CROP INSURANCE AND CREDIT:
A FARM LEVEL SIMULATION ANALYSIS

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The financial adversities experienced by the farm sector in the 1980's have continued to highlight the close interrelationships that exist between farm borrowers and their lenders. Both parties have a significant stake in actions that influence the profitability, liquidity, and risk positions of farm businesses. Especially important is the formation of effective managerial strategies, including the use of public programs, for responding to various sources of risk in agriculture and thus strengthening the lender-borrower relationship.

In this study we focus on analyzing the relationships between farmers' use of crop insurance and the cost and availability of credit from their major non-real estate lenders. As a risk response, crop insurance responds directly to shortfalls in crop yields. In the process, it should reduce lending risks and contribute to the economic performance of both the borrower and the lender. Crop insurance also has important policy implications since it serves as one of the several policy instruments used by the federal government to implement programs of stabilization, liquidity, and income enhancement for farmers. Indeed, the Federal Crop Insurance Act of 1980 authorized an expansion of the insurance program to become the primary form of disaster protection for farmers. The ranges of crops, regions, and financial protection were broadened substantially, and much emphasis was placed on acquainting farm lenders with the provisions and benefits of the expanded program in order for them to encourage insurance adoption by their farm borrowers.

Little empirical evidence is available, however, about the lenders' responses to farmers' use of crop insurance and about the implications of these responses for the financial performance of farm businesses. If, for example, farmers use of crop insurance results in greater credit availability and/or lower financing costs, then the farmers' insurance decisions and their resulting risk positions could be significantly affected. Most of the prior studies (Gardner and Kramer; King and Oamek; Kramer and Pope; Lee and Djogo) focusing on the farm-level effects of crop insurance have essentially assumed independence between use of insurance and the farm's financial organization. This assumption leaves unanswered several important questions about the financial effects of insurance: Do lenders in fact respond to farmers' use of crop insurance? Is their response a price response, a non-price response, or both? Are the responses significant? Do the responses differ among farms with different yield risks and structural characteristics? Can the responses

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be measured, analyzed, and integrated into a broader analysis of farm performance?

Our purpose in this study is to address some, but not all, of these questions. We sought, through a combination of survey and simulation procedures, to measure the form and magnitude of responses by a sample of non-real estate lenders to a crop farmer's use of crop insurance and to evaluate the effects of these responses on farm financial performance over a multi-year horizon. The empirical focus was on the use of crop insurance by representative farms in two regions of Illinois that differed substantially in relative yield variability. This inter-regional focus provides some generality about the differences in lender response to the relative amount of yield risk and to the use of crop insurance in the two regions. In the following sections, we describe the design of the study, the procedures for generating the lender responses, present the survey results, and evaluate their implications for financial performance using a farm-level simulation model.

Design of the Study

The study focused on cash grain farms in Illinois and on the responses to crop insurance by the farms' major non-real estate lenders, namely commercial banks and Production Credit Associations (PCA's). The basic components of the study included the identification of two regions in Illinois that differed substantially in their yield variability, the specification of representative farms in each region to serve as a basis for the survey and simulation procedures, the survey process and analysis of the results, and an evaluation of the effects of the lenders' responses on the financial performance of the representative farms using the farm-level simulation model. Each of these components is briefly summarized in this section (see Pflueger for a more detailed description).

The identification of two regions of Illinois that differed in yield variability occurred by collecting and analyzing data on corn yields from the Statistical Reporting Service (SRS) in Illinois. The corn yield data were collected for all counties of the state for the 1972-82 period, tested for trend (none was found), and then means, variances, and coefficients of variation were determined. Using the coefficients of variation two three-county regions were selected that differed substantially in their relative yield variability. The low variability region, located in east central Illinois, had an average coefficient of variation for corn yields of .151 for the three counties. The high variability region, located in southern Illinois, had an average coefficient of variation of .257.[1]

The selection of lenders to be surveyed coincided with the delineation of the two variability regions, although a broader set of counties was allowed in order to increase the sample size and to allow credit markets for both the lenders and borrowers to range beyond county boundaries (the low and high variability regions contained 12 and 15 counties respectively). All PCA's in these counties were included in the sample, as well as all commercial banks that on December 31, 1983, had at least $2 million in agricultural loans or a ratio of agricultural loans to total loans that exceeded .50. The sample of lenders for the low variability region contained 66 banks and 11 offices of 4 PCA's. The lender sample for the high variability region contained 59 banks and 11 offices of 3 PCA's. Thus, the sample size totalled 147 lenders.

