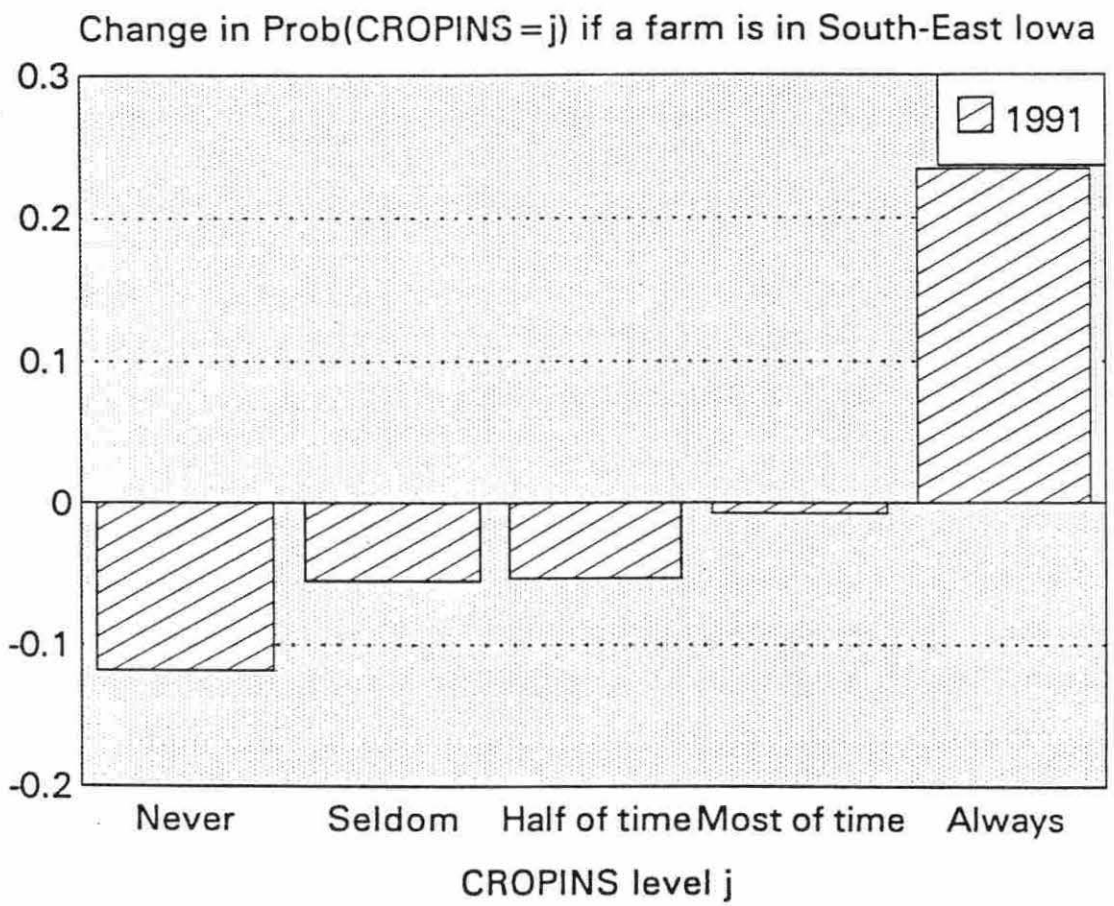

Figure 6.11 The difference in the predicted 1991 FCI probabilities for a farm located in South-Eastern Iowa and a farm located elsewhere

