Influences of Human Capital and Farm Characteristics on Farmers' Risk Attitudes

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Introduction

The environment in which farmers make decisions with regard to annual production and marketing has changed dramatically in recent years. Farmers face challenges on many fronts—

- Expanding markets through international trade, new products, or new product markets;
- Continuing technological changes (biotechnology, electronic trading, the Internet as it pertains to logistics and information to name a few);
- Continuing structural adjustments;
- Heightened expectations for environmental protection;
- Farm legislation providing farmers with greater latitude to make production decisions, and more responsibility for marketing decisions, leading to
- A more uncertain farm safety net.

Farmers, input suppliers, processors, distributors, and consumers are influenced by, and respond to, markets and expectations about the future. This last summer, as prices dropped and drought and other weather related problems intensified, farmers may have concentrated on near term income and cash flow issues. But some decisions require long-range planning. As farmers adapt, changes are made in their production, marketing, and financial arrangements. Continuing research on appropriate responses under different environments could improve the adaptive ability of farm families.

Insurance and other tools that can mitigate the effects of adverse production and price changes have become more common, introducing additional complexity into farmer's decision framework. Layered on farm program changes is a multitude of state, local, and national regulatory requirements pertaining to both choice of enterprises and production practices. These changes have not only affected current decisions, they have also introduced an added element of uncertainty into farmers' decision framework with regard to longer-term investment in facilities and land use practices.

Institutions are also changing, including the organizational structure and business arrangements of farms. The literature devotes considerable attention to contracts and vertical or horizontal coordination among segments of farming industry. Less attention focuses on changes that farmers have made, and continue to make in their household and business arrangements. The long-term trend of off-farm work by farm families is common knowledge. We are likely much less familiar with the complex web of business arrangements and linkages that have been incorporated into the business plans of a large share of farm businesses. Arrangements include ownership of multiple businesses, marketing through a variety of outlets including direct sale to consumers, networking with other farmers to acquire inputs and sell products, and acquiring capital from a variety of sources including other households and businesses. These complex arrangements introduce yet another source of uncertainty into annual and longer-term farm plans.

Since risk and uncertainty disrupt the flow of knowledge for the perfectly competitive firm, economists have viewed the study of risk to be of prime importance. Cochrane suggests that prior to 1910, nearly all economics related to agriculture was risk oriented. Over the years, good farm management has always been seen to contribute to higher profits (Heady and Jensen, 1954; Boehlje and Eidman, 1984, DeWet, Groenewald and Boshoff, 1992). While response to risk and uncertainty has long been studied, researchers seem increasingly preoccupied with the response to changes in technology and markets (Hamilton, 1994; Phillips, 1994; Sheldon, 1996).

As Boehlje and Eidman have argued, rarely would managers of farm businesses have complete knowledge of either input-output relationships or prices to use for making decisions with certainty. At best, farmers have some information on possible outcomes. Possible outcomes and farmers attitudes toward bearing risk affect choices made about the organization, operating structure, and financial arrangements of farms. Farmers usually do not take risks unless there is a probability of making money, and higher profits can be an indication of higher risks.

For many years, ERS has monitored structural change of the agricultural sector, and measured the financial performance of farms and the economic well-being of farm operator households. A part of this work focuses on savings and investment behavior, technology adoption, production practices, and structural adjustment in the farm sector. These aspects of behavior may be influenced by farmers' human capital or other attributes of the operator and the operator's household, including attitudes toward risk and ability to incorporate behaviors that mitigate risk into the production process.

We have two objectives for this paper. The first is to develop an index reflective of farmers' attitudes towards risk. In addition, we show how the risk indices are distributed by size of farm and other farm and operator characteristics, providing information as to how risk management tools may be used, and farm policies targeted. This information will be useful to help explain agricultural sector structural change, such as complex business arrangements arising in agriculture, and household portfolio investment choices.

Background

Risk has a variety of meanings. Certainly, in a sector as dynamic, competitive, and risky as agriculture, a greater understanding of the interactions among farming risks is critical and empowering, and has the potential to improve farmers' net incomes and the viability of their operations. The risk of income consistently failing to reach expectations threatens the survival of a business. The objective of risk management then is to reduce the chances of a vulnerable situation such as bankruptcy while achieving the highest possible return for the owners of equity consistent with their attitudes toward risk.

Economists assume that perfect information makes the market system operate smoothly. The process of framing ideas, weighing information, and narrowing possible outcomes to reasonably certain ranges applies to all management decisions. Since the sector is adapting to rapid change— in policy, in markets, and in technology— risk from the resulting adjustments in the production process increases. Thus, lack of knowledge of the consequences of outcomes seems to be the deciding factor in both risk and uncertainty.

Uncertain production and income can arise from a variety of sources. Changes in crop, livestock and input prices are major risks. In addition, producers face a variety of financial risks that result from fixed obligations connected with the use of debt and cash leasing. Government regulations and commodity programs and the general economic, tax, or trade policies can contribute to risk. But, farmers/ranchers face more than the general business risks that are associated with prices, production and marketing. Random production due to the uncertainty of weather and its interaction with the biology of agriculture always contributes to the risks that producers face. Other researchers have included risk associated with technology, legal or policy issues, environmental factors, social issues, and labor.

Yield risks arise from unanticipated environmental changes that affect yield or productivity. Events such as wet or cold springs that delay planting, drought, untimely rains, insects, or disease can result in declines in yields or rates of gain and performance. When yields are low, income may not be adequate to cover costs, and cash deficits accumulate. The risk is not so much if the farmer is insured against adverse weather effects, or has adequate cash reserves. The rapid development of new technology can make

current production methods obsolete shortly after they are adopted. The threat of obsolescence exists with many farming practices and adopting new technology too soon or too late may prove costly.

Marketing strategies help the farmer mitigate *price risks*. These strategies have the goal of reducing the variability of income, or income stabilization. Marketing strategies shift some of the risk of price changes to others outside of agriculture by agreeing to lock in a price, assure an outlet for the product, or by spreading risk across types of markets or across time periods. In addition to minimizing price variation, these agreements may have an income tax advantage to the cash-basis taxpayer who can agree to accept payment at a later date. While these strategies may reduce risk in the marketing of agricultural products, they may increase financial risk because the farmer may have fixed commitments that can not always be altered. Since the goal of risk averse farmers is to decrease the variability in income, while they may lessen the likelihood of losses, these costs may also serve to lower expected returns.

Financial risks are additional risks that farmers face as a result of how they organize their businesses, and acquire their production assets. An example is changes in costs of inputs, including those for items requiring substantial capital, such as land and machinery. Forward pricing of inputs is another way to control costs and maintain a reliable inventory. Farmers who have less than full equity in the businesses normally have to meet fixed financial obligations (cash leases or mortgage payments) regardless of changes in production or prices. Financial strategies can be used to reduce the risk of large losses or bankruptcy due to fluctuation of prices or income. While other strategies may reduce risk, financial strategies allow farmers to take on higher risk without damaging the viability of the business. Farmers' willingness to take risks, and their risk-bearing ability given their equity and cash flow positions, affect the structure and organization of their farms.

