FARMERS' CREDIT RISKS AND LIQUIDITY MANAGEMENT

Peter J. Barry, C. B. Baker, and Luis R. Sanint

Liquidity management is a principle means by which crop farmers cope with variations in cash flows that arise from uncertain commodity prices, yields, and production costs. The farmer's objective is to assure that cash can be generated quickly and efficiently in order to meet cash demands. Previous studies by Baker, Barry, and their colleagues have provided much insight on the role of credit in farmers' liquidity management, how credit appraisals differ among lenders, and how farmers' perceptions of these appraisals interact with their managerial decisions. However, these credit concepts and measurement procedures are developed in deterministic terms so that once the composition of credit is known, it is modelled as though it can be relied upon with complete certainty.

Farmers' reliance on credit as a source of liquidity leaves their financial control subject to lenders' decisions. Resultant credit risks are introduced by uncertainty about lenders' reponses to changing conditions in agriculture and in financial markets that influence their lending decisions. These uncertain responses give credit the characteristics of a random variable. Thus credit risk is an added element of farmers' portfolio risk that increases with their financial leverage and that has not been accounted for in prior analyses. It must be taken into account inasmuch as credit management is a component of overall farm business management.

The purposes of this paper are to further develop concepts underlying credit risk, to show how it affects optimal debt use and thus firm organization, and to evaluate alternative methods of empirically measuring credit risk. Some empirical evidence is reported on credit risk associated with variations in farmers' incomes and with changes in availability of loan funds in rural banks. Managerial consequences also are developed, using concepts of business and financial risk.

Liquidity Concepts

Liquidity concepts are based on relationships between a firm's composite value of assets and cash proceeds expected to result from the sale of each asset to meet liquidity needs. An asset is considered perfectly liquid if its sale generates cash equal to or greater than the reduction in value of the firm resulting from the sale (Baker). Assets become less liquid as their potential sale reduces the firm's value by more than their expected sales value. Factors influencing an asset's liquidity include transactions costs, marketability, time allowed for liquidation, liquidity risk, and the asset's contribution to a firm's capital integrity. Transactions costs include commission charges,

---

Peter J. Barry and C. B. Baker are Professors of Agricultural Economics at the University of Illinois. Luis R. Sanint is a Research Assistant in Agricultural Economics at Texas A&M University.

installation and assembly costs, transportation and storage costs, opportunity costs, and losses in transit, and may differ considerably among assets. Marketability refers to characteristics of the market in which the asset is traded. Included are quality of market information, volume of trading, number of participants, development of secondary markets, and other factors that cause differences between an asset's purchase and sale price at a given time (Modigliani). Timing refers to urgency of need for funds with sale proceeds generally increasing as time available for liquidation increases (Pierce).

Liquidity risk refers to the relationship between asset values and a firm's stochastic demands for cash (Chen, Jen & Zionts). An asset yielding a high return when cash demand is high is liquidity preferred. One yielding a low return when cash demand is high is liquidity averse, and one whose return is independent of cash demand is liquidity neutral. Among liquidity neutral assets, those with lower variances are considered to have higher liquidity (Cropper).

Capital integrity refers to the importance of an asset's income-generating role in the firm. Liquidations of current assets, like inventories or goods in production, are part of the firm's usual operations and generally have little effect on the firm's value not reflected directly in the firm's balance sheet. In contrast, liquidations of fixed assets like machines, breeding livestock, and real estate deplete the firm's capital base and reduce its income-generating capacity. Such assets have increasing illiquidity since the value of the firm declines by more than their sales value, even though some of them may have relatively high marketability, low transactions costs, or low liquidity risk.

Holding credit reserves as a source of liquidity provides a means of generating cash that avoids the costs associated with liquidating assets to meet cash demands and then reacquiring assets later when adverse conditions have passed. Using credit does not greatly disturb a farm's asset structure or production organization, its transactions costs are relatively low, and it is generally "marketable" (i.e., exchangeable for loans) in rural financial markets. However, costs of maintaining and borrowing from credit reserves must be considered. Borrowing reduces returns from investment opportunities that are foregone from further financial leverage, interest is paid when loans occur, and deposit balances, loan fees or other noninterest charges sometimes occur to compensate lenders for establishing lines of credit. Moreover, financial risk must be accounted for in the use of credit in borrowing (Gabriel & Baker) and there is uncertainty about future credit availability.

Identifying forces affecting credit availability and developing procedures for measuring credit risk are complicated by the complexity of credit determinants. As Figure 1 shows, some credit determinants originate in financial markets. Macro conditions attributed to monetary and fiscal policies, structural characteristics of financial markets, and aggregate economic performance may influence costs and availability of loan funds; so may micro conditions that characterize individual financial intermediaries. These financial market conditions are far removed from farmers'