Three survey methods were considered to obtain the lenders response to the use of crop insurance: (1) collecting data from existing loan portfolios; (2) surveying lender attitudes by questionnaire; and (3) surveying lender responses to a simulated borrowing situation. The simulated borrowing approach has an advantage over the other methods since it directly generates quantitative measures of the lenders' price and non-price responses to the farm practices or characteristics being studied. Moreover, this method has been used successfully in several previous studies (Barry et al.; Barry and Willmann; Baker). Thus, the third method was the preferred choice here. A mail questionnaire in contrast to a personal interview approach was selected to implement the survey.

Once the lender responses to crop insurance were summarized and analyzed, they were integrated into the farm-level simulation model to evaluate their effects on the model farms' profitability, liquidity, solvency, and survivability over a ten-year planning horizon. The simulation model, called PICFARM, is maintained and utilized by the U.S. Department of Agriculture for analyzing the farm-level effects of various policy options and economic scenarios (Baum and Richardson; Baum). The USDA version is adapted from the model developed by Richardson and Nixon, which has received wide use and comprehensive documentation in the literature (eg. Richardson and Nixon; Richardson and Condra; Perry et al.). The model was well suited for use in this study: It contained a comprehensive set of financial components that can accommodate the results of the lender survey; its stochastic properties allow random variation in crop yields; and it contains various specifications on major policy instruments available to farmers, including Federal Crop Insurance.

The specification of the representative farms in the two variability regions was used to both elicit the lender response and simulate business performance over time. The differing characteristics of the survey environment and the simulation model precluded an exact matching of the model farm's specifications for these two purposes. Nonetheless, a high degree of consistency was maintained. The greater weight in the specification process was placed on designing the survey to ensure the highest possible quality of lender response. In the following sections we will describe in greater detail the farm specifications for both the survey and simulation process.

Lender Responses to Crop Insurance

The lender survey contained two case loan requests, one of which excluded the use of crop insurance by the farm borrower and one including its use. The lenders also received a biographical sketch of the borrower, a description of the Federal Crop Insurance program as it applied to the case farm, and the case farms' historic and projected financial statements. These materials were prepared under the guidance of an advisory panel of farm lenders who served as a pre-test mechanism for the survey. Using this information, the lenders were asked to evaluate and respond to the case loans in terms of maximum credit limits for operating and capital loans, interest rates, loan maturities, security requirements and other loan provisions.

Farm Characteristics

The representative farm's beginning financial position was structured to represent a relatively young, low equity borrower who owned a small portion (10%) of the land he operated and leased the rest on a cash rent basis. The initial ratio of debt to equity was set at approximately 2.70 in the low variability region (equivalent to a debt to asset ratio of .73) and 2.34 in the high variability region (a debt to asset ratio of .70). These specifications reflect the high financial risk of the 1980's (U.S. Department of Agriculture). Despite the high leverage, the case farmer still was characterized to the lender as having gained the necessary experience and improved his financial position to the point where he could begin to upgrade some of his machinery, equipment, household facilities, and other capital assets in order to provide a basis for orderly growth in the future. Within this context, the loan request was set high enough to fully test the farm's credit limits, especially on capital credit. Moreover, individual capital items and the operating loan could be reduced or deleted until the lenders' approval occurred. The loan requests with and without the use of crop insurance were the same except for a lower operating loan in the high variability region to reflect the smaller size of farm. In addition, when insurance was used the operating loans were higher due to the financing needed to cover the insurance premium. The case farm for the low variability region had a larger total size (1,000 acres versus 600 acres), higher yield expectations (128 bushels versus 87 bushels for corn and 41 bushels versus 33 bushels for soybeans), higher land values ($2,500 per acre versus $2,000 per acre), and other minor adjustments due to differences in operating characteristics and economic conditions between the two regions.