Technological, legal and labor risks are further identified as risks that further complicate the impact of risks on the farm operator. Technology and choice of production process clearly impacts current investments in assets and the future profitability of the farming system. Legal and social risk may come with changes in government policy toward environmental requirements, qualification for special programs, and the use of non-farm capital and contractual arrangements. The risks associated with availability, accessibility, and costs of labor (including health and safety issues of the worker) may impact farm operations that depend on hired workers.

Farmers respond to risk based on their attitudes toward accepting risk, their expectations of market movements, available methods of risk management, and their skill at applying those methods. Success in farming, as in other businesses, requires a deliberate and knowledgeable approach to risk management. Risk-bearing abilities can be strengthened by successful use of appropriate risk management strategies. According to Patrick and Ullerich, the amount of risk that farmers feel comfortable with will be influenced by their risk-bearing ability, while Jose and Crumly show that farmers' management approaches will differ by personality types. Some farmers are willing and able to take high risks; others may wish to minimize risk.

The cornerstone of economic research on risk is a set of axioms using direct utility elicitation proposed by von Neuman and Morgenstern and further developed by Luce and Raiffa, Arrow, and Pratt. The work is based on the expected utility model (EUM) which provides a single-valued index that orders action choices according to the preferences or attitudes of the decision-maker. The EUM clearly distinguishes between a decision-maker's perception of the amount of uncertainty involved and the attitude toward additional income. The amount of uncertainty is reflected by the decision-maker's expectations, which are expressed as a probability density function. Decision-makers value the amount of uncertainty and other characteristics associated with the action choices according to their unique attitudes, as those actions and attitudes are encapsulated in the utility function.

Various categories of risk-takers have been used. In the first, a decision-maker's attitude toward risk can be inferred from the shape of the utility function. Three types of risk-takers are defined based on whether their utility function is linear, concave and convex. A linear function indicates risk neutrality where the expected utility of an action is equal to the action's expected monetary value. A function concave to the origin indicates risk aversion—because marginal utility declines as wealth increase, the decision maker prefers a certain return to an uncertain expected return of equal magnitude. Risk takers have utility function that are convex to the origin. Robinson used four categories to describe risk takers: avoiders, daredevils, adventurers, and calculators. He indicates that most farmers are "calculators" because they understand that they must take some chances to get ahead, but recognize that there are degrees of risk in every situation. Before making a decision or taking action they gather information and analyze the odds.

These classifications for risk preferences give us insight into approaches that farmers may take in the management of their farms. A risk premium is the difference between the expected return from a risky investment and the expected return to a non-risky investment. Farmers that avoid risk or who are risk adverse require a risk premium (pay-off) to compensate them for the costs of the risk. The more risk there is, the higher the cost to the operator. So, for increasing risk, an increasing premium or return is required. Farmers that are risk neutral will take on risk if the expected return is the same as a non-risky investment. Those that are risk-preferring will pay for the satisfaction of being able to take risks. Not all farmers will view the same situation as having the same risk. Researchers usually assume that farmers will attempt to manage their farms so that risk is reduced.

Because risk and uncertainty are so universally understood to have a role in agriculture, it is not surprising that substantial research has focused on techniques for analyzing risk. Risk programming models such as the mean-variance analysis have served as the conceptual framework for many risk analyses in agricultural economics, based on theory originated by Markowitz to explain diversification as a rational choice by decision-makers. Freund first applied quadratic programming to farm production decisions and Lin et al. used quadratic programming to develop risk efficient sets for a panel of California farms. They tested whether farmers' decisions were consistent with a set of assumptions about maximizing profit, expected utility, and lexicographic utility. Other models such as linear programming, MOTAD, target MOTAD and stochastic programming approaches have been used to generate risk efficient outcomes.

Recently, a Canadian study categorized farmers' by their attitudes toward farming, change and risk, their behavior with respect to change and their expectations of government and industry (Angus Reid Group). These groupings were then used to refine communications and delivery of existing government programs, and identify future needs. However, Lins, Gabriel, and Sonka and Martin note that research on uncertainty may not easily be incorporated into a farm plan and that the models may predict more risk aversion behavior than in fact is observed. Martin's study of the importance which producers attach to different risk management strategies suggests that strategy use differs across farm types. Realities of climate, soil type, nature of the product, market factors and market structure, employment status of the operator, farm and household position in the life-cycle, and attitudes toward risk affect which strategies are chosen and how they are used. Martin cautions that researchers should be wary of using "concern" about a particular risk source as a rationale for studying the application of a specific strategy aimed at reducing risk, since concern may be an impediment to the adoption of the strategy.

Actual risk attitudes have been estimated, but the process is time consuming and expensive. Formative research includes that by Biswanger for his elicitation of attitudes of Indian peasants. Jolly provides an overview of the farm management process and how the assessment and control of risk might be incorporated. He uses that framework then to identify economic research and extension problems to be addressed if the managerial skills of the agricultural producer are to be improved. Jolly suggests, as have others (Barry and Fraser, 1976; Schertz, 1979; Tweeten, 1984 and 1994; King and Sonka, 1988; Boehlje, 1995), that the changing environment in which agriculture operates requires increasing emphasis on

response to risk. Economists also note that non-agricultural markets also have seen an increase in risk and instability (Ansoff, 1979, Drucker, 1993).

Because the sector is changing rapidly, farmers and policy makers are looking for ways to understand and explain those changes. The Agricultural Resource Management Study (ARMS) is the mechanism that USDA uses to collect information about production practices and financial condition of America's farms. Respondent burden is always a concern in a survey, particularly when topics that seem tangential to the main purpose of the survey are introduced. Even though understanding farmers' responses to risk may be critical to understanding structural change, the measurement of risk attitudes of farmers is not the primary purpose of ARMS (see discussion on Data Sources below). Thus, we needed a mechanism to assess farmers risk preferences, and determine how those preferences affected their use of risk tools available to them, in a manner that was sensitive to respondent burden and that was theoretically well-grounded.

In 1996, we had the opportunity to measure farmers' tolerance toward risk by asking them to self-assess through the ARMS. On a scale of 0 to 10, farmers' were asked to determine the amount of risk that he/she was comfortable with. If the respondent does everything he/she can to avoid risk as much as possible, then the appropriate code would be 0. If the respondent understands that risk is a part of every day life, but makes decisions without regard to the amount of risk, then that farmer was considered risk neutral and coded 5. If the respondent took risks because he/she considered that the enjoyment of the risk outweighs any possibility of a loss, then the respondent should have used code 10.

Figure 1 shows a distribution of the risk scores from the self-assessment. This self-assessment of risk showed farmers consider themselves risk avoiding, with a mean value of 3.89. Although the median and mode was nearly the same for all sizes of farms, the mean was lower (more risk avoiding) for small farms than for larger farms. Farmers specializing in field crops other than grain and in beef had low risk acceptance scores. Farmers specializing in grains, and poultry had relatively higher scores, but still in the risk avoiding range below the mid-point of five. The mean self-assessment score showed no discernable differences among regions of the United States.