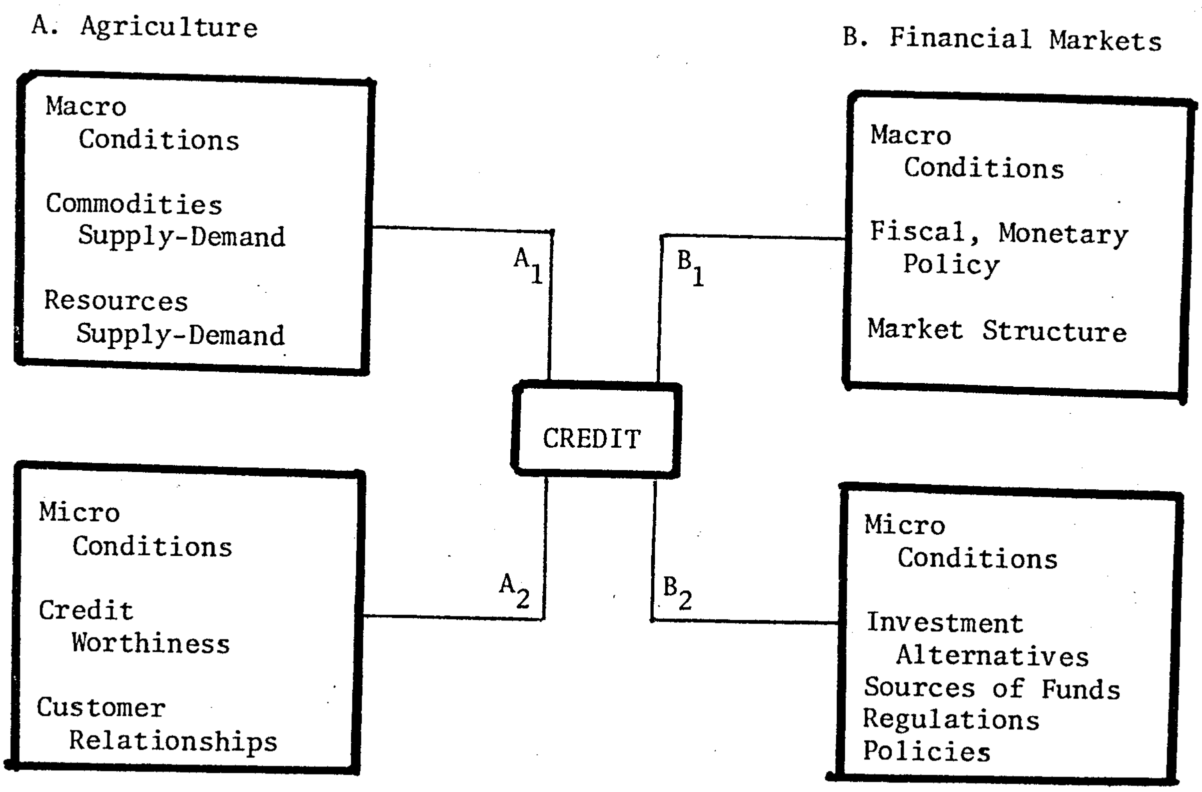

FIGURE 1: Farmers' Credit Determinants

operating environment and may have little or no direct relationships with factors influencing farmers' cash demands. They influence but are not influenced by farmers' credit management. Hence farmers can only monitor them as part of their financial environment.

Other credit determinants originate in agriculture through macro effects of supply-demand conditions for commodities and resources, and through micro effects of farmer-lender relationships that are strongly influenced by the lenders' concept of farmers' credit worthiness. Credit worthiness is estimated on the basis of evidence farmers supply to assure lenders that lending risks will be minimal and that debt servicing will occur according to the terms of the loan contract.

In gaining these assurances, lenders consider a farmer's personal characteristics and credit history, managerial qualities, his wealth position including collateral offered as loan security, and income and repayment expectations. These financial factors often are translated into credit limits through commonly used rules-of-thumb. Examples are lenders' willingness to loan up to 75% of farmlands' current market value, to require a 40% margin of equity in cattle placed on feed, to loan up to 75% of a crop's expected sales value, and to aim for an overall debt-to-equity ratio not to exceed 1.0. The limits often are modified to reflect the managerial characteristics, security position, and financing practices of the individual operators as in the cases of younger, low-equity borrowers, unsecured notes, use of hedging or other risk-reducing marketing practices, installment contracts, dealer credit and so on.

The lending rules produce a credit limit. The difference between the credit limit and the actual loan commitment is the credit reserve. The lending rules reflect a risk premium a lender associates with the contingency of having to liquidate the various assets being financed, while still providing sufficient funds to cover the indebtedness. Moreover, once borrowing has occurred, the farmer's remaining credit reserve becomes more volatile in response to changes in asset values and income expectations. Credit would decline (increase) with lower (higher) market values of crops, livestock, machines, and land at rates that increase as leverage increases.

These characteristics of credit worthiness mean that the relationships between credit as a source of liquidity and holding assets as a source of liquidity are quite similar. That is, the effects of transactions costs, marketability, time, and liquidity risks are about the same whether liquidation occurs by a farmer or by a lender, in the event that a loan reaches forceable liquidation. The effects of capital integrity are similar too since liquidation of many fixed assets is an act toward dissolution of the firm. In general, then, the liquidity risk characteristics of assets extend to holdings of credit reserves and thereby add, along with other determinants of credit, to the costs of holding credit reserves. Credit is positively correlated with net values of assets, given the firm's liability structure, and is positively correlated with net income expectations, given the repayment commitments.

Credit Risks and Optimal Leverage

The effects of credit risk on optimal leverage are shown for a farm investor who can be characterized as an expected utility maximizer. First credit is treated in deterministic terms; then it is treated as a random variable whose properties are expressed through the cost of borrowing. Consider a risk averse farmer who must choose a level of debt (D) with which to leverage equity (E) in financing risky production with total assets (A). Expected returns and variance from investment in risky assets are designated as $\bar{r}$ and σ_r^2, respectively. When credit is specified in deterministic terms, the cost of using credit in borrowing is expressed as interest rate i with zero variance. When credit is treated as a random variable, the cost of using credit in borrowing is expressed as expected rate $\bar{i}$, with variance σ_i^2, and covariance σ_{ri} with returns from risky assets. Hence, a probabilistic concept is used to reflect risk with variance serving as the basis for measuring likelihoods of events occurring that produce results less than expected. Moreover, the cost of credit is considered to be comprised of an interest component i_b that is paid the lender and a liquidity premium i_r reflecting the value of the credit reserve.

To show a closed-form solution, let the investor's utility function be approximated by the negative exponential

1) $U(\pi) = 1 - e^{-2\lambda\pi}$

where λ reflects the degree of risk aversion ($\lambda>0$) and π is the level of income. Freund has shown that maximizing the expected value of a negative exponential integrated over a normal density function, as is assumed now for r and later for i, is equivalent to maximizing

2) $E[U(\pi)] = E(\pi) - \lambda\sigma_\pi^2$

Notation $E(\pi)$ and $\sigma_\pi^{\ 2}$ now represent the expected profits and variance, respectively, of the investor's portfolio. Expected profits are defined as the returns generated by assets less the cost of borrowing

3) $\pi = \bar{r}A - iD,$

and portfolio variance is

4a) $\sigma_\pi^2 = \sigma_r^2 A^2$

where debt is specified in deterministic terms, and

4b) $\sigma_\pi^{\ 2} = \sigma_r^{\ 2}A^2 + \sigma_i^{\ 2}D^2 + 2AD\sigma_{ri}$

where debt is a random variable.