The case farm situations also were designed so that crop insurance was the farmer's principal risk response. Crop enterprises were limited to corn and soybeans (typical for each region) for rotational purposes; crop sales occurred at harvest with no use of hedging or forward contracting; no participation in other government programs occurred; little financial reserves were maintained; little or no credit reserves were held, at least after the loan request was granted; and leasing of farm land occurred with cash rent rather than share rent so that all the yield risk was carried by the farm operator. Finally, when crop insurance was used, the case farmer selected the highest levels available for yield coverage and valuing losses.

Survey Responses

This survey was mailed in late 1984 with the final lender response occurring in early February of 1985. In total 69 responses were received--43 from the low variability region and 26 from the high variability region--for a gross response rate of 46.9%. Of the total responses, 55 were considered useful for a net response rate of 37.4%. Of the useful responses, 34 were from the low variability region and 21 from the high variability region. A non-useful response occurred if a blank survey was returned, if the loan request exceeded the institutions' legal lending limit, or if the survey was incomplete. Timing likely had a major influence on the response rate. By necessity, the survey was sent during a busy time of the year for the agricultural lenders and at a time of significant financial stress in agriculture. Thus, most lenders were occupied more than usual with customer counseling, credit analysis, and loan workouts.

Empirical Results

Table 1 gives a descriptive summary of the lender responses on the major variables contained in the survey, classified by region and by use of insurance: no insurance (Case A) and insurance (Case B). These variables include the dollar and percentage amounts of the various types of credit, the interest rates on operating and capital credit, and their respective loan maturities. The credit responses will be treated shortly. For now it is interesting to note that the mean interest rates on operating and capital credit showed essentially no response to the use of crop insurance and were nearly the same between the two regions. The average loan maturities showed moderately higher responses, especially when insurance was used in the high variability region. The total loan request was granted by only one lender, although crop insurance was needed to generate this response. Most of the lenders' responses occurred in the curtailment of capital credit. In contrast, 37 (67.3%) of the lenders granted the full operating loan request under Case A conditions and 42 (76.4%) granted the full operating request under Case B conditions.

The numbers of lenders who exhibited credit and interest rate responses are indicated in Table 2. These responses are based on comparisons of the percentages of the loan granted under Cases A and B. A positive (negative) response occurred if the percentages of operating credit, capital credit, or both (total credit) increased (decreased) from Case A to B. Price responses occurred when the interest rates were lower and/or the loan maturities longer for Case B. As Table 2 shows, 23 of the 55 lenders showed no credit response to crop insurance. Of the rest, 12 showed an operating credit response, 13 showed a capital credit response, 4 showed both an operating and capital credit response, 3 showed an interest rate response, and 4 showed a negative credit response.

In percentage terms 58.2% of the lenders granted either more credit or a lower interest rate when crop insurance was used with the capital credit response predominating. Of this total, 21.8% showed a positive response for operating credit, 23.6% for capital credit, 7.3% for both operating and capital credit, and 5.4% showed a price response. Moreover, the incidence of response was greater in the high variability region where 85.7% of the lenders indicated a credit response compared to 41.2% in the low variability region. Still, however, 14.3% of the lenders in the high variability region indicated a reduction in credit that appeared attributable to the presence of the insurance premium in the operating loan for Case B. Thus, the lenders' responses exhibited considerable disparity.

In Table 3 we present mean values and standard deviations of the lender responses for the various types of credit and the use of t tests to analyze the statistical significance of the response to crop insurance within the regions and by type of lender.[2] The first section of the table shows the responses by all lenders without regard to region. As shown by separate rows of this section, the percent of operating credit granted was 82.67% for Case A and 95.33% for Case B, the percent of capital credit granted was 23.33% for Case A and 29.01% for Case B, and the percent of total credit granted was 53.48% for Case A and 65.00% for Case B. For each type of credit, the increase for Case B relative to A was statistically significant at the 5% level; the mean differences and t ratios are shown in the last column of the table. Thus, for the aggregate responses, these results indicate that lenders on average would extend greater amounts of operating, capital, and total credit to those borrowers who use insurance according to the insurance provisions specified in the loan request.