This self-assessment procedure was shown to be useful by van Kooten and Schmitz in assessing farmers' risk preferences and willingness to pay or receive compensation for modifying land use in order to conserve waterfowl habitat. They borrowed from the theory of reasoned action (RA) first proposed by Fishbein and Ajzen in the 1970s, and used extensively since by researchers in the fields of psychology and the health professions to determine correspondence between attitudes and behavior. Jolly notes that risk attitudes appear to be a basic psychological concept that economists use to interpret the curvature of the utility function. However, understanding risk bearing ability and the capabilities of the decision-maker, estimation of the distribution of outcomes, and risk preferences is a "heroic task." He points out that economists need to determine rules that are simple to understand and sufficiently flexible to reflect the objectives of individuals. The sources of risk and possible responses make the problem of assessing risk preferences an almost impossibly large problem. Robison and Barry note that considering a firm that faces just 10 sources of risk, 20 possible responses, and operation in 3 markets involving 3 different types of activities for purchases and sales of 6 goods would yield 10,800 potential utility models. Although Fishbein and Ajzen would not deny that constructs other than attitude influence behavior, their modeling procedure goes a long way towards reducing the task of analysis to more manageable proportions.

Noting that a single index of self-assessment is subject to bias of farmers' perceptions of their own risks and of interpretation of the assessment tool, we sought help in developing a more complete risk assessment tool that could also meet the respondent burden test. Bard and Barry presented research that constructed an index of farmers' risk attitudes by eliciting responses using the expected utility theory. Theory suggests that risk attitudes influence the way farmers manage risk inherent in production agriculture. They hypothesized that attitudes toward mechanisms or tools used to manage risk reflect the

producers' risk preferences. They developed a questionnaire using questions about the degree of agreement or disagreement with selected financial, marketing, and production risk management tools. For scale validation, farmers were presented with marketing plans where they had to select between two options with different probabilities. Depending on which plan the participants selected, the program led them to a new situation. This "closing-in" procedure continued until the process led to a range of the respondents' indifference curves, thus permitting a range of risk aversion to be calculated.

In comparing the elicitation method with the self-assessment approach, Bard and Barry found that farmers, on average, self-assess themselves relatively higher or more ready to accept risk with the elicitation method. Farmers exhibited a broader range of self-perception of willingness to accept risk than through either managing risk or willingness to accept uncertainty as shown through their marketing plan. When measuring consistency between methods, only the scores between the risk management tools questions and the scientific elicitation were statistically significant. Bard and Barry conclude that the lower correlation between the farmers' self-assessment (rho=.175) and summed management score (rho=.371) with the scientific elicitation score imply that farmers' perceptions of themselves are not highly consistent with their implementation of risk management tools or attitude towards uncertainty.

Data and Methods

This report documents ERS's efforts to monitor the changes in the agricultural sector through the annual collection of data on the finances, structure, and management of U.S. farms. Data to develop the risk index comes from the 1998 Agricultural Resource Management Survey. The survey is composed of several versions of questionnaires. All versions collect the same core group of questions related to farm income, expenses, and operator characteristics. In addition, each version contains a different set of specialized questions designed to address a unique topic of interest. Each version has two sample weights that allow the data to be expanded to the U.S. farm population in two ways: along with all other versions of the ARMS, or independently, with only the data from that version.

One version of the questionnaire is dedicated to the collection of special data on farms and farm operator households. Since 1993, USDA has queried farmers about their management style, and their uses of certain marketing, production and financial management strategies. The 1998 survey continues our concentration on this topic by asking questions designed to elicit information that can be used to develop a risk preference index.

The farm establishment is the focus of the questionnaire. A farm is defined as an establishment that sold, or normally would have sold, at least $1,000 of agricultural products during the year. Farms included in this study are legally organized as proprietorships, partnerships, family corporations, or non-family corporations. Our data are cross-sectional, so we are restricted to looking at the financial condition of farms at a point in time. However, by examining both the income and wealth of the farm, we get a better picture of the financial performance of the business in past years, and its ability to withstand future losses.

The sample size of the database is approximately 12,000, representing 2.1 million farms and ranches in 48 contiguous states. The survey focuses on one operator per farm—the primary farm operator. A primary farm operator is the one who makes most of the day-to-day decisions. When management is equally shared, USDA interviews the oldest person. This one-farm/one-operator survey design gives us good financial information for the farming business, but limits information about the people who farm when more than one family is involved. For the attitude questions, we only queried the primary operator. Partners or shareholders may hold other views.

USDA attempts to reduce as much of the non-sampling errors due to questionnaire design, enumeration, and response as possible. The survey is pretested, training schools for enumerators and statisticians are

provided, and a comprehensive data edit and analysis are conducted at the field, State and National levels. Estimates reported adhere to strict statistical reliability requirements— estimates have coefficients of variation of 25 percent or less, unless otherwise noted. Comparisons of estimates between groups are significant with a 90 percent confidence interval, or better. Technical documentation for the survey is found in "Financial Performance of U.S. Farm Businesses, 1987-1990" by Mitchell Morehart, James D. Johnson, and David E. Banker (Washington: Economic Research Service, Agricultural Economics Report 661, 1992).

Responses to potential losses resulting from risk require adjustment to the production process to either lower costs or increase income. Adjusting output is not always a possible response for farming operations. Actions that reduce price variability, lower input costs, assure input supply or output price, or spread risk to others serve to reduce risk (stabilize income) for farmers. Other actions such as holding inputs in reserve may also reduce risk. A number of widespread and well-known actions have been recommended to farmers and are briefly listed below.

- **production strategies** such as forward pricing of inputs, selecting commodities that produced a stable or low-variability income, using custom feeding, harvesting or contract labor, leasing or renting livestock, machinery or equipment, and land, or participating in government programs; and
- **marketing strategies** such as hedging, contracting, spread sales over the year; and
- **financial strategies** such as keep unused borrowing capacity or an open credit line, maintaining equity in cash and current assets, matching the maturity of loans with cash flow, renegotiating or pre-paying a loan agreement or land contract, purchasing crop or livestock insurance, or allowing nonfarm use of land.

Since theory suggests that risk attitudes influence the way farmers manage the risk inherent in production agriculture, attitudes towards mechanisms or tools used for managing will reflect the producer's risk preferences. As a result of the Bard and Barry research, reduced sets of questions that elicit risk preferences were designed to ascertain the degree to which a farmer agrees or disagrees with the use of the tools. Beginning with 25 questions, the objective was to reduce the items to a revised scale containing the optimal amount of information about risk attitudes. These reduced sets are each 13, 12, 10, and 5 questions, with the 12 question scale offering the best explanation of the variance due to true differences in a person's attitude towards the construct being measured. Since questions were developed from research conducted on a homogeneous group of farmers in Illinois, the next step to developing a risk index was to test the applicability of the questions on a national scale.