For the deterministic credit case, substituting the expressions in equations 3) and 4a) into equation 2) yields

$$5)\quad E[U(\pi)] = E[rA - iD] - \lambda[\sigma_r^2 A^2].$$

Substituting D + E = A and considering the level of debt (D) as the decision variable, the first order condition for an expected utility maximizing level D* is

$$6)\quad dU(\pi)/dD = \bar{r} - i - 2\lambda\sigma_r^2 D - 2\lambda\sigma_r^2 E = 0$$

which gives optimal debt of

$$7)\quad D^* = \frac{\bar{r} - i - 2\lambda\sigma_r^2 E}{2\lambda\sigma_r^2}$$

Differentiating 7) with respect to $\bar{r}$, i, λ, σ_r^2 and E shows the following comparative static properties

$$8a)\quad dD^*/d\bar{r} = \frac{1}{2\lambda\sigma_r^2} > 0$$

$$8b)\quad dD^*/di = \frac{-1}{2\lambda\sigma_r^2} < 0$$

$$8c)\quad dD^*/d\lambda = \frac{-\bar{r} + i}{2\lambda^2\sigma_r^2} < 0$$

$$8d)\quad dD^*/d\sigma_r^2 = \frac{-\bar{r} + i}{2\lambda^2\sigma_r^4} < 0$$

and

$$8e)\quad dD^*/dE = -1 < 0$$

These results show that optimum debt use increases as rates of return on assets increase and decreases in response to increases in cost of credit, risk aversion, variance of return, and equity. All these results are reasonable, although the trade-off between equity and debt in expression 8e) appears unusual. However, it is consistent with the constant absolute risk aversion assumption that characterizes a negative exponential utility function. Hence, increasing wealth (E) does not cause a change in holdings of risky assets (A); rather, it allows a reduction in risk-free debt while holding constant the level of risky assets. Holdings of risky assets, and thus debt, would only increase with equity if risk aversion (λ) decreases or if some other parameter value changes accordingly.

For the case where credit is considered a random variable, the expression for expected utility maximization becomes

$$9)\quad E[U(\pi)] = E(\bar{r}A - \bar{i}D] - \lambda[\sigma_r^2 A^2 + \sigma_i^2 D^2 + 2AD\sigma_{ri}]$$

Again, substituting D + E = A and considering the level of debt as the decision variable, the first order condition for an expected utility maximizing level D* is

$$10)\quad dU(\pi) = \bar{r} - \bar{i} - 2\lambda\sigma_r^2 D - 2\lambda\sigma_r^2 E - 2\lambda\sigma_i^2 D - 4\lambda D\sigma_{ri} - 2\lambda E\sigma_{ri} = 0$$

which gives optimal debt of

$$11)\quad D^* = \frac{\bar{r} - \bar{i} - 2\lambda E(\sigma_r^2 + \sigma_{ri})}{2\lambda(\sigma_r^2 + \sigma_i^2 + 2\sigma_{ri})}$$

Comparative static properties are as follows

$$12a)\quad dD^*/d\bar{r} = \frac{1}{2\lambda(\sigma_r^2 + \sigma_i^2 + 2\sigma_{ri})} > 0$$

$$12b)\quad dD^*/d\bar{i} = \frac{-1}{2\lambda[\sigma_r^2 + \sigma_i^2 + 2\sigma_{ri}]]} < 0$$

$$12c)\quad dD^*/_{d\lambda} = \frac{-\bar{r} + \bar{i}}{2\lambda^2(\sigma_r^2 + \sigma_i^2 + 2\sigma_{ri})^2} < 0$$

$$12d)\quad dD^*/d\sigma_r^2 = \frac{-\bar{r} + \bar{i} - 2\lambda E(\sigma_i^2 + \sigma_{ri})}{2\lambda(\sigma_r^2 + \sigma_i^2 + 2\sigma_{ri})^2} < 0$$

$$12e)\quad dD^*/dE = \frac{-(\sigma_r^2 + \sigma_{ri})}{\sigma_r^2 + \sigma_i^2 + 2\sigma_{ri}} < 0$$

$$12f) \quad dD^*/d\sigma_i^2 = \frac{-\bar{r} + \bar{i} + 2\lambda E(\sigma_r^2 + \sigma_{ri})}{2\lambda(\sigma_r^2 + \sigma_i^2 + 2\sigma_{ri})^2} < 0$$

$$12g) \quad dD^*/d\sigma_{ri} = \frac{-\bar{r} + \bar{i} - \lambda E(\sigma_i^2 - \sigma_r^2)}{\lambda(\sigma_r^2 + \sigma_i^2 + 2\sigma_{ri})^2} < 0$$

Comparison of expressions for optimal debt in equations 7) and 11) indicates that the addition of risk measures for credit will mostly lead to lower use of debt, although the result depends upon the level of covariance σ_{ri}. To illustrate, set equations 7) and 11) equal to each other and solve for σ_{ri}. The result is

$$13) \quad \hat{\sigma}_{ri} = \frac{\sigma_i^2(2\lambda\sigma_r^2 E - \bar{r} + \bar{i})}{2(\bar{r}-\bar{i}-\lambda\sigma_r^2 E)}$$

As long as the actual σ_{ri} exceeds $\hat{\sigma}_{ri}$, the optimal level of debt derived with equation 11) will be less than the level of debt derived with equation 7). Suppose, for example, that the variables have the following values: $\bar{r} = .12$, $\bar{i} = .08$, $\sigma_r^2 = .0016$, $\sigma_i^2 = .0004$, $\lambda = .0000624$, and $E = \$100,000$. The value of $\hat{\sigma}_{ri}$ then is $\hat{\sigma}_{ri} = -.00013$, which requires negative covariance in order for debt use to increase when credit is a random variable.

Comparative static properties are similar to those for the deterministic credit case. Optimal debt use increases as rates of return on assets increase and decreases in response to increases in costs of credit and risk aversion. Debt use generally should decrease with increases in risk measures too, although strongly negative covariances between credit costs and rates of return might result in debt increases.

In general, these results appear consistent with intuitive judgments about financial structure and credit risk. However, it is important to note that they are conditional by use of expected utility maximization, by the choice of utility function, and by the normality assumption about both $\bar{r}$ and $\bar{i}$. In the case of credit cost i, for example, there may be good reasons why a lender's credit responses to farm risks would not be normal, perhaps reflecting his failure to share proportionately in the farmer's gains and losses. Nonetheless, these assumptions are maintained through the analysis.

Measuring Credit Risks

Measuring credit risks for farmers would be fairly straightforward if lenders' risk responses were expressed solely as adjustments in risk premiums on interest rates for loans. Under these conditions the strength of association between responses of interest rates on individual loans and changes in farm risks would show the part of credit risk that is attributed to individual farmer's credit worthiness. Similarly, the strength of association between interest rate changes induced by conditions in financial markets and changes in farm loan demand would show the part of credit risk attributed to market forces.

However, measurement of credit risk is hampered by lack of explicit risk pricing on loans by lenders to reflect their judgment about farmers' credit worthiness and availability of loan funds. Interest rates on loans from major nonreal estate farm lenders like rural banks and Production Credit Associations seldom vary much among individual borrowers. Even when rates do vary, the response may be more to differences in loan sizes and costs of lending than to differences in risk. Instead, lenders' risk responses to differences in farmers' credit worthiness primarily are reflected in nonprice results that include differing loan limits among borrowers, and differences in security requirements, loan maturities, loan supervision and documentation, and other means of credit administration (Baker; Barry & Willmann; Robison & Barry).