The next two sections of Table 3 consider the magnitude and significance of the credit response to crop insurance within the two regions. For the low variability region, the mean values of the differences in credit responses between Cases A and B are positive for each type of credit, although statistical significance only occurs for operating and total credit. For capital credit, the mean value of the percent of loan granted increased from 22.00% in Case A to 25.37% in Case B--a relatively small increase of 3.37% compared to that for operating credit. For the high variability region, the mean values of the differences in credit responses are positive as well as being statistically significant for each type of credit. Capital credit in particular exhibits a much stronger increase in response to crop insurance, with the difference between Cases A and B averaging 12.04%. Thus, based on these results differences in variability characteristics between regions may well affect the lenders non-price responses to crop insurance, especially in the case of capital credit.[3]

The final two sections of Table 3 consider the responses to crop insurance by type of lender. For commercial banks, the mean values of the difference in credit responses between Cases A and B are positive and statistically significant for each type of credit. These results roughly parallel the responses for all lenders, in part because commercial banks are dominant among the responding lenders. The results for PCA's are subject to greater qualification because the number (9) of their responses is relatively low. Nonetheless, some interesting differences occur in the responses of these two types of lenders. None of the mean values of the differences in credit responses for PCA's were statistically significant. The general tendency for PCA's was to grant the full operating loan request irregardless of the crop insurance strategy and to grant little if any of the capital loan request. In fact, the mean values of the capital and total credit responses for PCA's declined due to the negative capital credit response to crop insurance by one of the PCA respondents in the high variability region. In general, then, without the use of crop insurance banks appeared more conservative granters of operating credit compared to PCA's, although their capital credit responses were stronger. The operating credit responses evened out when crop insurance was used, although banks continued to have a stronger capital credit response.

Simulation Specifications

The farm-level effects of the lender responses were analyzed with the simulation model using three primary scenarios plus other secondary scenarios in which the sensitivity of the results was evaluated through changes in key parameter values. The three primary scenarios were: (1) farm performance without use of crop insurance; (2) farm performance with the use of crop insurance but without the lender response; and (3) farm performance with both crop insurance and the lender response. For each scenario, in the two variability regions, the model ran 100 stochastic iterations allowing yields for corn and soybeans to be selected at random from normal probability distributions measured over the 1972-82 time period using farm level yield data from the Illinois FBFM system.[4] Only yield variability was considered in order to maintain the focus on crop insurance as the major risk response.

The model farms were specified to remain in a steady state of size and fixed asset structure over the model horizon. Providing for growth opportunities would have added realism and allowed the model farm to utilize the additional credit attributed to crop insurance in financing asset acquisition and perhaps adding to profit potential. However, the farm's initial position of low equity, high leverage, and vulnerability to financial stress suggested a conservative approach to future expansion plans and an emphasis on the liquidity-providing, stabilizing features of crop insurance. Moreover, allowing expansion would require a pace of growth and related borrowing needs that would be consistent with the risk attitudes of the model farmer, including his valuation of crop insurance as a response to risk relative to other risk responses and sources of risk. The non-optimizing nature of the simulation model precluded using this type of attitudinal information. Thus, the more conservative approach based on a steady size state was used.

The financial components of the simulation model allowed the lender responses to crop insurance to be specified in terms of interest rates, loan maturities, and minimum equity to asset ratios for intermediate and total assets. Since the survey responses showed no substantial changes in interest rates or loan maturities in response to crop insurance, major emphasis was placed on the non-price effects. The model was structured to place no restrictions on the amount of short term credit during a year. This specification is consistent with the survey results which showed little curtailment of operating credit. Any cash flow deficits at year end are covered by intermediate term borrowing in the following year until the intermediate limit is reached. Then refinancing through long-term loans occurs until the overall solvency limit is reached, at which point the farm is declared insolvent. Since the survey results indicated generally positive responses to all types of credit in both variability regions, our approach to including the lender responses was to reduce the minimum equity to asset ratios for the total farm and for its intermediate assets by .05 and .10, respectively, when scenario 3 was used. At the farm level, this resulted in a reduction of the solvency limit from .40 to .35.[5]

Other model specifications included data on commodity prices, yields, costs of production, depreciation patterns, inventory values, beginning indebtedness, interest rates, inflation rates, consumption, and taxation. Costs of production and inventories for machinery and other farm assets were estimated from FBFM records and from the advisory panel of lenders. Data for interest and inflation rates were obtained from the USDA's specification of the PICFARM model. The USDA provided data for a representative farm constructed from SRS data using consistent interest and inflation rate expectations obtained from the Economic Indicators of the Farm Sector and the Agricultural Finance Data Book. Most inflation rates fell in the 6 to 8% range over the 10 year horizon, while interest rates fell in the 8 to 10% range. The tax and consumption specifications also were those found in the PICFARM model, as were the price projections on corn and soybeans.[6]