ERS chose to include the risk index solicitation questions in the 1998 ARMS questionnaire. Citing respondent burden, ERS chose a 10-question scale (with similar, but slightly lower reliability measures) to use in the 1998 questionnaire, replacing the question about forward pricing of inputs with a question about the use of hedging. Table 1 shows the list of questions used in the ARMS survey. Because these questions are unusual for the ARMS, we made every attempt to identify for the enumerator FAQs on the purpose of the risk index so that they would be prepared to explain it to farmers, and training for the administration of the survey instrument. Even so, respondents representing six percent, or 123,000 farms, and 4 percent of the value of production, refused to answer either the whole section, or parts of the section. A short examination of the refusals indicated that most were from small farm operators who considered themselves retired but still farming, or who did not farm as their major occupation. Other non-sample bias may be present in the administration of the instrument. The population in this study included all respondents that completed the risk attitudes question set—a sample of 8,000, representing 1.9 million farms.

Development of the Risk Assessment Score

In this first phase of the research, we present descriptive statistics to help us define groups, if any, of farmers with different perspectives on risk in agriculture. The standard ARMS answers to questions that detail the income and expenses, assets and debt of the operation were collected, as well as demographic information describing the farm, farm operator, and farm operator household.

Developing a scale involved scoring responses from 1 to 5 depending on the degree to which farmers agree with the statement, and summing over the set. The score includes responses from all the questions, even though a particular question may not be applicable to the respondent's situation. For example, it would be difficult for a farmers specializing in fruit, vegetables, nuts, nursery, or greenhouse products to use hedging. And, dairy farms spread sales over the year because of the nature of the commodity, not necessarily because that strategy is a risk management tool. To prevent response bias, some of the questions are worded in such as manner that if the respondent strongly agrees with the question, it implies that the farmer is willing to accept more risk than if he or she disagrees with the statement. Other questions are phrased such that if the farmer agrees with the statement, the implication is that the risk management tools is used to decrease risk. The average score for each of the questions is in Table 1. Scores for the questions are adjusted so that the higher the score, the more risk the farmer is willing to accept risk and fewer tools are used to mitigate risk. Scores for each question are summed so that a score of 10 indicates that the respondent is strongly not willing to accept risk and used the full set of tools to manage risk. A score of 50 indicates that the respondent is willing to accept a great deal of risk and does not use the any of listed tools to mitigate risk.

Distribution of the estimates

Risk assessment scores ranged from 10 to 45, with a mean of 28.6 and a median of 29. The cumulative distribution for the risk assessment score for all respondents is shown in Figure 2. The results suggest that on average, the respondents were risk neutral to slightly risk-avoiding, but that attitudes toward risk vary markedly between individuals. Very few farmers scored less than 25, so we call respondents with lower scores risk avoiding, rather than risk averse. That no one scored higher than 45 (out of possible 50) indicates that these respondents were not risk-preferring. Thus we will call respondents with higher scores, risk-accepting.

First, we examined the data at the national level, for all respondents. Respondents were divided into groups based on fifths as nearly as could be done with discrete scores. Scores for each quintile were: 10-25, 26-28, 28-30, 30-32, and 33-50. Then, estimates for the income statement, balance sheet, standard financial ratios, characteristics of the farm, farm operator, and farm operator household were developed for each group. Because the middle quintiles are separated by only a few points, comparisons of selected farm and operator characteristics are only presented for the lowest fifth and highest fifth (groups for which the risk assessment score is low or high) can be seen in Tables 2-4.

Financial characteristics of farms for the two groups based on the risk assessment score show striking differences. In general, for risk avoiding scores (25 or less), average gross cash income was more than 6 times higher than gross cash income for risk accepting respondents (score of 33 or higher). Net farm income for risk avoiders was almost 10 times as high as for risk acceptors. Assets values also show the same pattern with risk avoiders having more than 3 times the value of assets than risk acceptors. Because debt retains the pattern as well, average debt-to-asset ratio for the two groups is about the same.

Returns to assets, returns on equity and operating profit margin for risk acceptors are all negative, and the economic cost to output ratio is considerably over 100, indicating that economic costs (which includes returns to equity and operator labor and management) exceed the value of output. On the other hand,

operator profit margin for risk avoiders is 9 percent and the economic cost to output ratio is under 100, indicating that risk avoiders, on average, earn economic profits.

Risk acceptors have many of the characteristics associated with the small farms they operate. Compared to risk avoiders they are less likely to use hired labor, land rental (cash or share), and custom work. They were less likely to have purchased new cars or equipment for the farm. Their marketing techniques relied on cash sales, and they were slightly more likely to have sold to individuals, although the difference is not significant. Risk acceptors were less likely to have participated in government programs such as the loan deficiency program or the AMTA program.

That risk acceptors have smaller farms, translates into households that rely more on off-farm endeavors. Over half the farm operators and almost that share of farm spouses work off farm. On average, they had negative farm income to the household (definition includes depreciation as a farm expense), and household income of $36,000. The average U.S. household income is approximately $50,000, so these risk acceptors fall short by almost a third. One might assume that because they would be competing in the off-farm market, they might be younger and/or have higher education attainment, but those in the risk accepting category have the same average age and lower educational attainment, affirming that risk avoidance behavior increases with education. On the other hand, risk avoiders have considerably higher income at $81,320—mainly due to the positive farm income to the household, but also because off-farm income is higher. About 43 percent of the risk avoiding operators and 47 of their spouses work off-farm.

With these descriptive statistics in mind, we began to look at the distribution of scores for various categories. Stochastic efficiency criteria can help us judge whether preferences of farmers with selected characteristics are different from other farmers. First degree stochastic dominance (FSD) is the simplest and most universally applicable efficiency criterion. Developed in the early 1960s, FSD requires the assumption that all decision-makers prefer more to less. Under FSD, an alternative with an outcome distribution defined by cumulative distribution function has values less than the all the values of the function under consideration (illustration). Visual inspection may be used as dominance criteria when functions are well-defined and do not intersect. However, when many alternatives must be evaluated, or there is no clear discrimination among functions, FSD may not effectively reduce the choice set.

We examined the cumulative distributions for the risk assessment scores for three subsets representing farmers by a typology developed by ERS, by region, and by commodity specialty. The typology categorizes farmers according the their asset base, farm sales, household income, and major occupation. Regions are illustrated in Figure 3. Commodity specialty is the commodity that contributes to the largest portion of gross sales for the farm. The respondents were further categorized according to age and education attainment. Distributions for selected features of these groups are shown in Figures 4-10. Distributions that are shifted to the lower left side of the distribution illustrate risk-avoiding behavior. Distributions that are shifted to the upper right side illustrate risk-accepting behavior.

From these distributions we found that respondents operating larger farms, those living in the Heartland of the United States, and those specializing in general grains have lower risk scores, indicating that these farmers do more things to avoid risk. Farmers that score higher are respondents operating smaller farms, respondents that do not farm as their major occupation, and those specializing in soybeans. A higher score indicates that farmers do not attempt to control for risk by using the listed strategies.

Other distributions were examined for farmers categorized by their age and educational levels. Although we hypothesized that acceptance of risk would decrease with age, risk assessment distributions do not seem to be much different for farmers in different age groups. Education was assumed to provide skills for the farmer to be able to mitigate risk and the distributions show that those farmers with less than a high school education accept more risk than farmers with college degrees. Distributions for farmers with

high school or some college were virtually the same, but less risk accepting than farmers with less than high school education and more risk accepting than farmers with college degrees.