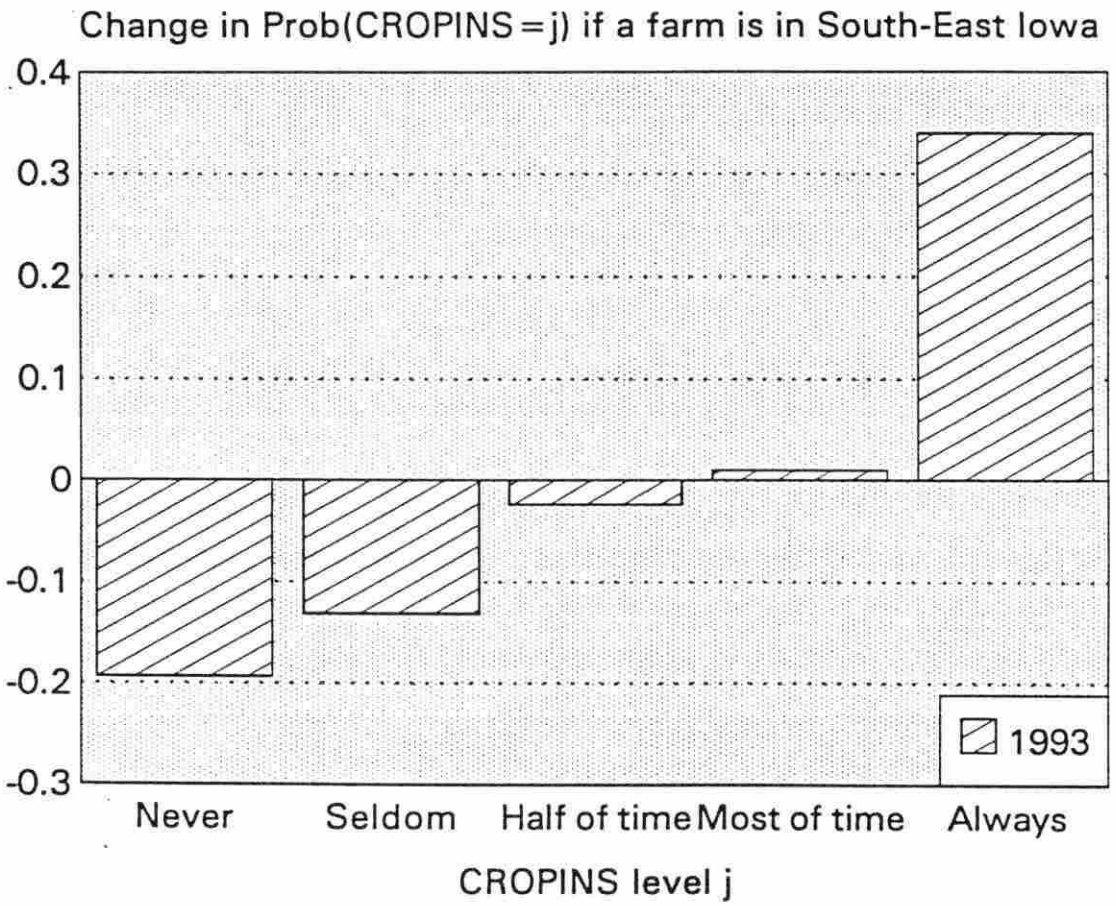

Figure 6.12 The difference in the predicted 1993 FCI probabilities for a farm located in South-Eastern Iowa and a farm located elsewhere

7. SUMMARY AND CONCLUSIONS

Original Hypothesis

The Federal Crop Insurance Program (FCIP) provides subsidized multiple peril crop insurance for farmers in all counties with significant agricultural production. Federal Crop Insurance (FCI) participation remains low despite several design changes adopted in 1980 and thereafter. Actuarially unfair FCI premiums and the availability of government disaster payments are commonly blamed for causing low FCI participation. However, participation in the program is low even in areas where FCI premiums seem to be actuarially fair. This suggests that forces other than FCI premiums influence farmers' decision to participate in FCI. Based on the conceptual model presented in Chapter 2 and on previous studies reviewed in Chapter 3, five groups of factors that might influence the use of FCI in addition to the FCI premiums and disaster programs were identified.

First, demographic characteristics may have a direct or indirect impact on farmers' decisions to buy FCI. Younger farmers, with less experience and higher education were expected to be more likely to use FCI than older farmers with lower education. Younger farmers tend to operate larger farms, rent more land, and have relatively more debt and less equity. Also, farmers with higher education may have better

knowledge and understanding of risk issues and the use of risk transfer tools.