Changes in availability and cost of loan funds that arise from forces in financial markets are more likely to be expressed in interest rates, although differences in sources and uses of funds among major types of farm lenders cause other differences in their loan policies. Farm Credit System (FCS) lenders, for example, acquire most of their loan funds from national financial markets through sales of consolidated bonds or discount notes that occur under highly competitive conditions. Hence, their access to loan funds is considered unlimited as long as they pay market interest rates. In turn, loan funds are priced to farm borrowers with variable interest rates that periodically are adjusted for changes in average cost of funds, reserve or capital requirements, or other costs of intermediation. These loans also are considered exempt from state usury laws. So, observations on changes in interest rates on FCS loans should closely indicate the part of farmers' credit risk that is attributed to changes in financial market conditions.

In contrast, changes in interest rates at smaller rural banks are less satisfactory as indicators of credit risk attributed to financial market conditions. Rural banks rely heavily on local markets for attracting deposits as their major source of funds. Demand deposits have no interest cost and rates on all time deposits but large, negotiable certificates of deposits have legal limits. Hence, factors affecting fund availability for rural banks are much more insulated from national financial markets than for larger urban banks and for FCS. When needed, nonlocal sources of bank funds generally are sought from correspondent banks through purchases of federal funds or through loan participations that are priced with a combination of interbank balances and interest rates (Barry; Benjamin). Moreover, relatively few farm loans from rural banks are priced with variable interest rates. Data from the Federal Reserve System indicate that in late 1978 only about 13% of the amount of farm loans by U.S. banks occurred with a floating (variable) rate. Use of floating rates increased slightly with size of farm loans and increased greatly for the largest banks.

Lenders' nonprice responses to changes in farm risks and to changes in financial market conditions, especially in rural banks, mean that attempting to measure linkages between historic changes in interest rates, farm risks, and farm loan demands is not an effective way to reflect farm credit risks. Instead estimates are needed on how the lenders' nonprice responses are related to farm risks and farm loan demands. Moreover, the lenders' nonprice responses also make it difficult to express credit risk in terms of a farmer's costs of borrowing as occurred in deriving optimal leverage in the preceding section.

The relationship between farmers' costs of borrowing and lenders' nonprice credit responses to risk is shown by using earlier approaches to optimal credit use that account for the liquidity premium on a credit reserve (Barry & Baker; Barry, Hopkin & Baker; Baker & Bhargava). This approach specified optimal credit allocation as an equilibrium reflecting equality at the margin between a payoff schedule from using borrowed funds in the farm business and a cost of credit schedule that includes both the interest obligation to the lender and a credit reservation price reflecting the farmer's liquidity premium on maintaining the credit reserve. The liquidity premium signifies the liquidity risk component of the farmers' total portfolio risk and is determined by the level of risk aversion.

Panel A of Figure 2 shows, for example, that a farmer who exhibits increasing cost of credit V_i and decreasing payoff from credit V_L will allocate 70% of total credit OC to borrowing in amount OA and 30% to reserve in amount AC. However, total credit OC now is considered a random variable that is characterized by a probability distribution (P) with mean $\overline{c}$ and standard deviation, σ_c. Once borrowing has occurred in amount OA, events that reduce (increase) total credit will be absorbed entirely by reduction (increase) in the size of the credit reserve. A loss (gain) in credit reserve will raise (lower) the farmer's liquidity premium on the remaining reserve, and thereby increase (lower) his total cost of credit.

Suppose, as indicated in panel B, that total credit is reduced by 20% to OC^1. Original borrowing in amount OA means that 87.5% = (70%/80%) of credit OC^1 now is committed to borrowing with only 12.5% in reserve. Costs of credit increases to $i^1 = i_b + i_r{}^1$ due to the increased liquidity premium, resulting in a nonoptimal credit allocation. Alternatively, if total credit increases by 20% to OC^{11} (Panel C), borrowing of OA means that 58% = (70%/120%) of credit OC^{11} now is committed to borrowing with 42% in reserve. Costs of credit then declines to $i^{11} = i_b + i_r{}^{11}$ due to the lower liquidity premium.