Finally, we examined a group that closely represents the respondents in the Bard and Barry study—farmers in the Heartland, whose major occupation was farming, and who specialized in corn and/or soybeans. We call this group the CSHEART farmers. The CSHEART farmers have characteristics that should seem to shift the distribution to the left and, in fact, the distribution for CSHEART farmers dominates by visual inspection the distribution for all other farmers (figure 11).

Discussion

Measuring farmers' risk attitudes is an important and relevant issue, particularly as legislation remains that reduces government involvement in the sector, and technological and organizational responses to the market change the structure of agriculture. This analysis is the first of its kind conducted on a national scale. The questions used to develop a risk assessment score and thus imply risk preferences of farmers were drafted to contain the optimal amount of information about risk attitudes, while considering respondent burden and other data collection issues. Its implications are still at an exploratory stage, but we can already draw some conclusions.

Evidence suggests that farmers with more at stake have lower risk assessment scores, indicating that they think that the behaviors from our list are ways to manage their risk. Larger farms, operators whose major occupation is farming, and those specializing in grains (and farmers in those regions that depend on grains) have lower risk assessment scores than other farmers. As educational attainment increases, the willingness and ability to modify behavior to deal with risk increases shifting the distribution of better educated farmers down and to the right towards risk avoiding preferences.

However, it is difficult to discern if the lower risk score indicates an actual preference for risk avoidance, or whether it is a measure of use for the selected set of tools that assist the farmer in avoiding risk. Although questions were carefully crafted to reflect as wide an array of tools as possible, the list still contains strategies that may be biased towards or against particular types of farms and farmers. For example, farmers specializing in vegetables had higher incidence of risk accepting than grain operators. However, vegetable farmers probably do not use hedging as a risk management tool, which raises their score, which in turn, serves to shift the distribution upward and to the left toward risk accepting. Other examples can be found for questions for beef operations, smaller farms, and farmers who can not or do not spend as much type farming as those whose major occupation is farming. This phenomenon may be most clearly evident in the comparisons of the CSHEART farms with all other farms.

The bias may be inherent in the technique of postulating use of a tool as expressive of risk preferences. While preferences may be to avoid risk, the list of tools that can be used to avoid risk is not and can not be exhaustive. Thus expression of behavior through use of risk management tools may not reflect the true preferences of the farmer. Having accepted this postulate, this modeling procedure goes a long way towards reducing the task of risk analysis to more manageable proportions. However, the question remains, to what extent does this risk assessment score reflect the true risk preferences of all farmers?

The ARMS data present a wealth of information about the farm, operator, and operator's household. Together with a measurement of the willingness to accept risk, these farm and demographic characteristics can be used to explain movement in farm structure and economic well-being. It is this next step that our research takes us, to use the risk assessment score as an explanatory variable for technology adoption, production practices, or use of government programs. If it can be shown to be useful in explaining the variation in any of these dependent variables, particularly for the group defined as

CSHEART, the risk assessment scoring technique will prove to be a valuable instrument for both analysts and policy makers.

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Table 1—Questions used in the 1998 ARMS Survey to assess risk.

How much do you agree or disagree with the following statements?

Item	Adjusted average score*
1. I never have enough cash on hand or assets that can be easily convert to cash to pay all my bills.	3.08
2. I never hire custom work to be done.	2.98
3. I always spread the sale of my commodities over the year.	2.93
4. I rely heavily on market information (government reports, private market news services, etc.) in making my marketing decisions.	3.14
5. My farming operation has adequate liability insurance	2.43
6. Most of my machinery is new or in good repair	2.79
7. The concentration of my farming operation in one geographic area substantially increases my total risk.	3.08
8. In case of emergency, I have sufficient back-up management/labor to carry on production.	2.67
9. I have adequate hail/fire insurance for crops.	3.16
10. I never hedge by using future and/or options for marketing crops or livestock.	2.69

*Some questions are worded so that if respondent strongly agrees with the question, it implies that the farmer is willing to accept more risk than if he or she disagrees with the statement. Other questions are phrased such that is she agrees with the statement, she is implying that she utilizes the risk management tools to decrease risk. Score is adjusted so that 1 = risk avoiding behavior and 5 = risk accepting behavior.

Source: Bard and Barry, 1998.

Table 2--Selected farm finance characteristics according to farmers' risk assessment cores, 1998

	Risk assessment score					
	10-25 Risk avoiding		33-50 Risk accepting		All	
	Estimate	C.V.	Estimate	C.V.	Estimate	C.V.
Number of farms	441,107	3.6	318,503	7.8	1,941,645	2.1
Percent of farms	22.7	1.6	16.4	3.8	100.0	0.0
Percent of value of production	49.4	2.2	5.6	3.6	100.0	0.0
Gross cash income	183,482	4.4	28,922	10.6	85,149	2.3
Cash expenses	139,226	3.3	26,616	9.3	67,405	2.3
Net cash farm income	44,256	8.5	2,307	46.4	17,743	4.3
Net farm income	32,297	10.9	3,813	26.7	14,544	7.2
Farm assets	772,690	3.5	277,474	8.5	518,963	4.0
Farm liabilities	96,531	4.8	28,101	8.8	57,091	4.4
Farm equity	676,159	3.8	249,372	8.9	461,872	4.2
Debt/asset ratio	0.12	4.8	0.10	7.4	0.11	3.7
Profitability:						
Return on assets (percent)	2.20	21.2	-2.42	21.6	0.46	45.3
Return on equity (percent)	1.08	46.2	-3.72	16.7	-0.64	37.6
Operating profit margin (percent)	9.01	17.9	-20.01	22.1	2.67	43.2
Financial efficiency:						
Economic cost-output ratio(percent)	96.1	11.7	127.59	3.6	103.25	1.2

Source: Compiled by ERS from USDA's 1998 Agricultural Resource Management Study.

Table 3-- Selected farm management characteristics according to farmers' risk assessment scores, 1998

	Risk assessment score					
	10-25 Risk avoiding		33-50 Risk accepting		All	
	Estimate	C.V.	Estimate	C.V.	Estimate	C.V.
Hired labor	54.1	3.9	26.1	9.2	39.6	3.9
Used cash rent	40.2	4.1	26.6	8.7	30.9	3.4
Used share rent	20.9	7.1	7.2	15.2	12.8	4.4
Used custom work	53.6	3.9	27.2	11.3	41.0	3.3
Bought new cars, equip	54.3	2.9	35.6	14.8	42.0	3.8
Had cash sales only	80.8	1.2	94.3	1.0	88.8	0.5
Had marketing contracts	15.7	6.2	4.8	14.6	9.0	4.0
Had production contracts	4.6	16.2	1.3	35.3	2.6	7.4
Sold directly to individuals	11.8	14.7	16.2	22.5	12.7	6.6
Had CRP land	8.8	11.0	6.9	19.8	9.5	7.0
Received disaster payments	12.6	9.1	5.3	15.9	8.0	4.5
Rec'd loan deficiency payments	26.9	5.9	10.2	29.3	15.2	5.6
Received transition payments	38.6	5.2	16.7	18.0	25.4	3.6
Had income from sales of equip	10.3	11.9	3.0	25.8	6.3	7.4
Received FCIC endemity	7.0	13.2	2.3	22.5	4.5	6.5
Received other insurance endemity	6.85.9	1.7	29.3	3.8	5.3	
Had stock in a coop	28.2	4.6	9.6	15.1	16.8	2.8
Used precision farming	8.4	6.0	4.0	64.0	4.5	10.1

Source: Compiled by ERS from USDA's 1998 Agricultural Resource Management Study.