A second group of factors hypothesized to be relevant to the FCI decision were farm characteristics. Larger, less diversified farms and farms with relatively more rented land were expected to use FCI more often because of their higher risk exposure.

The use of business risk management tools was the next group of factors with a possible influence on the FCI participation decision. Six management strategies were considered: crop-hail insurance, participation in government programs, forward contracting, hedging, commodity options, and crop share leases. The business risk management strategies were hypothesized to be complements to the use of FCI since they help manage different types of business risk than does FCI. Also, the use of the business risk tools may reflect farmers' overall attitude toward business risk.

Risk balancing concept suggests that the farm financial structure should influence the FCI participation decision. Lower financial leverage, higher credit reserves, and better financial performance of a farm operation indicates a lower level of financial risk and higher risk bearing capacity of the farm. According to the risk balancing concept, a lower level of financial risk and higher total risk tolerance of a

farm should allow more business risk exposure, and, thus, may be substituted for FCI.

Finally, due to differences in soil and weather conditions, as well as enterprise mix across the State of Iowa, farm location may also influence farmers' decision to buy FCI.

Findings

Both logistic regression models, differing only in the sample analyzed, were statistically significant at 1% level allowing the rejection of the joint hypothesis that variables included in the models did not help significantly in explaining the use of FCI. The prediction rate, the proportion of the responses predicted correctly, was 70% for Model 1991 and 78% for Model 1993. The low values of the pseudo-R^2 ratio (0.09 for Model 1991 and 0.17 for Model 1993) can be attributed to the cross-sectional type of the data analyzed. In addition, the impact of the FCI premiums, the availability of disaster payments, and possibly other factors relevant to the FCI participation decision were not considered which may also be reflected in the low R^2 values.

Most of the results support the original hypothesis about the relationship between the use of FCI and the explanatory variables. The use of three business risk management tools, hail insurance, government programs, and

commodity options, appears to have a significant impact on the use of FCI. The results lead to the conclusion that hail insurance, government programs, and commodity options appear to be perceived by farmers as complements to FCI.

Also, the analysis seems to support the concept of the trade-off between business and financial risk. The results imply that farmers who face relatively lower financial risk, in other words, farmers with relatively lower debt levels and higher credit reserve seem to be less likely to buy Federal Crop Insurance. However, the results are inconclusive as to the farm efficiency and its influence on the use of FCI.

Finally, the location of a farm operation seems to play a significant role in farmers' FCI participation decision. Farmers operating in areas with higher exposure to risk appear to be more likely to buy FCI. On the other hand, farmers in areas more specialized on dairy production seem to participate in the FCIP less often.

The analysis does not show evidence that a farmer's age, experience, or education have a significant impact on the use of FCI. However, these factors might have effected FCI decisions indirectly through debt and equity levels, the relative amount of land rented, or the use of risk management tools. Also, the hypothesis that larger and less diversified farms would purchase FCI more frequently was not confirmed. Finally, the use of crop share leases, forward contracting,

and hedging, as well as holding debt from the Farmers Home Administration do not appear to be relevant to the FCI participation decision.

Conclusions and Need for Further Research

This study attempted to show that factors beyond the FCI premiums and the availability of government disaster payments influence farmers' decision to participate in the Federal Crop Insurance Program. The uniqueness of the data analyzed in this study is in that they accommodated more detailed examination of the impact of farm financial performance and the use of business risk tools on the use of FCI. The results of the analysis support the hypothesis about the presence of influences other than the FCI premiums and disaster payments in farmers' decisions to participate in FCI.

First, it appears that farmers' use of the business risk management tools, such as hail insurance, government programs, and commodity options, has a positive impact on the use of FCI. Farmers who use hail insurance, government programs, and commodity options more often are more likely to participate in FCI as well. In other words, farmers seem to perceive various price and yield risk reducing instruments as complements to FCI and use them together with FCI in an integrated risk management strategy. This result may be a

reflection of farmers' attitude toward risk and their familiarity with the ways of managing agricultural risk. Consequently, educational programs targeting farmers' awareness of risk as well as their understanding of available risk management strategies may contribute to the understanding of the way Federal Crop Insurance protects farmers and possibly increase FCI participation.