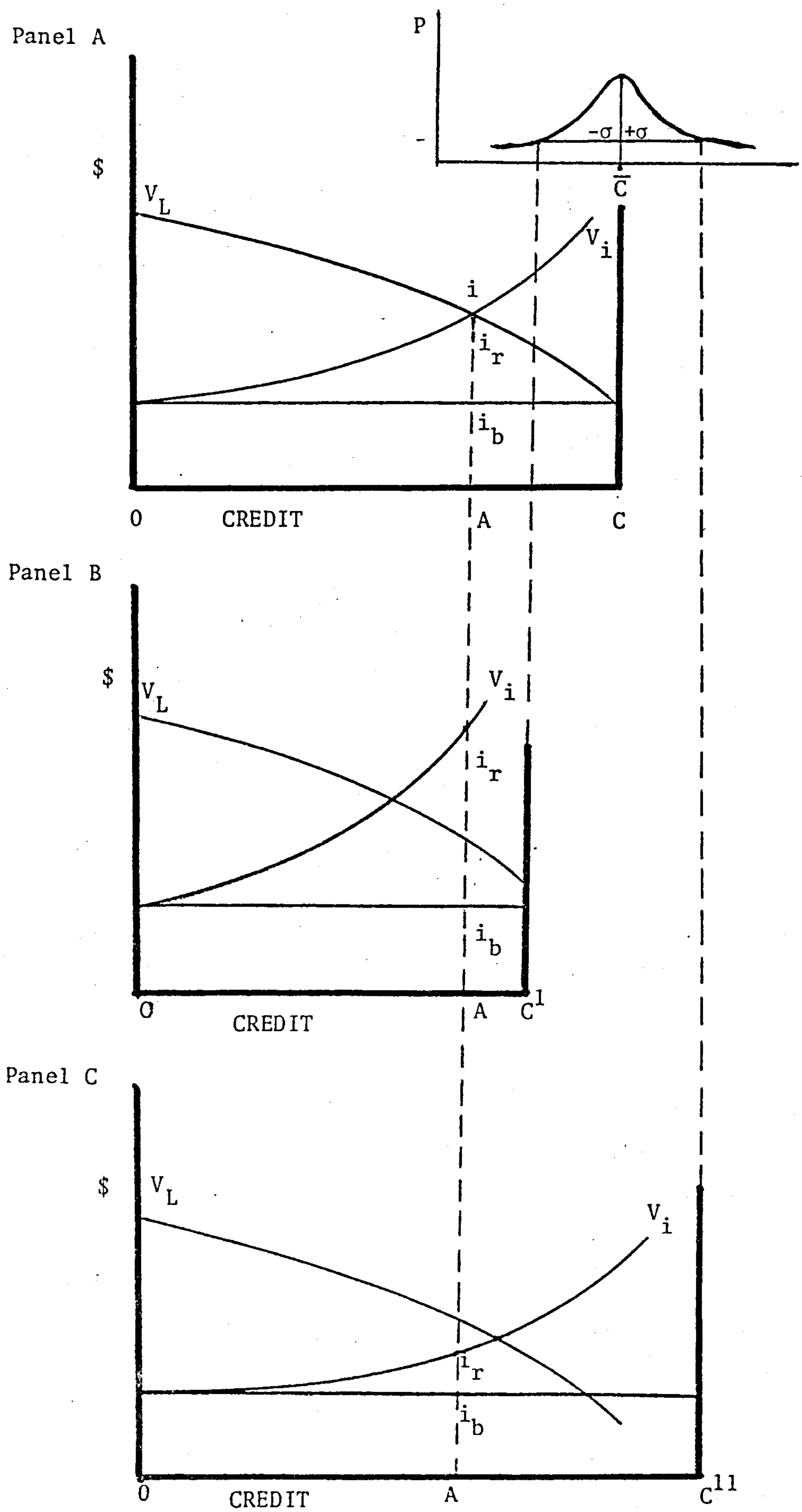

FIGURE 2: Credit Variations and Costs

Hence, variations in the lenders' nonprice responses, shown here by variations in credit limits, are directly related to a farmer's costs of credit. Moreover, measures of credit risk can be shown by the mean and variance of credit, and by its correlation with factors affecting farmers' financial performance and demand for loans. The following analysis focuses on procedures for measuring two components of credit risk arising from farmers' borrowing activities with rural banks: credit in response to risks in farm operations; and credit in response to lenders' availability of loan funds.

Credit and Farm Risks

To illustrate the relationship between credit and farm risks, suppose as before, that a farmer's income is a random variable expressed in terms of a normal probability distribution with known mean and standard deviation. As indicated in Figure 3, confidence limits can be established about the mean, and likelihoods of events occurring above or below designated levels can be estimated. At any given time, the farmer's credit is evaluated, in part at least, by the level and riskiness of his expected rate of return. So, as actual rates of return vary about the expected value, credit also should vary. Lower credit availability (or higher credit costs) should result from lower farm returns and higher credit availability (or lower credit costs) should result from higher returns.

The procedure suggested here for measuring this linkage between farmers' income variation and credit is to simulate a case farm whose level and standard deviation of expected income are estimated from an historic time series of prices, yields and costs, and then to elicit credit evaluations for the case farm from a sample of lenders based on selected gain and loss conditions. In turn, the likelihoods associated with the gain and loss conditions are derived with risk parameters estimated from the historic series. Thus, a "moderate gain" might be the occurrence of actual income that is 1.0 standard deviation above the expected value; a "favorable gain" might be actual income that is 1.5 standard deviations above the expected value. Similarly, "moderate loss" and "severe loss" might be occurrences of actual incomes that are 1.0 and 1.5 standard deviations, respectively, below the expected value. In this way, the resulting variations in lenders' credit responses can be correlated with variations in farmers' income on the basis of the latter's known statistical properties.

This approach was implemented by following credit elicitation procedures of earlier studies (Baker; Barry & Willmann) where lenders responded through a survey to a case loan request for a representative farming situation. Here, the loan request contains the case farmer's financing needs for operating expenses, capital expenditures, and other cash obligations for the coming year. The total loan request was set high enough to anticipate the lender's rejection and designed for deletion of individual items until loan approval was obtained. The approved loan request then signifies total borrowing capacity for each risk condition.

