Factors Influencing a Lender's Decision to Grant North Dakota Farmers Operating Credit

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Highlights

Lenders grant $2.24 billion of nonreal estate credit to North Dakota farmers annually. Their decision involves the granting of credit to both new and existing customers that apply. The decision is complex because the credit-worthiness of farmers varies and loan losses are costly to a financial institution. Financially strong farmers may shift lenders to obtain more favorable terms, expanded financial services and increased security. To gauge an applicant's credit-worthiness, lenders employ a variety of formal and informal methods. If an applicant does not meet a lender's standards, credit is denied.

Previous studies of lender behavior have shown that a borrower's characteristics, including net worth and income generating capacity, primarily determine whether credit is granted in a static single period analysis. Yet, these studies fail to explain an apparent paradox -- why lenders continue to grant credit to selected new borrowers even though they expect above average rates of default and negative returns.

This study uses a stochastic dynamic programming framework and an experiment designed to collect data from a panel of lenders to show that such a decision is indeed profit maximizing if it is evaluated over longer periods of time. After granting credit for one period, lenders receive information that sufficiently improves decision making in subsequent periods.

When evaluated in a dynamic setting, a lender's discount rate, the borrower's future repayment status and patronage become equally important factors in a lender's decision to grant new farmers credit. These variables, in addition to varying costs of funds, administrative expenses and profit margins explain why farmers may be granted credit by one lender and not another. The results also show that lenders appear willing to incur a significant short run cost in an effort to acquire long term customers.

Factors Influencing a Lender's Decision to Grant
North Dakota Farmers Operating Credit

An apparent paradox exists in agricultural credit. Despite high
levels of default and negative rates of return, lenders continue to grant
operating credit to farmers with whom they have no prior business
experience. Previously, such behavior was rationalized as an altruistic
public service to small rural communities. Increased capital and
agricultural production expands an area's economic base and development
(Ginder, Stone and Otto).

This article demonstrates that the lender's behavior is indeed profit
maximizing if it is evaluated in a dynamic rather than static setting.
After granting credit for one period, lenders receive information that
sufficiently improves decision-making in subsequent periods. Therefore,
extension of credit over a period of time is profitable whereas average
returns for the first period are not.

A borrower's characteristics, including net worth and income-
generating capacity, primarily determine whether an operating loan is
granted in a static single-period analysis (Sonka et al.). When the credit
granting decision is evaluated in a dynamic setting, a lender's discount
rate and subjective estimate of a borrower's conditional probability of
default and patronage in future periods become equally important factors.
These variables, in addition to varying costs of funds, administrative
expenses and profit margins explain why farmers may be granted credit by one
lender and not another.

Organization of the paper is as follows: the next section briefly
describes the extent and characteristics of the management problem. This
general discussion is followed by specification of a stochastic dynamic
programming (DP) optimization model. An experiment designed to collect data
from a panel of lenders for purposes of model estimation is discussed in the
third section. Statistical results and optimal decision rules are presented
in the fourth section. The final section summarizes the study's findings
and discusses possible limitations.

The Lender's Dilemma

Lenders granted $2.24 billion of nonreal estate credit to North
Dakota farmers in 1985 (USDA). This total consists of both operating and
intermediate debt. To reduce transactions costs and increase flexibility,
lenders frequently combine both types of debt into a single, renewable
"master note"[1]. Hence, intermediate credit is often treated as operating
credit. Each year lenders must decide whether to grant operating credit to
new and existing customers that apply.

During 1986, 6.9 percent of North Dakota farmers change financial
institutions (Leistritz et al.). A discontinued line of credit is not the
only reason farmers change lenders. Debt-to-asset ratios of farmers that
switch are evenly distributed over the ranges .01 - .40, .41 - .70 and
greater than .70. Credit-worthy farmers may shift lenders to obtain more
favorable terms, expanded financial services, and increased security[2].

Since farmers of varying financial strengths apply for operating credit, lenders must evaluate each applicant's credit-worthiness. Lenders undertake a large risk when operating credit is granted to new farm customers with low probabilities of repayment. Loan losses, defined as the amount uncollected on a defaulted loan, are very costly to a financial institution (Gustafson et al.; Lee and Baker). When a borrower defaults, lenders lose uncollected principal, acquisition and administrative costs.[3] Due to recent periods of financial stress in the agricultural sector, large loan losses, declining loan volume and deregulation, financial institutions in rural communities are highly leveraged, operate on slim profit margins and are especially vulnerable to failure.