Second, the analysis offers some evidence supporting the concept of the trade-off between business and financial risk outlined by Gabriel and Baker (1980) and Collins (1985). The notion of the risk trade-off, or risk balancing, implies that a lower level of financial risk allows a higher level of business risk, and vice versa. The lower level of financial risk results, in part, from lower relative debt levels. Another factor that reduces farm financial risk is the credit reserve in the form of either farm equity or liquid asset holdings. The results of this study demonstrate that all of these financial risk reducing factors, relative debt level, the value of net worth, and liquidity, appear to be relevant to farmers' decision to buy Federal Crop Insurance. In other words, lower relative farm indebtness and higher credit reserve seem to be substituted for FCI by Iowa farmers. The results, thus, imply that buying FCI may not be considered an attractive alternative for financially strong farms. The low participation in the FCIP may, therefore, be a result of low

levels of financial risk for at least some farm operators. In other words, it appears that the goal of achieving higher FCI participation rates may not justified from the point of view of farmers. Consequently, an alternative FCI program that can be actaurially sound and profitable at a participation rate lower than 50 % (identified as a break-even point for the current FCIP design) should be considered. Obviously, an approach different than the one adopted in this study would be necessary to allow evaluation of alternative FCI designs.

In addition to business risk and financial decisions of a farm operator, the location of a farm operation seems to be another important factor influencing farmers' decision to buy Federal Crop Insurance. Farmers in areas with relatively higher risk exposure appear to be more interested in the FCIP. On the other hand, farmers in areas with lower yield risk seem to participate in FCI less frequently. The fact that the farm's location appears to be relevant to the decision to purchase FCI stresses the need for actuarially sound FCI premiums accurately reflecting relative risk exposure of individual farmers and different areas.

Despite these new insights into individual farmers' decisions to participate in Federal Crop Insurance, several issues remain to be examined. First, several explanatory variables used in the regression appear to indirectly reflect

the influence of farm size on the use of FCI. Models that would investigate the impact of the size of a farm operation on the FCI probabilities should, therefore, be considered.

Second, the results presented here do not lead to a straightforward conclusion about the impact of the relative amount of rented land on FCI participation. Subsequent studies may, therefore, focus on relating an increase in risk exposure resulting from land rental arrangements to farmers' decision to buy FCI.

Still another issue that deserves further consideration is the influence of forward pricing instruments, such as forward contracting and hedging with futures markets, and the impact of farm efficiency on farmers' decision to purchase FCI.

Also, individual farmers' risk exposure itself, expressed perhaps in terms of yield variability, and farmers' risk aversion may be examined in future studies of FCI use.

Finally, models using an objectively measured dependent variable, such as the proportion of expected output insured by FCI, or effective FCI coverage levels, rather than a scale variable, may offer further insights to farmers' decision to participate in Federal Crop Insurance.

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APPENDIX A: A SAMPLE 1991 FARM FINANCE SURVEY QUESTIONNAIRE

1991 Farm Finance Survey

1. In what county is most of your farming operation located?

2. What is your age?

3. How many dependents are you supporting (including yourself)?

4. How many of these dependents are under 18 years of age?

5. What is the highest level of school that you have attended (please circle one)?

a.	Husband	High School	College	Post Graduate
b.	Wife	High School	College	Post Graduate

6. How many years have you been farming?

7. During the 1990 crop year, how many acres did you

a.	own	_____
b.	rent from others	_____
c.	rent to others	_____

8. Approximately what percent of your 1990 gross farm sales came from each of these sources?

a.	crops	_____
b.	beef	_____
c.	pork	_____
d.	dairy	_____
e.	other farm enterprises	_____

9. Since January 1989, what changes have you made in your farming operation (estimate the percentage change in capacity)

		increase	decrease	no change
a.	land base	_____	_____	_____
b.	livestock facilities	_____	_____	_____
c.	machinery and equipment capacity	_____	_____	_____
d.	breeding herd	_____	_____	_____