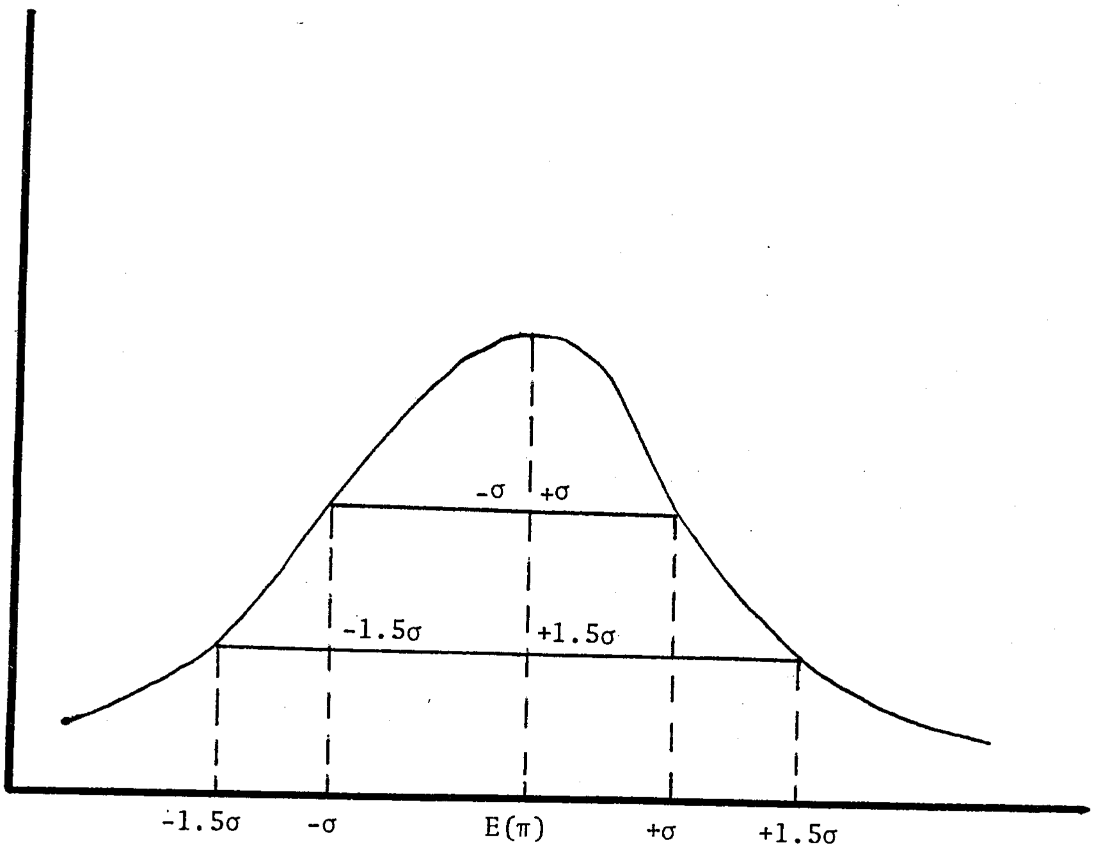

FIGURE 3: Income Distribution

Loan documentation is provided by financial statements showing financial performance for three sets of risk conditions experienced by the farmer in the preceding year. Two replications of this procedure accounted for the moderate and severe cases. In the first replication lenders were asked to indicate the total loan granted for average and moderate conditions experienced by the farmer in the preceding year. The first case, called the average case, assumed that the farmer experienced an average or expected level of performance in the preceding year. The second case, called the adverse case, assumed that the farmer experienced a below average level of performance in the preceding year with a combination of prices and yields resulting in losses that might occur in one out of six years. The third, favorable case assumed that the farmer experienced above average performance in the preceding year with prices and yields resulting in gains that might occur in one out of six years. These levels of variation roughly fall within one standard deviation of the expected value.

The second replication differed from the first only in the magnitude of gain and loss experienced by the farmer. Results for the adverse and favorable cases were modified to reflect yield and income conditions that might occur in one out of 15 years--occurring about 1.5 standard deviations from the expected value. In all cases, the representative farm was characterized as a young, established farmer whose management ability was known. Hence, variations in income were due to random factors. Moreover, the sequence of borrowing needs and types of lenders were fixed so that their variations had no influence on the lenders' credit responses.

Besides the lenders' designation of loan limits for these risk conditions, they also were asked to provide information on other loan terms that might reflect their response to the case farmer's risk position. These loan terms included the interest rate charged on the loan under the stipulated farm income conditions, security or collateral requirements, and any other loan requirements. Thus, while the survey focused on total borrowing capacity associated with the various farm risk conditions, it also generated information on other potential risk responses by lenders.

A mail survey was sent in fall 1979 to 101 unit banks and production credit associations in south-central and eastern Texas. Banks in the sample were required to have more than $1.2 million in farm loans to assure familiarity with farm financing. Fifty lending institutions responded to the survey; however, 16 responses were negative due to several reasons: failure to make the type of loan outlined in the survey, the large loan size, lack of time to complete the survey. Thirty-four useful responses occurred from 25 banks and 9 PCA's, with 19 responses from replication 1 and 15 responses from replication 2.

Table 1 reports farm characteristics and sizes of loan request for the five risk cases, and averages of the lenders' loan limits for each risk case. Averages of loan granted are indicated in dollar values and as percentages of original loan request. Using percentages accounts for differences in size of the operating loan requests for the loss situations that result from the need for additional, carryover financing.

Preliminary appraisal of the survey results indicates a positive relationship between the farm's credit and the level of farm financial performance in the previous year. The average loan granted and percentages of loans granted are small for the loss situations, and increase as the representative farm's income conditions become more favorable. As an example, the percentage of total loan granted increases from 57% for the severe loss to 82% for the favorable gain.

However, the results also indicate that lenders tend to differentiate their credit response between loans for operating purposes and loans for capital purchases. Most of the credit adjustment occurs in the loan limits for capital purchases where the percentage of loan granted ranges from 16% for the severe loss to 69% for the favorable gain. In contrast, credit for operating expenses, including carryover loans, appears much more stable with percentages of loan granted ranging from 78% for the severe loss to 90% for the favorable gain. Hence, based on these preliminary results, credit reserves for capital items appear to have much stronger correlation with variations in farm income in the previous year than do credit reserves for operations. These numerical results are consistent with many lenders' written comments on the survey indicating that, when occasional farm losses are anticipated, there is need for both farmer and lender to exert careful financial control to see the operation through the adverse period. Restricting capital transactions is a favored control mechanism.

Numerical results also indicate that lenders appear more responsive to the occurrence of loss or gain, than to the actual magnitudes of the loss or gain. The credit response for a moderate loss or gain, relative to the average case, appears much more significant than does the credit response between a moderate and severe loss, or a moderate and favorable gain. This lack of strong response to the extreme conditions may reflect the lender's lack of sharing in the farmer's short-run profits or losses. The credit responses might differ for two or more consecutive years of loss or gain.

Survey responses about other methods of risk response by lenders indicated small differences in security requirements, although security interests in crops, machinery and equipment were unanimous. In some cases, liens on real estate and credit life insurance were required. No differences in interest rates occurred among lenders or among the risk cases because market interest rates were high enough to be limited by state usury laws. Hence, nonprice loan methods were the lenders' sole response to farm risks.

TABLE 1

Results of Lender Survey for Farmers Income Variation

	Farm Income Conditions					
	Case 1: Severe Loss	Case 2: Moderate Loss	Case 3: Average Conditions Rep. 1	Case 3: Average Conditions Rep. 2	Case 4: Moderate Gain	Case 5: Favorable Gain
Farm Characteristics						
Farm Receipts	$ 63,893	84,498	125,707	125,707	166,917	187,520
Additions to Retained Earnings	$(45,690)	(25,085)	11,036	11,036	28,154	35,198
Net Worth	$239,619	260,224	296,345	296,345	313,463	320,507
Debt-to-Equity Ratio	.79	.65	.50	.50	.46	.44
Loan Request						
Operating Loan						
Expenses	$127,549	127,549	127,549	127,549	127,549	127,549
Carryover	$ 34,482	17,877	0	0	0	0
Capital Purchase Loan	$ 76,550	76,550	76,550	76,550	76,550	76,550
Total Loan Request	$242,581	221,976	204,099	204,099	204,099	204,099
Loan Granted						
Average Operating Loan Granted	$125,676	120,493	111,309	112,428	116,482	114,524
Average Capital Loan Granted	$ 11,967	15,592	37,078	36,368	50,349	52,705
Average Total Loan Granted	$137,643	136,085	148,387	148,795	166,831	167,229
Percent of Operating Loan Granted	78%	83%	87%	88%	91%	90%
Percent of Capital Loan Granted	16%	20%	48%	48%	66%	69%
Percent of Total Loan Granted	57%	61%	73%	73%	82%	82%

Credit and Loan Fund Availability

One approach to measuring risk associated with loan fund availability in rural banks is to correlate bankers' expectations about changes in farmers' loan demand with their expectations about changes in fund availability. A high correlation would indicate that fund availability tends to be high when demands for farm loans are high. As a result, farmers' risks associated with credit availability would be low. A low or negative correlation would indicate that fund availability is low when demands for farm loans are high. As a result, farmers' risks from credit availability would be relatively high.