Yield data were estimated from farm level FBFM records over the 1972-82 period for the three-county regions cited earlier. The low variability region had per acre expected yields and standard deviations for corn of 127.8 bushels and 20.5 bushels, respectively, and for soybeans of 41.2 bushels and 5.1 bushels. The high variability region had expected yields and standard deviations of 81.2 bushels and 21.7 bushels for corn and 32.9 bushels and 5.7 bushels for soybeans. Information on crop insurance premiums was obtained from the regional field office of the FCIC who indicated that the same premiums could be used for each variability region since their actuarial tables did not indicate substantial differences in the rates. The initial insurance premiums and price protection levels were $6 per acre and $2.90 per bushel, respectively, for corn and $4 per acre and $6 per bushel for soybeans. Both the premiums and the price protection levels were adjusted over the model horizon to maintain a constant relationship to the USDA's price patterns for corn and soybeans.

Simulation Results

The simulation results were evaluated using a set of performance criteria that represented the farm's profitability, liquidity, and risk positions. Consistent with the type of output produced by the PICFARM model, profitability was measured by the net present value of the income flows over the model horizon, by the present value of ending net worth, and by the Van Horne profit index defined as beginning net worth plus the net present value of the income flow divided by beginning net worth. When the model was run stochastically, the output was not in a form to calculate annual rates of return to assets or equity. Liquidity was measured by the level of ending cash reserves reported in the model output. Again, no annual liquidity ratios could be calculated; however, the farm's steady size state caused profits from operations to accumulate as cash reserves for liquidity purposes. Finally, the farm's solvency position was measured by the mean value of the equity to asset ratio at the end of the model horizon and by the model farm's probability of survival over the horizon. The probability of survival is determined by the number of iterations in which the farm operation remained solvent.

We anticipated that the use of crop insurance together with the lender response would reduce and stabilize the farm's profitability position as indicated by the mean values and coefficients of variation over the solvent iterations for the various profitability measures. In addition, insurance was expected to improve the farm's liquidity, solvency and survival prospects. These results indeed tended to occur, although the farm's profitability levels also improved in the crop insurance scenarios relative to the no-insurance case. As Table 4 shows, the use of crop insurance in scenario 2 (without the lender responses) increased and stabilized the profitability and liquidity measures for both variability regions. The ending equity to asset ratio increased marginally and the probabilities of survival increased considerably from .580 to .710 in the low variability region and from .450 to .620 in the high variability region. The improvement in profitability likely reflects the combined effects of the level of subsidy in the insurance premiums which transfers insurance benefits to farmers and the tendency for indemnity payments to substitute for the additional borrowing and debt restructuring that would occur at relatively high interest costs in years of low crop yields without the use of insurance.

The addition of the lenders' response in scenario 3 results in lower and less stable profitability measures relative to the results for scenario 2, but still stronger profit performance compared to scenario 1 conditions. The stabilizing effects of crop insurance remain beneficial relative to the non-use of insurance, but the model farm's tendency to use the additional borrowing capacity for financing purposes at high interest costs in low yield years has an off-setting effect on profits. In both variability regions, the mean values of the ending cash reserves and equity to asset ratios also are lower in scenario 3 than in scenario 2. However, the lender response together with insurance does have a positive effect on the farm's survival prospects; the probabilities of survival increase to .750 and .720 for the low and high variability regions, respectively. Thus, compared to scenario 2, crop insurance and the lender response improve survival prospects through greater borrowing at interest costs high enough to diminish expected profitability.

To test the sensitivity of the model results, we varied three of the major parameters of the farm situations and re-ran the simulation model for the high variability region since it had the greater number of insolvencies over the model horizon. The first secondary scenario involved a reduction in the farm's initial indebtedness to yield a beginning equity to asset ratio of .45. The concern here was that excessively high initial debt levels could have caused substantial insolvencies regardless of the risk responses used. The second secondary scenario involved an increase in commodity prices by 25% in all years of the horizon. If the high incidence of insolvencies reflected the farm's inability to generate enough revenue to cover all fixed and variable costs, then this chronic condition could make the use of crop insurance ineffective under any conditions. The third secondary scenario involved a reduction in crop insurance premiums by 75%. This change was intended to test the relative effects of the premium levels on the survival rates relative to the other specifications on indebtedness and commodity prices.