10. Which of the following statements best describe your plans for your farm business for the indicated time period (check all that apply)

		1991-1995	1996-2000
a.	continue present operation as is	_____	_____
b.	expand land base	_____	_____
c.	expand breeding herd	_____	_____

d. expand machinery capacity _____ _____

e. rent land out and retire _____ _____

f. transfer farm operation to a family member and retire _____ _____

g. sell out and retire _____ _____

h. other _____ _____

11. Since January 1989, have you ever requested financing to expand your farm business?
yes _____
no (skip to 18) _____

12. Was your farm business expansion request approved?
yes _____
no (skip to 16) _____

13. Were you required to make changes in your request for expansion financing in order to receive financing?
yes _____
no (skip to 15) _____

14. Estimate the percentage change from your original financial request for farm business expansion that you were required to make.

	Increase (%)	Decrease (%)
a. the size of the expansion	_____	_____
b. down payment	_____	_____
c. term of the loan	_____	_____
d. interest rate	_____	_____
e. collateral	_____	_____

15. Estimate what percent of your expansion financing was obtained from the following lenders and indicate how long you have done business with each.

	Financing Provided (%)	Years
a. your own funds (equity) including trade-in value of machinery	_____	N/A
b. local bank	_____	_____
c. larger urban bank	_____	_____
d. Farm Credit System	_____	_____
e. FmHA	_____	_____
f. insurance company	_____	_____

g. merchant or dealer _____ ____
h. individual _____ ____
i. other _____ ____

100.0

16. If your loan for the expansion was <u>not</u> approved, check all the reasons that apply

a) income from expansion was too variable _____
b) insufficient documentation (budgets, cash flows) _____
c) previous loss experience _____
d) insufficient cash flow _____
e) insufficient collateral _____
f) current debt levels were too high _____
g) not a profitable expansion _____
h) lack of experience with this enterprise _____
i) loan was wrong purpose for this lender _____
j) other (please indicate) _____

17. Did you contact more than one lender about financing your expansion?

yes _____
no _____

18. Has inadequate financing limited the profitability or growth of your farm business?

yes _____
no (skip to 21) _____

19. If yes, rate the importance of the following impacts of this restriction on your farm business (1 = most important, 5 = least important)

a. modernization of facilities and equipment 1 2 3 4 5
b. full utilization of facilities or machinery 1 2 3 4 5
c. ability to fully employ existing labor force 1 2 3 4 5
d. ability to generate adequate family income 1 2 3 4 5
e. ability to take advantage of future economic opportunities 1 2 3 4 5
f. ability to employ and support additional operator or family 1 2 3 4 5
g. other (please indicate) 1 2 3 4 5

20. Would you be willing to take on additional debt if your lender offered to make credit available?

yes _____
no (skip to 22) _____

21. Why have you limited your borrowing? (Check all that apply)

a. interest rates are too high _____
b. I want to maintain cash reserves _____
c. I want to maintain a credit reserve _____
d. my lender is unwilling to offer additional credit _____

e. profit margins were insufficient _____

22. Which risk management strategies do you employ? (Circle)

	frequency of use				
	never	sometimes			always
a. multiple peril crop insurance	1	2	3	4	5
b. hail insurance	1	2	3	4	5
c. hedging	1	2	3	4	5
d. forward contracting	1	2	3	4	5
e. commodity options	1	2	3	4	5
f. crop share leases	1	2	3	4	5
g. participate in government programs	1	2	3	4	5

23. From your 1990 tax records (Form 1040, 1040F, 1040E and Form 4797) or your farm account book, please list the following information:

	1990 dollar values
1040	
a. Total Income, (line 23)	_____
b. Wages and Salaries, (line 7)	_____
c. Interest and Dividends, (lines 8a + 8b + 9)	_____
d. Capital Gains or Losses (lines 13 + 14 + 15)	_____
1040F	
d. Gross Income, (line 11)	_____
e. Interest Expense, (lines 23a + 23b)	_____
f. Depreciation, (line 16)	_____
g. Total Expenses, (line 35)	_____
1040E	
h. Net farm rental income received	_____
4797	
i. Sale of breeding stock, (line 18)	_____