Measures on these expectations are based on responses of several hundred bankers in the Seventh Federal Reserve District to quarterly surveys about farm lending conditions conducted by the Federal Reserve Bank of Chicago. Included in these surveys are questions about loan demand, fund availability, loan repayment rates, renewals or extensions, collateral requirements, loan-to-deposit ratios, and interest rates on farm loans. Bankers' responses are aggregated by Federal Reserve economists and reported in terms of relative frequencies or averages (Federal Reserve Bank of Chicago; Board of Governors of the Federal Reserve System).

On several items, bankers are asked whether conditions during the current quarter of the year are higher, lower, or the same as in the year earlier period. Index numbers for these items then are computed by subtracting the percent of bankers that respond "lower" from the percent that respond "higher" and adding 100. As examples, since 1970 the index for "loan demand" ranged from a low of 114 in the first quarter of 1971 to a high of 169 in the third quarter of 1977. Hence, the bankers' expected growth in farm loan demand is indicated by the index never falling below 100 during this period, although differences in levels of expected growth still are reflected by variations in the index.

In contrast, the index of fund availability shows considerably more variation with several movements around 100. It rises from 80 in the first quarter of 1970 to 149 in the second quarter of 1972, then remains fairly high for several quarters until declining rather rapidly to a low of 69 in the fourth quarter of 1974. The index then climbs to around 130 until early 1977 when it declines to a decade low of 51 in the second quarter of 1979. In a similar fashion, bankers' preferences for lower loan-to-deposit ratios follow fairly closely the index of fund availability. Thus, the index for preferences about loan-to-deposit ratios may serve as an alternative measure of fund availability. Figure 4 charts the pattern of changes in two of these indexes over the 1970 to 1979 period.

Data in Table 2 show correlation coefficients and other statistics for the quarterly series of index values for loan demand and fund availability in the Seventh Federal Reserve District for the period beginning in 1970 and extending through the second quarter of 1979. The correlation coefficient is negative .23 indicating that farmers' risks associated with fund availability from these commercial banks are fairly high in light of past patterns of their loan demand. Moreover, the higher coefficient of variation for fund availability indicates its relatively greater variation than farmers' demand for loans.

TABLE 2

Measures of Credit Conditions at
Seventh Federal Reserve District, Agricultural Banks, 1970-79

Index	Mean	Standard Deviation	Coefficient of Variation	Fund Availability	
				Covariance	Correlation
Loan Demand	138.13	13.16	.095	-82.37	-.226
Fund Availability	110.71	27.68	.250	NA	NA
Average Loan-to-Deposit Ratio	57.55	3.80	.066	-79.30	-.75
Banks with Loan-to-Deposit Ratio Above Desired Level	110.32	21.09	.191	511.78	.876

Further evidence about fund availability is provided by the relationship between the index for fund availability and the index for preferences about loan-to-deposit ratios. The correlation coefficient between these two indexes for the 1970-1977 time period is .876. This relatively high correlation means that fund availability is very low (high) at a time when bankers prefer lower (higher) loan-to-deposit ratios. Finally, banks' actual loan-to-deposit ratios also show a close relationship with bankers' responses about fund availability. However, this relationship is inverse, as reflected in a correlation coefficient of negative .75. Thus the index for fund availability tends to be low (high) when the actual loan-to-deposit ratio is high (low). However, coefficients of variation for the series of loan-to-deposit ratios and fund availability indexes indicate that the fund availability index shows relatively higher variation about its mean than does the loan-to-deposit ratio.

An important advantage of using these survey responses is that they reflect the lenders' expectations about future credit conditions. Presumably these expectations are used in managing bank portfolios. However, it is not clear whether the expectations on loan demand might reflect transfers of farm customers to other lenders, or whether expectations on availability of loan funds indeed are independent of changes in loan demands. Hence, several sources of bias may influence the lenders survey responses.

Managerial Implications

Concepts and empirical results reported here have shown that credit risk is an added element of financial risk, and therefore of farmers' total portfolio risk. Consequently, the effects of credit risk must be accounted for in developing managerial responses to changes in factors affecting farm business risks. To show the effects of credit risk on portfolio adjustment, we introduce a conceptual framework and empirical results developed by Gabriel and Baker that show how the distinction between business and financial risk is important in understanding farmers' responses to changes in risk. Their approach and empirical results are briefly introduced and shown to give similar conceptual results to the derivation of optimal leverage that is given in a preceding section. Then we consider how the addition of credit risk might further influence managerial responses to risk.

Gabriel and Baker define business risk as the variability of net operating income or net cash flows that is independent of the firm's financial organization. Hence it is reflected by the risky return (σ_r) on total assets (A). Financial risk is the added variability of net returns to equity holders that results from the fixed financial obligations associated with debt financing and (cash) leasing. Following their approach, but with notation used in this paper, and assuming that credit risk is zero, financial risk may be expressed as

$$13)\quad FR = \frac{\sigma_r A}{\bar{r}A} \cdot \frac{iD}{\bar{r}A - iD}$$

Hence, financial risk is determined by the degree of business risk inherent in the firm, $\sigma_r A/\bar{r}A$, and the relationship, $iD/(\bar{r}A-iD)$, which is determined by the financing decisions.

Total risk (TR) can then be expressed by its components as

$$14a) \quad TR = \frac{\sigma_r A}{\bar{r}A-iD}$$

or

$$14b) \quad TR = \frac{\sigma_r A}{\bar{r}A} \cdot \frac{\bar{r}A}{\bar{r}A-iD}$$

where the first term to the right of the equality reflects business risk and the second term reflects the change in risk attributed to the financing decision. Higher leverage increases the ratio $\bar{r}A/(\bar{r}A-iD)$, and thus increases total risk relative to business risk.

Gabriel and Baker introduce the concept of risk balancing by showing how trade-offs between business and financial risk may occur as a farmer is constrained to maximum level of total risk tolerance. That is, a decline in business risk may lead to the acceptance of greater financial risk, thereby offsetting the effects of the diminished business risk on total risk. In this fashion, the decision maker adjusts his portfolio in response to changes in business risk, and to changes in other parameters, so as to maintain a portfolio organization that is optimal with respect to his objective function. The nature of this adjustment process is similar to that of the expected utility maximizing farmer whose optimal debt and related comparative static properties were derived in equations 1) through 8). In equation 8d), for example, optimal debt, and thus leverage, was shown to decrease (increase) in response to an increase (decrease) in variance of return on risky assets. This result signifies an increase in financial risk from higher leverage in response to a reduction in business risk, in order to maintain an expected utility maximizing portfolio, and provides a result consistent with that of Gabriel and Baker.