Table 4-- Selected operator characteristics according to farmers' risk assessment scores, 1998

	Risk assessment score					
	10-25 Risk avoiding		33-50 Risk accepting		All	
	Estimate	C.V.	Estimate	C.V.	Estimate	C.V.
Operator average age	54	1.1	54	1.6	54	0.6
Education:						
Some high school or less	10.6	13.8	22.4	12.1	15.3	7.6
Completed high school	40.1	7.5	42.7	9.7	41.3	3.1
Some college	24.9	8.0	22.0	13.4	24.7	4.0
Completed college (BA, BS)	17.5	9.0	9.7	23.5	13.4	4.8
Graduate school	6.9	12.9	3.3	28.2	5.3	8.7
Major Occupation:						
Farming	53.4	2.9	34.6	9.6	39.6	3.4
Hired manager	1.6	18.8	na	na	1.2	15.8
Nonfarm work	32.2	5.7	49.0	7.4	43.1	2.5
Retired, still farming	12.7	13.5	15.5	15.4	16.1	7.0
Gender:						
Male	95.8	0.7	90.6	2.2	91.7	0.8
Female	4.2	16.8	9.4	21.5	8.3	8.5
Race or Ethnicity:						
Non-white	5.1	22.5	12.1	21.1	7.1	11.6
White	94.9	1.2	87.9	2.9	92.9	0.9
Total household income	81,320	7.6	35,691	6.4	59,793	3.5
Farm income to household	21,926	10.4	-320	268.2	7,671	9.0
Total off-farm income	59,394	10.4	36,011	5.9	52,122	3.3
Operator had off-farm job	42.6	4.6	57.8	6.4	53.3	2.2
Spouse had off-farm job	46.8	4.1	43.6	8.4	43.6	2.7
Shared farm income w/ other hh	9.0	13.8	7.4	26.4	7.2	6.4
Average number of hh (reporting)	1.16	3.1	1.11	2.1	1.11	0.7

Source: Compiled by ERS from USDA's 1998 Agricultural Resource Management Study.