As shown in the last three rows of Table 4, each of these changes yielded the anticipated increase in probabilities of survival. While the magnitudes of change in the different parameters are not directly comparable, it is still noteworthy that the survival rates responded most to the increase in commodity prices and least to the reduction in crop insurance premiums. The strong survival response to the reduction in indebtedness relative to the base scenarios also shows that the use of crop insurance together with the lender responses may significantly benefit farm's differing from the initial model farm only by a stronger financial position.

Concluding Comments and Implications

The survey and simulation procedures used in this study proved effective in eliciting the lenders' responses to crop insurance and evaluating their effects on farm financial performance in the two variability regions. In general, the survey results indicated that borrowers typical of the case situations analyzed here could anticipate a positive, yet moderate response from approximately 60% of their non-real estate lenders as a result of participating in the Federal Crop Insurance program. However, the magnitude of the response would differ considerably among lenders and would occur primarily as an expansion of the amount of available credit for non-real estate purposes, with little if any change in interest rates, loan maturities, or other loan terms. Regional differences in yield variability did not appear to be a major factor in the magnitude or form of the lender response for operating credit, although a stronger response in the availability of capital credit occurred in the high variability region. The incidence and magnitude of the credit responses also appeared to differ by type of lender, although the small number of PCA's responding to the survey limits the conclusiveness of this finding.

These results suggest that the farmer's use of crop insurance, at least from the lenders' viewpoint, could reduce the farm's business risk enough to allow higher financial risk arising from the greater amount of credit made available to borrowers. The higher financial risk would materialize if borrowers increased their use of borrowed funds in response to using crop insurance; alternatively, the farm's liquidity position could improve due to the greater accumulation of financial and credit reserves. The results of the simulation analysis were consistent with these observations. In both variability regions, the use of crop insurance alone increased the expected level and stability of the farm's profitability, contributed to greater liquidity, and increased the probabilities of survival. When both crop insurance and the lender responses were considered, the profitability and liquidity measures were reduced, although not to the base levels with no use of insurance, and the probabilities of survival increased. Thus, for the particular specifications of the model farms, the lender response to crop insurance allowed additional borrowing to enhance survival prospects, although at higher interest costs and reduced profit levels. In subsequent sensitivity analysis, the survival rates increased further in response to lower levels of initial indebtedness, reductions in crop insurance premiums, and especially to revenue increases from higher commodity prices. Thus, crop insurance may have considerable merit when it is combined with other management or policy actions that reduce indebtedness or increase revenues for highly leveraged, low equity crop farms.

Several qualifications should be cited about the interpretation of these results. Participation in crop insurance was the primary form of risk response followed by the model farms and yield variability was the sole source of risk. In practice, of course, farmers experience numerous sources of risk and would utilize other types of risk response in addition to or in place of crop insurance. Moreover, lenders would respond in non-price and/or price terms to the full set of farmers' actions in producing and marketing their crops, managing their cash flows, and capitalizing their farming operations. Thus, the emphasis

Footnotes

1. Because the SRS data were disaggregated from the state level to the county level, the relative yield variabilities were checked by examining historic yield data on individual farms in the two regions that had participated in the Illinois Farm Business Farm Management System (FBFM) during the 1972-1982 period. The means, variances, and coefficients of variation again were measured and largely coincided with the measures from the SRS data. This validated the selection procedure based on the SRS data.

2. The use of t tests occurred because the analysis focused on the differences in the credit responses to the absence and presence of crop insurance in the case loan requests. No attempt was made to explain the effects of lender characteristics or other factors that might affect the lenders' responses. Other statistical procedures also were considered but not used. Analysis of variance was not appropriate since the bounds on the credit requests yielded limited dependant variables. Tobit analysis could handle the bounded feature, but was not strictly appropriate since more than one bound was in effect simultaneously for some lenders.