Gabriel and Baker tested the risk balancing hypothesis empirically using the following model as a basis for regression analysis of aggregative data for the period 1949-1976

$$15) \quad FR = f(CV_{t-1}, (I/D)_{t-1}, (NI/A)_{t-1}, \%CH\ LND_{t-1}),$$

where CV_{t-1} = a five-year moving coefficient of variation of net operating income for the farm sector of the U.S. (CV_{t-1} is based on net operating income for years t-1, t-2, t-3, t-4 and t-5.)

$(I/D)_{t-1}$ = the ratio of total interest payments to total debt in year t-1.

$(NI/A)_{t-1}$ = the ratio of net income to total assets in year t-1.

$\%CH\ LND_{t-1}$ = % change in the land price index from March year t-1 to March year t.

FR_t = the ratio $iD/_{(\bar{r}A-iD)}$ in year t.

Factors other than business risk are assumed to influence the decision makers' ability and/or willingness to make adjustments in the firms' financial risk. Among those factors are the average cost of debt capital and the profitability of assets. In addition, changes in the price of land are assumed to affect firm liquidity as credit adjusts to new equity values.

The data used in the regression equation were aggregate income, balance sheet, and farmland price data provided by USDA publications, Farm Income Statistics, Balance Sheet of the Farming Sector, and Farm Real Estate Market Developments. While the variable definitions are straightforward, some clarifications are needed. Although cash rental obligations increase financial risk, the available figures on rental payments are "contaminated" with share type rental payments which do not affect financial risk. Consequently rental obligations were excluded as an element of financial risk. In addition, data on principal payments on debt are not available so that the net operating income definition of business risk was employed.

Although the conceptual framework presented here is micro in nature, the preliminary test of the risk balancing hypothesis used aggregate data. The aggregative analysis was used because of difficulty in obtaining adequate farm-level data (i.e., a long enough time series for farms). Thus the aggregate results would describe the behavior of the "aggregate of decision makers." Although this approach is inconclusive in itself, it may provide a point of departure for future research.

The regression results (see Table 3) indicate an inverse relationship between business risk (CV_{t-1}) and financial risk. That is, in the aggregate, there appears to be a financial response to changes in business risk which tends to support the risk-balancing hypothesis.

While the other explanatory variables are of secondary interest here, we will look briefly at their role in explaining changes in the dependent variable. The coefficient for $(I/D)_{t-1}$ is positive and significant which indicates, as one might expect, that high (low) debt capital costs lead to high (low) financial risk, *ceterus paribus*.

TABLE 3

Regression Results

	Constant	CV_{t-1}	$(I/D)_{t-1}$	$(NI/A)_{t-1}$	$\%CH\ LND_{t-1}$
Coefficients	-.10	-.24	6.28	-1.58	.20
Std. Errors	.075	.129	1.10	.441	.109
T-Ratios	-1.35	-1.85*	5.71**	-3.59**	1.82*

R^2 = .92 Durbin-Watson Statistic = 1.00***

* Significant at the 5 percent level.

** Significant at the 1 percent level.

*** The Durbin-Watson test for autocorrelation is indeterminant.

The variable $(NI/A)_{t-1}$ displays a coefficient with the expected sign as well as a high level of significance. All things otherwise the same, greater asset profitability should lead to high debt coverage ratios and lower financial risk.

Finally, as stated earlier, land values influence credit availability positively, increasing liquidity and allowing financial risk also to increase. This relationship is supported by the positive and significant coefficient associated with %CH LND.

When credit risks are introduced, the relationships between business risk and financial risk become more complicated. Earlier comparative statis analysis (equations 9-12) showed that strongly negative covariances between farmers' credit costs and rates of return might actually warrant higher leverage in response to increased business risk. In practice, this seems unlikely, since responses of surveyed lenders indicated that their credit responses to variations in farm income appeared to exhibit a strongly positive relationship. Hence, reductions in business risk are associated with reductions in costs of credit, thereby favoring higher leverage. Moreover, evidence on negative correlation between lenders' expectations about changes in farmers' loan demands and changes in availability of loan funds signifies added credit risks for farmers. In any case, credit risks appear to be important factors in overall portfolio risk and warrant further study about their effects on farmers' risk and liquidity management.

REFERENCES

Baker, C. B. "Firm Growth, Liquidity Management, and Production Choices." Production Economics in Agricultural Research AE-4108. Department of Agricultural Economics, University of Illinois, 1966.

Baker, C. B. "Credit in the Production Organization of the Firm." Amer. J. Agr. Econ. 49(1968): 507-521.

Baker, C. B., and V. Bhargava. "Financing Small Farm Development in India." Australian J. Agr. Econ. 18(1974): 101-118.

Barry, P. J., J. A. Hopkin, and C. B. Baker. Financial Management in Agriculture. Interstate Publishers, Danville, Illinois, 1979.

Barry, P. J., and C. B. Baker. "Reservation Prices on Credit Use: A Measure of Response to Uncertainty." Amer. J. Agr. Econ. 53(1971): 222-228.

Barry, P. J., and D. R. Willmann. "A Risk Programming Analysis of Forward Contracting with Credit Constraints." Amer. J. Agr. Econ. 58(1976): 62-70.

Barry, P. J. "Rural Banks and Farm Loan Participation. Amer, J. of Agr. Econ. 60(1978): 214-224.

Benjamin, Gary. "Correspondent Banking in Illinois: Credit Flows and Pricing Practices." Improved Fund Availability at Rural Banks. Federal Reserve Board of Governors, 1975.

Chen, A. H., F. C. Jen, and S. Zionts. "The Joint Determination of Portfolio and Transaction Demands for Money." J. of Finance. 29(1974): 175-186.

Cropper, M. L. "A State-Preference Approach to the Precautionary Demand for Money." Amer. Econ. Rev. 66(1976): 388-394.

Federal Reserve Bank of Chicago, Agricultural Letter biweekly, 1979.

Federal Reserve Board of Governors Survey of Bank Loans to Farmers.

Freund, R. J. "An Introduction of Risk into a Risk Programming Model." Econometrics 24(1956): 253-263.

Gabriel, S., and C. B. Baker. "Concepts of Business and Financial Risk." Unpublished manuscript, Department of Agricultural Economics, University of Illinois, 1979.

Modigliani, F. "Liquidity Preference and the Theory of Interest and Money." Econometrics 12(1944): 45-88.

Pierce, J. L. "Commercial Bank Liquidity." Federal Reserve Bulletin 52(August, 1966): 1093-1102.

Robison, L. J., and P. J. Barry. "Portfolio Adjustments: An Application to Rural Banking." Amer. J. of Agr. Econ. 59(1977): 311-320.