Figure 1--Self-assessment score for farmers in 1996

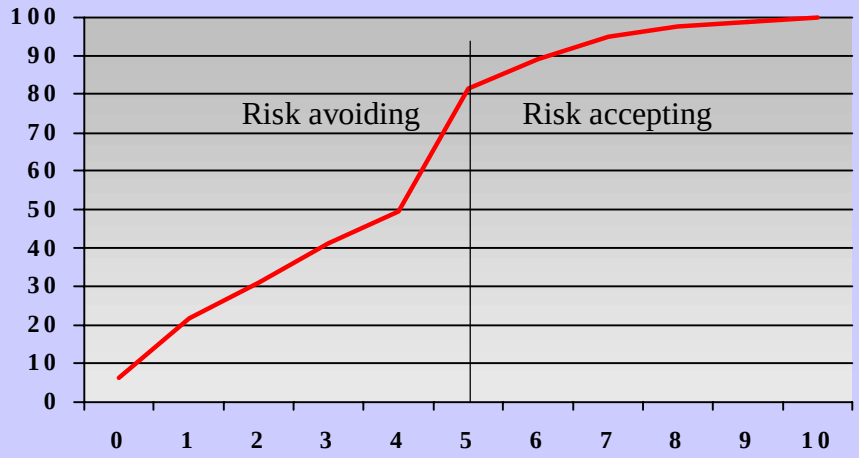


Figure 2--Risk assessment score for all farms, 1998

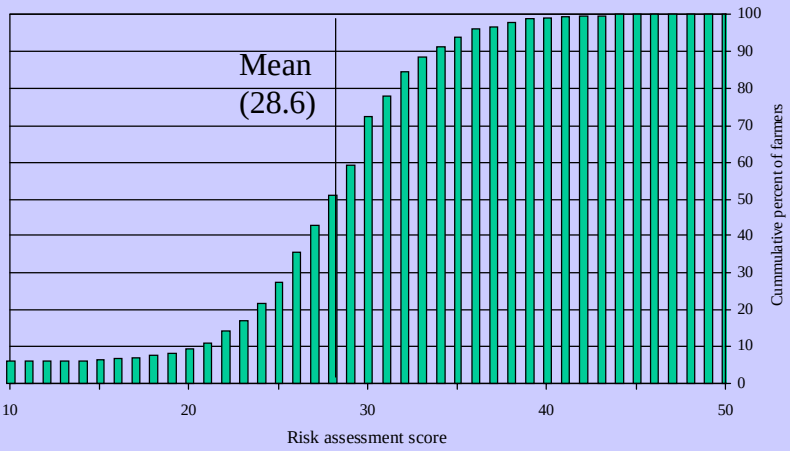


Figure 3--USDA Farm Resource Regions

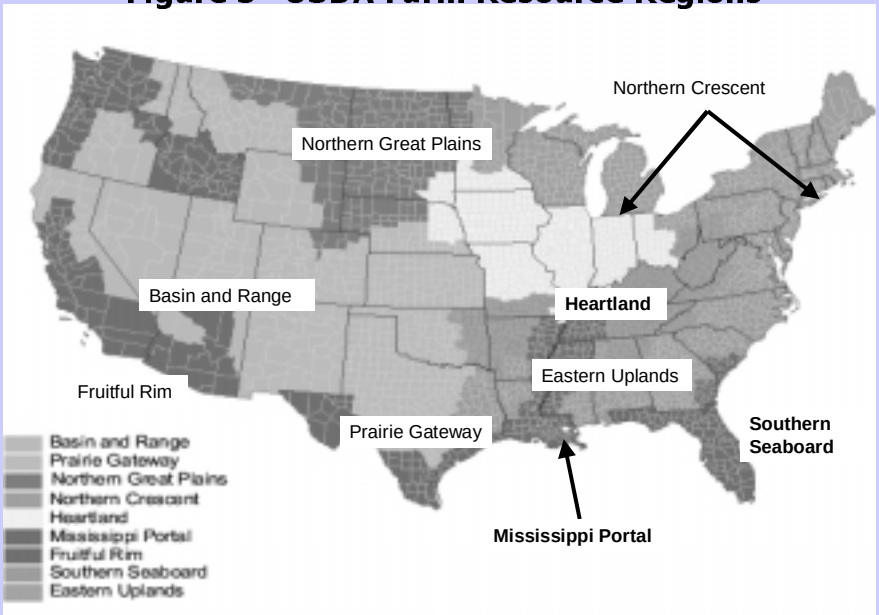


Figure 4--Risk assessment score distribution by farm typology

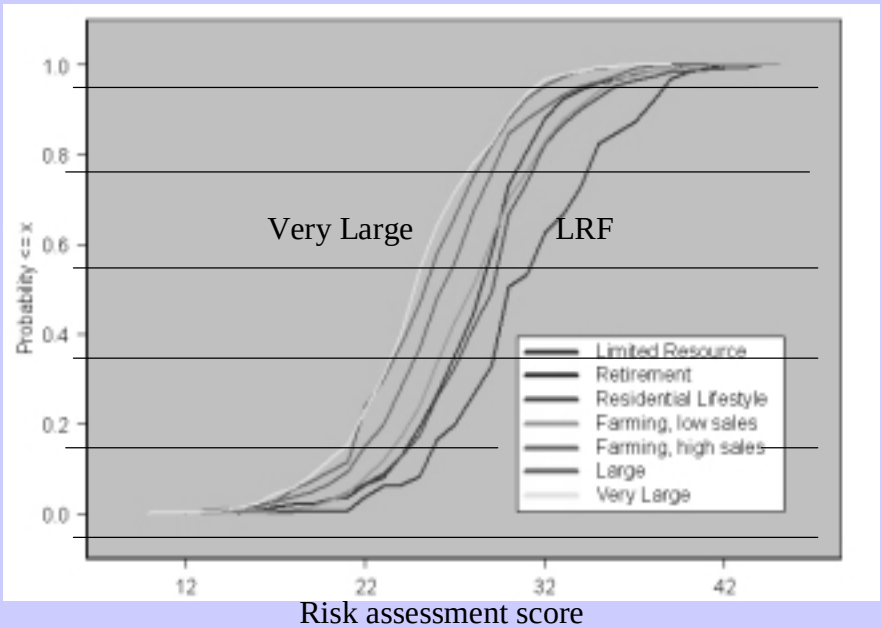


Figure 5--Risk assessment score by commodity specialty--crops

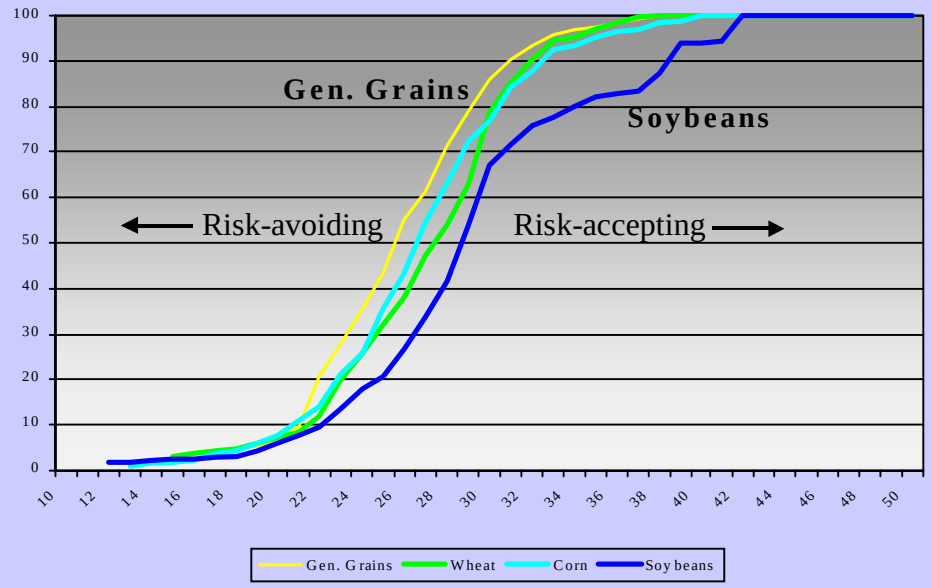


Figure 6--Risk assessment score by commodity specialty--livestock

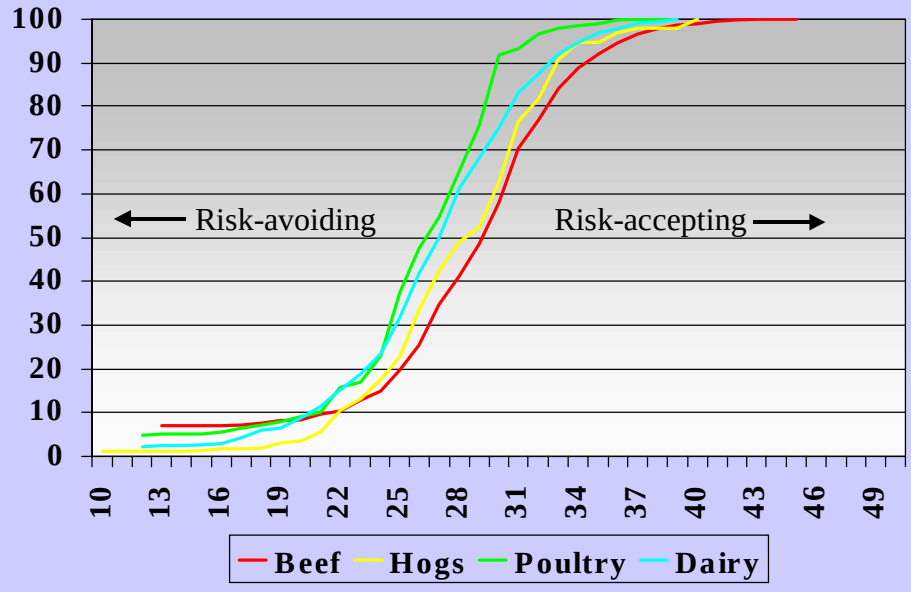