3. Inter-regional comparisons of the credit responses are hampered by the differences in sizes and other operating characteristics of the representative farms. The sizes of the operating loan requests in the survey were scaled according to farm size; thus, the mean responses on the percent of operating loan granted are comparable. Moreover, the differences in the mean responses for operating credit (85.49% and 78.10% for Case A) are not significant at the 5% level, but do become significant at the 10% level. In contrast, the sizes of the capital loan requests in the survey were the same for the two regions, even though the farms differed in size and debt levels.

   To achieve inter-regional comparability, we estimated the initial equity to asset ratios for the two farms under Case A conditions, including the capital loan requests granted by the lenders in each region. The equity to asset ratios did not differ significantly between the two regions for the Case A conditions, suggesting that the capital credit responses without insurance were essentially the same in the two regions. As occurred above, the changes in the equity to asset ratios when insurance was used (Case B) were significant within each region at the 5% level.

4. Yield variability originally was specified with a beta distribution to reflect the tendency for yields to be negatively skewed. However, in the final analysis normally distributed crop yields were used to overcome an apparent malfunction of the beta component of the simulation model that caused the mean values of the simulated crop yields to differ substantially from the true means and that caused the simulated variances of the crop yields to trend upward

over time rather than remaining stationary. Using normality corrected both of these problems. Using normality also tended to reduce by small amounts the likelihood of exceedingly low crop yields, and thus tended to understate the payoffs from using crop insurance by an unknown but likely small amount.

5. The minimum equity to asset ratio of .40 implies that the farm is starting in an insolvent position since a ratio of .30 was used in the lender survey. Several factors are involved here. Given the adverse agricultural conditions of the mid 1980's and the financial position of the case farms, it is likely that lenders would set a lower level of leverage as the target over time or as the default rate for insolvency purposes. In addition, in order to use the stochastic sub-routine of the PICFARM model, the first year of the horizon was run deterministically in order for the stochastic process to begin. This ensured a known and moderately successful level of farm performance in Year 1. Finally, the case farms were formulated to reflect an improving trend of historic performance. Thus, the solvency criterion was set at .40 compared to the initial value of .30.

6. These prices were generated with the FAPSIM model, the current U.S. aggregate economic forecasting model used by the Economic Research Service of the U.S. Department of Agriculture. The price projections provided by the model covered the first five years of the simulated horizon. Subsequent price projections were estimated by adding to the fifth year prices annual increments of $0.012 per bushel for corn and $0.05 per bushel for soybeans according to trend values found in an earlier study by Aukes.

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Table 1. Summary Measures of Lender Response to Crop Insurance by Variability Region

	Low Variability Region				High Variability Region			
	Mean Response	Standard Deviation	Minimum Response	Maximum Response	Mean Response	Standard Deviation	Mimimum Response	Maximum Response
Case A, No insurance								
Operating credit								
$ extended	194,060	73,412	0.0	227,000	74,190	31,988	0.0	95,000
% extended	85.49	32.34	0.0	100.00	78.09	33.67	0.0	100.00
Capital credit								
$ extended	34,532	42,124	0.0	148,600	35,898	40,900	0.0	106,400
% extended	22.00	26.83	0.0	94.65	22.86	26.05	0.0	67.71
Total credit								
$ extended	228,592	96,490	0.0	375,600	110,088	44,775	0.0	189,500
% extended	59.59	25.16	0.0	97.81	43.71	17.78	0.0	75.20
Interest rates								
Operating credit, %	13.75	.66	12.5	15.3	13.59	.45	12.50	14.50
Capital credit, %	13.78	.62	13.0	15.3	13.60	.73	12.50	15.00
Loan maturity								
Operating credit, yrs.	.92	.19	.50	1.00	.79	.24	.50	1.00
Capital credit, yrs.	4.50	1.50	1.00	7.00	4.37	2.52	1.00	7.00
Case B, Insurance								
Operating credit								
$ extended	229,310	9,529	198,500	233,000	91,238	20,224	23,000	101,000
% extended	98.42	4.09	85.19	100.00	90.33	20.02	22.77	100.00
Capital credit								
$ extended	44,441	47,142	0.0	157,000	54,798	47,455	0.0	148,600
% extended	28.31	30.03	0.0	100.00	34.90	30.23	0.0	94.65
Total credit								
$ extended	273,751	47,787	211,050	390,000	146,040	45,224	89,000	249,600
% extended	70.19	12.25	54.11	100.00	56.61	17.52	34.50	96.74
Interest rates								
Operating credit, %	13.60	.64	12.50	15.30	13.58	.44	12.50	14.50
Capital credit, %	13.76	.62	13.00	15.30	13.64	.70	12.50	15.00
Loan maturity								
Operating credit, yrs.	.92	.18	.50	1.00	.77	.24	.50	1.00
Capital credit, yrs.	4.77	1.81	1.00	10.00	5.10	2.47	1.00	10.00