24. What was the approximate market value of farm and financial assets you have owned the past two years? Please use your financial statements if available:

		Jan. 1990	Jan. 1991
a.	Cash in checking, savings accounts		
b.	Financial investments (CD's, mutual funds)		
c.	Crops and livestock for sale (including CCC crops under loan)		
d.	Machinery, equipment, breeding stock		
e.	Land and buildings		
f.	Total assets		

25. Please list your outstanding loan balances for farm <u>real estate</u> and farm <u>non-real estate</u> debt by type of lender on January 1, 1990, and 1991.

		Non-Real Estate Debt		Real Estate Debt	
		Jan.1990	Jan.1991	Jan.1990	Jan.1991
a.	Bank				
b.	Farm Credit System				
c.	Farmers Home Admin.				
d.	Insurance company				
e.	Individual				
f.	Merchant or dealer				
g.	Other loans (including CCC)				
h.	Total debt				

APPENDIX B: A SAMPLE 1993 FARM FINANCE SURVEY QUESTIONNAIRE

1993 Farm Finance Survey

Information About You and Your Farm

1. In what county is most of your farming operation located?_____

2. What is your age?_____

3. How many dependents are you supporting (including yourself)?_____

4. How many of these dependents are under age 18?_____

5. Please enter the number that corresponds with the highest level of education that you have completed?

   Wife: 1.high school 2.comm. college 3.college 4.post graduate

   Husband: 1.high school 2.comm. college 3.college 4.post graduate

6. How many years have you been farming?_____

7. During the 1992 crop year, how many acres did you:

   a. Own _____
   b. Rent from others _____
   c. Rent to others _____

8. How do you describe your farming operatio? (Please check one)
   a. Family or individual operation (do not include partnership and corporation)
   b. Partnership operation (include family partnerships)
   c. Corporation

9. Number of households or families involved in the farming operation
   -----

10. Approximately what percent of your 1992 gross farm sales came from each of these sources?

    a. Crops _____%
    b. Beef _____%
    c. Pork _____%
    d. Dairy _____%
    e. Other farm enterprises _____%

Credit Available for Expansion

11. Over the past two years, since January 1991, have you ever requested financing from a credit institution to expand your farm business?

Yes_____
No _____(skip to 15)

12. Was your farm business expansion request? (check one)

Completely approved _____
Partially approved _____
Was not approved _____ (skip to 14)

13. If your financing request was approved (completely or partially), please indicate the total amount borrowed and the average terms of the loan(s).

Use of Borrowed Funds	Amount Borrowed ($)	Interest Rate (%)	Length of Loan (years)
Machinery, equipment			
Breeding livestock			
Livestock facilities			
Other agricultural buildings			
Land			
Other			

14. If your loan for the expansion was not approved, check all reasons that apply.

a. Income from expansion was too variable

b. Insufficient documentation (budget or cash flow)

c. Previous loss experience

d. Insufficient cash flow

e. Insufficient collateral

f. Current debt levels were too high

g. Not a profitable expansion

h. Lack of experience with this enterprise

i. Loan was wrong purpose for this lender

j. Other (please indicate)_____

15. Has inadequate financing limited the profitability or growth of your farm business?

Yes_____
No_____

16. Would you be willing to take on additional debt for expansion if your lender offered to make credit available?

Yes_____
No_____

17. Please indicate the reasons why you have chosen to limit borrowing levels. (check all that apply)

a. Interest rates are too high

b. I want to maintain cash reserves

c. I want to maintain a credit reserve

d. Profit margins are insufficient

e. My lender is unwilling to offer additional credit

f. Other (Explain) _____

Risk Management

18. Which risk management strategies do you use? Indicate the frequency with which you use these tools (please circle)

		Frequency of Use				
		Never	Seldom	Half of time	Most of time	Always
a.	MPCI	1	2	3	4	5
b.	Hail insurance	1	2	3	4	5
c.	Hedging	1	2	3	4	5
d.	Forward contracting	1	2	3	4	5
e.	Commodity options	1	2	3	4	5
f.	Crop share leases	1	2	3	4	5
g.	Participate in government programs	1	2	3	4	5