Figure 7--Risk assessment score by region

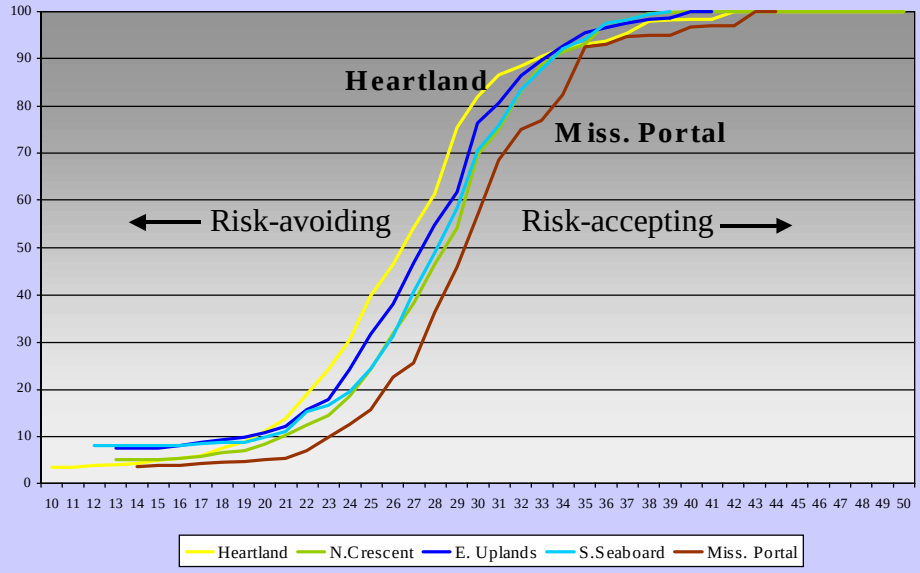


Figure 8--Risk assessment scores by operator's age group

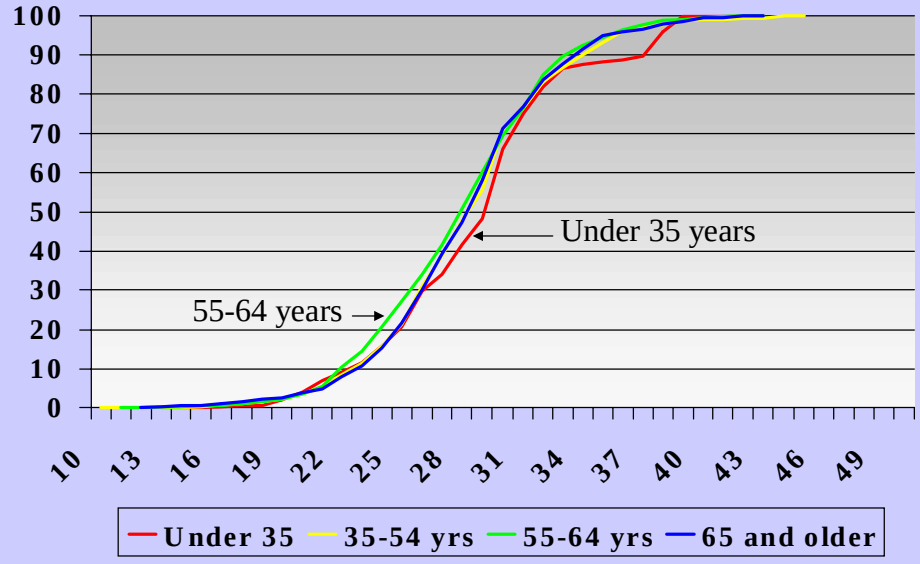


Figure 9--Risk assessment scores by operator's educational attainment

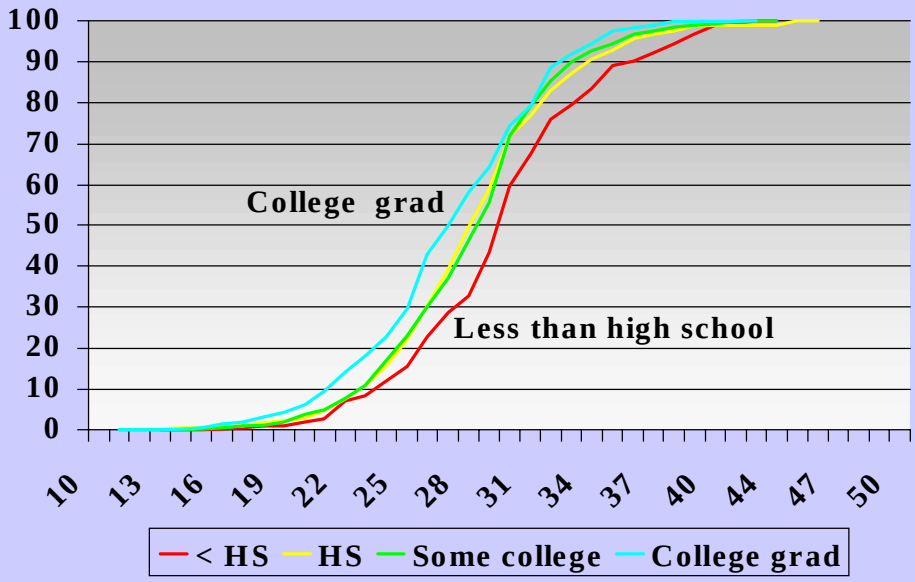


Figure 10--Risk assessment scores by major occupation, 1998

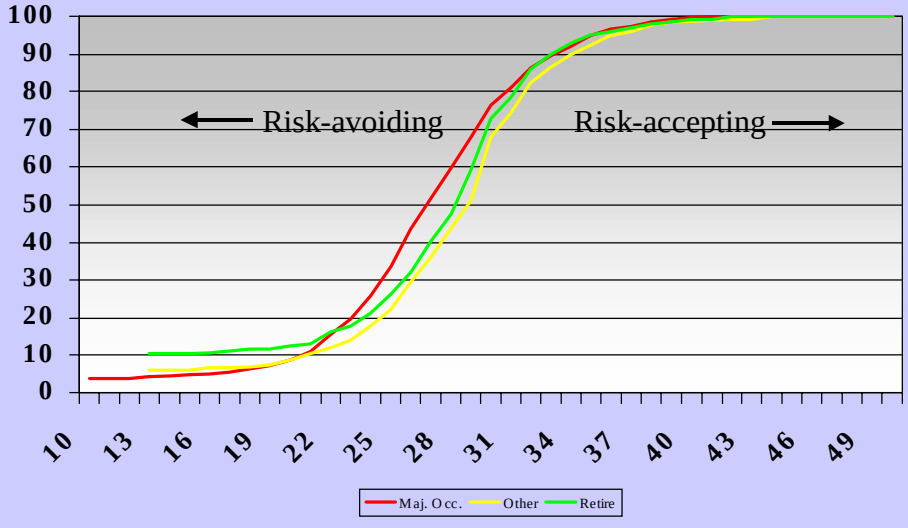
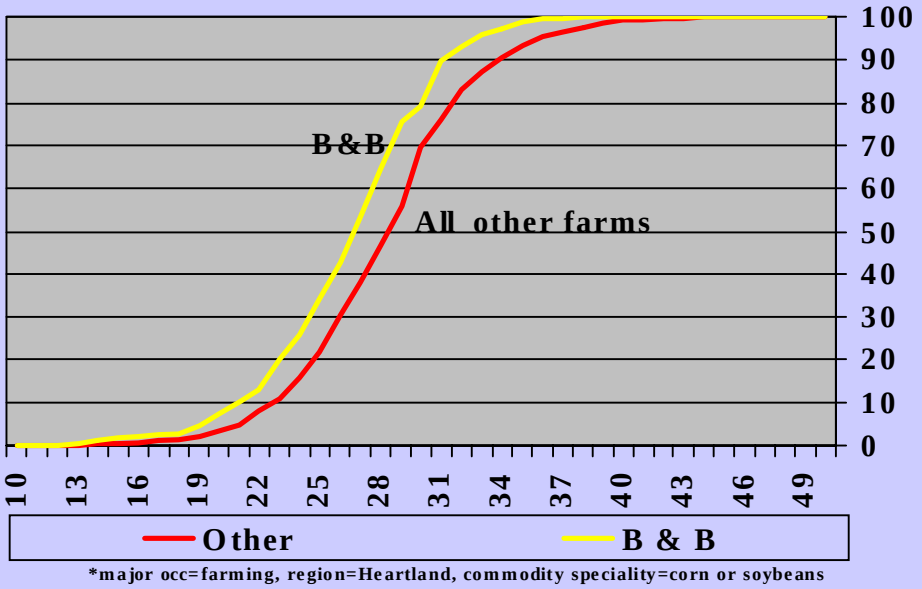


Figure 11--Risk assessment score, by Bard & Barry criteria



*major occ=farming, region=Heartland, commodity speciality=corn or soybeans