Table 2. Number of Lenders Responding in Price and Non-Price Terms to Crop Insurance[a/]

	No Response		Operating Credit Only		Capital Credit Only		Operating and Capital		Price Response		Credit Decrease	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All lenders	23	41.8	12	21.8	13	23.6	4	7.3	3	5.4	4	7.3
Low variability region	20	58.8	6	17.6	5	14.7	3	8.8	3	8.8	1	2.9
High variability region	3	14.3	6	28.6	8	38.1	1	4.8	0	0.0	3	14.9
Banks	18	39.1	10	21.7	12	26.1	4	8.7	2	4.3	3	6.5
PCA's	5	55.6	2	22.2	1	1.1	0	0.0	1	1.1	1	1.1

a/ Percentages in the table reflect the percent of responses for the category in each row. These percentages may total to greater than 100% since lenders may exhibit more than one response.

Table 3. Percentages of Loan Requests Granted by Type of Credit, Regions, and Type of Lender

	Case A (No Insurance)		Case B (Insurance)		Case B Minus Case A
	Mean Response	Standard Deviation	Mean Response	Standard Deviation	Mean Difference (t ratio)
All lenders					
Operating credit	82.67	32.7	95.33	13.2	12.66 (3.16)*
Capital credit	23.33	26.3	29.01	28.7	5.68 (2.30)*
Total credit	53.48	23.7	65.00	15.8	11.52 (4.40)*
Low variability region					
Operating credit	85.49	32.3	98.42	4.1	12.93 (2.31)*
Capital credit	22.00	26.8	25.37	27.6	3.37 (1.02)
Total credit	59.53	25.1	70.19	12.3	10.66 (2.88)*
High variability region					
Operating credit	78.10	33.7	90.33	20.0	12.24 (2.22)*
Capital credit	22.86	26.1	34.90	30.2	12.04 (2.27)*
Total credit	43.69	17.8	56.60	17.5	12.92 (3.59)*
Banks					
Operating credit	79.53	35.0	94.67	14.3	15.14 (3.22)*
Capital credit	24.91	27.2	33.46	29.3	8.54 (2.59)*
Total credit	52.50	25.6	66.49	16.5	13.99 (4.66)*
PCA's					
Operating credit	98.68	4.0	98.72	2.5	0.04 (0.04)
Capital credit	9.10	16.5	6.27	7.0	-2.83 (0.68)
Total credit	58.48	9.1	57.39	9.2	-1.09 (0.39)

*Statistically significant at the five percent level

Table 4. Performance Measures for Solvent Runs of the Simulation Analysis Classified by Variability Region and Crop Insurance Scenario

	Low Variability Region Scenario			High Variability Region Scenario		
	1	2	3	1	2	3
Net present value						
Mean	313,864	330,468	321,374	224,927	240,580	232,833
Coefficient of variation	36.3	31.3	34.0	33.5	28.0	29.8
Present value, ending net worth						
Mean	337,687	349,340	340,248	184,877	197,559	189,813
Coefficient of variation	33.8	29.6	32.1	40.8	35.2	36.5
Profit index						
Mean	4.0	4.2	4.1	4.3	4.6	4.4
Coefficient of variation	27.2	23.8	25.6	25.8	22.6	23.1
Ending cash reserve						
Mean	460,684	481,904	473,326	269,227	303,546	284,769
Coefficient of variation	68.0	59.4	62.3	72.9	60.5	63.8
Ending equity to assets						
Ratio	.751	.770	.750	.770	.788	.778
Probability of survival						
Base model	.580	.710	.750	.450	.620	.720
Lower initial debt	NA*	NA	NA	.710	.900	.950
Higher commodity prices	NA	NA	NA	.860	1.000	1.000
Lower insurance premiums	NA	NA	NA	.480	.680	.760

* No runs were attempted for the low variability region using the secondary scenarios