19. Please describe your crop production and insurance program for corn and soybeans produced in 1992.

Crop	Planted (acres)	Insured	
		Multiple peril (acres)	Crop-Hail (acres)
Corn			
Soybeans			

20. Please describe your typical MPCI program

Crop	Average APH* Yield bu./ac.	Coverage level (35, 50, 65, 75%)	Elected Price ($/bu.)	Premium ($/ac.)
Corn				
Soybeans				

*APH is actual production history

Use of Merchant and Dealer Credit

Increasingly farmers are turning to institutions other than banks or the Farm Credit System for non-real estate financing. In this section we ask a few questions about your use of nontraditional credit suppliers, such as your local coop, a farm supply firm, an equipment manufacturer or a machinery dealer.

21. Since January 1, 1992 have you received non-real estate credit from a commercial source other than a bank or the Farm Credit System?

    Yes_____
    No_____ (skip to 24)

If you answered yes, please complete the following:

Use of Credit	Amount Borrowed ($)	Loan Term (months)	Interest Rate (%)
Seed, fertilizer			
Feed			
Feeder livestock			
Machinery, equipment			
Grain storage			
Livestock facilities			
Other			

22. Please indicate the importance of the following reasons for using these "nontraditional" credit suppliers. Rate each item on the five-point scale with a "1" being not important and "5" being very important.

	Not Important				Very Important
1. Easy to obtain (limited paperwork, quick approval)	1	2	3	4	5
2. Competitive interest rates	1	2	3	4	5
3. Can't obtain credit elsewhere	1	2	3	4	5
4. Loan size restricted by banks's legal lending limits	1	2	3	4	5

5. Other _____

23. Which nontraditional credit supplier did you use during this period? (check all that apply)

Local coop _____
Regional coop _____
Private farm supply firm _____
Machinery dealer _____
Livestock contracting firm _____
Other: _____

Farm Income and Balance Sheet

24. From your 1992 tax records (form 1040, 1040F, Form 4835, and Form 4797) or your farm account book, please list the following information:

1040 Form

a. Total income, (line 23) _____
b. Wages and salaries, (line 7) _____
c. Interest and dividends, (line 8a + 8b +9) _____
d. Capital gains or losses (lines 13+14+15) _____

1040F Form

e. Gross income, (line 11) _____
f. Interest expense, (lines 23a + 23b) _____
g. Depreciation (line 16) _____
h. Total expenses, (line 36) _____

Form 4835

i. Net cash and share rental income received from farm property (line 32) _____

4797 Form

j. Gain from sales of farm property excluding land (Parts I,II and III) _____

25. What was the approximate market value of farm and financial assets you have owned the past two years? (please use financial statements if available)

	Jan. 1992	Jan. 1993
a. Cash in checking, savings accounts	_____	_____
b. Financial investments (CDs, mutual funds)	_____	_____
c. Crops and livestock for sale (including CCC crops under loan)	_____	_____
d. Machinery, equipment, breeding stock	_____	_____
e. Land and buildings	_____	_____
f. Total assets	_____	_____

26. Please list your outstanding loan balances for farm <u>real estate</u> and farm <u>non-real estate</u> debt by type of lender on January 1, 1992 and 1993.

	Non-Real Estate Debt		Real Estate Debt	
	Jan. 1992	Jan. 1993	Jan. 1992	Jan. 1993
a. Bank				
b. Farm Credit System				
c. FmHA				
d. Insurance Company				
e. Individual				
f. Merchant or dealer				
g. Other loans (incl. CCC)				
h. Total debt				

Comments: _____

_____

_____

_____

_____

Note: If you have a question that requires an answer from the ISU Economics Department, please complete the following:

I authorize Iowa Agricultural Statistics to forward my name and address to Dr. Robert Jolly, ISU, Economics Department, for response to my questions.

Name: _____

Address: _____ Iowa _____

(Town) (Zip)