Some lenders formally appraise borrowers. Credit scoring methods price loans in accordance with a borrower's liquidity, leverage, profitability, collateral, tenure, repayment capacity and history, management ability and other personal characteristics (Lufburrow et al.). Lenders price loans explicitly through the use of interest rates, fees, and service charges as well as implicitly by requiring compensating balances, loan limits, collateral, loan documentation and supervision. However, as Lufburrow et al. note, "In general, credit evaluations have mostly occurred through the personal observations and subjective judgments of loan officers, using what data farmers have supplied."

When lenders are unable to price loans in accordance with profit goals, costs of funding and administering the loan, as well as compensation for lending and liquidity risks, credit rationing occurs (Stiglitz and Weiss). In 1984, 9.3 percent of all North Dakotas farmers were refused credit, largely because of insufficient equity or farm income (Watt, Larson, Pederson, and Eckstrom).

Ironically, lenders continue to grant credit to selected new applicants on a trial basis -- fully expecting above average rates of default and negative returns. Although the decision appears irrational in light of pricing and credit rationing options available, granting credit for one period permits discrimination of borrowers in the future because some new borrowers will repay while others default. As lenders revise probabilities of loan repayment based on this new information, the initial credit granting decision becomes rational and profit maximizing when considered in a multiperiod framework. Hence, lenders are willing to incur a significant short run cost in an effort to acquire long term customers. Factors affecting these tradeoffs in the lender's decision are mathematically illustrated with a stochastic DP model.

Stochastic Optimization Model

Optimization problems with separable objective functions and discrete decision variables are readily solved by DP and yield optimal decision rules which are in closed-loop form (Dreyfus and Law). The following model is similar to one formulated by Bierman and Hausman for commercial trade credit in that it accounts for dynamics of repayment, but differs because it

accounts for greater detail including partial repayment and is empirically estimated.

Extending credit to unfamiliar farmers is a risky decision for lenders as repayment is uncertain. Assume one of the following mutually exclusive repayment states i is likely: (a) full repayment of principal and interest [i=1], (b) repayment of interest only [i=2], and (c) default [i=3]. Expected profit (π) in period n is defined as:

$$\pi(n,i) = \sum_{j=1}^{J} p(n,i,j) \, [REV(n,i,j)$$

$$- CF(n) - AO(n,i,j) - LL(n,i,j)] \tag{1}$$

where the probability of transition from state (n,i) to state (n+1,j) is p(n,i,j), REV(n,i,j) is uncertain gross revenue from lending, CF(n) is a lender's cost of funds which is known is advance, AO(n,i,j) are administrative and overhead expenses, and LL(n,i,j) is a loan loss charge for unrecovered principal. Gross revenue is equal from borrowers who repay fully or interest only on outstanding debt and zero from borrowers who default. Administrative and operating expenses vary with repayment status. Loan losses arise when borrowers default.

Lenders are assumed to maximize expected monetary values. The fundamental recurrence relation of DP for this application is:

$$f(n,i) = 0 \qquad\qquad\qquad\qquad \text{for } n = N$$
$$f(n,i) = \max \, [\text{extend credit, deny credit}]$$

$$= \max \, [\pi(n,i) + \alpha\delta\sum_{j=1}^{J} p(n,i,j) \, f(n+1,i,j), \; 0] \; \text{for } n < N \tag{2}$$

where f(n,i) is the expected value of an optimum policy of credit extension from period n to the horizon, α is the probability a borrower will be granted credit again in n+1 and δ is a discount factor.

Initially, lenders must decide whether to extend or deny credit to new applicants. If losses from credit extension are expected to exceed returns, credit is denied and the firm's return is zero.[4] If expected returns are positive, credit is extended and a likelihood α exists that the customer will be granted for credit in future periods. Hence, the firm realizes two returns, a current return and the discounted value of future credit extensions. Each return considers the expected profits and costs of full repayment, partial repayment and default. If credit is granted, lenders must again decide whether to extend or deny credit one period later; as long as credit is granted, the problem recurs in subsequent periods, and returns from those future periods must be considered in solving the present decision.

The second term of equation 2 tends to zero. The probability (α_{t+n}) a customer is granted credit declines as n increases. Further, the discounted value of those returns also falls to zero. These relationships thereby permit a finite analysis and define ending conditions. Horizon year N is the point where the value of the recursive function is zero. Terminating before this date could change the initial decision, although any change is likely to be insignificant for most practical problems.

The credit granting function above has a number of desirable characteristics. It allows for prior probabilities of payment, includes the potential for future profit and permits systematic revision of repayment probabilities based on past experience (Bierman & Hausman).

Transition probabilities from one state to another can be either estimated with historical data or subjectively specified. Bierman and Hausman did not consider partial repayment and conveniently modeled the transition function as a Bernoulli trial. Cumulative outcomes (probabilities of repayment) over time formed a binomial process with unknown parameter p, a random variable distributed according to a beta probability density function with parameters (r, n). The expected value of p is r/n. Revision of prior probabilities is remarkably simple (Raiffa and Schlaifer). If credit is extended n' times and r' collections are observed, parameters of the posterior distribution r'' and n'' and the expected value of p is

$$p = \frac{r''}{n''} = \frac{r + r'}{n + n'} \tag{3}$$

If n is large relative to n', each additional extension of credit has a negligible impact on the probability of repayment.

This simplification requires that (a) an applicant desires a constant dollar amount of credit each period and (b) probabilities of repayment are stationary over the decision horizon. Such assumptions are difficult to make if the granting of operating credit alters farmer's leverage or wealth positions over time.

To keep the above DP model manageable, a traditional Markovian relationship for repayment is postulated:

$$p(n, i, j) = \text{Prob } (x_{n+1} = j \mid x_n = i) \tag{4}$$

indicating the probability of transiting to state j is conditional upon the current state i. Transition probabilities $p(n, i, j)$ have the usual statistical properties:

$$0 \leq p(n, i, j) \leq 1 \tag{5}$$

$$\sum_{j=1}^{J} p(n, i, j) = 1 \tag{6}$$

Experimental Method and Data Collection Procedures

Data to estimate the model were collected in an experimental setting during which lender responses to a simulated borrowing situation were elicited. This approach was selected over other survey methods because it: (a) provided the necessary quantitative and probabilistic information for model estimation; (b) obtained lender's responses to a specific management problem; and (c) minimized the possibility of extraneous variables influencing the lender's decision. Arrow and Simon advocate use of experimental methods when investigating decision making behavior. In addition, the method has been successfully used in the study of Illinois cash grain farmers' investment behavior (Gustafson).

Two representative farm situations, one located in the Red River Valley and the other in the East Central region of North Dakota, were constructed to reflect diverse areas of cash grain production in the state. Data were obtained from adult vocational agriculture farm business summaries (Watt, Johnson, and Ali). The Valley farm consisted of 1,385 acres while the East Central farm involved 2,855 acres. Crops representative of each region (continuous and fallow wheat, barley, sunflowers on the East Central farm on continuous and fallow wheat, barley, and sugarbeets on the Valley farm) were raised; no livestock was produced, crop sales occurred at harvest; participation in government programs was assumed; no off-farm income was available. The Valley farm cash rented 290 acres whereas the East Central farm share rented 1,640 acres. Financial statements for each farm were prepared with the aid of a simulation model.[5]

Financial characteristics of the farms were structured to represent an established borrower who was seeking a lender with lower cost financing. Debt-to-asset ratios were set to .40 for each farm. A panel of farm lenders located outside of each region considered these ratios representative and served as a pretest mechanism for the study.

The first situation was presented to five randomly selected lenders who granted farmers credit in the geographic region surrounding Wahpeton, N.D. and Breckinridge, Minn. while the second situation was introduced to six farm lenders in the Jamestown and Valley City, N.D. areas.[6] Each lender was from a unique commercial bank or Farm Credit Service's office. These two areas were selected because of the high concentration of financial institutions in predominately rural areas of homogeneous farm production.

During the experiment, lenders described the characteristics of their institution were provided with a biographical sketch of the borrower and with historical and projected financial statements from the simulation model and were asked if they would grant the operating loan request (fig.1). If the initial request was denied, the experiment was terminated.

If operating credit was granted, lenders were asked to specify credit terms to subjectively estimate the likelihood the case farm borrower would transit to one of the three possible repayment states, and to estimate the administrative, operating and loan loss expenses associated with each

Randomly select lender

Describe lender's financial institution

Discuss case farm's loan request

Proceed with next state

Does lender grant loan request? —no→ First year?

yes

Have lender specify:

1. Credit terms

2. Transition probabilities

3. Expenses associated with each state

no

yes

Second year completed? —yes→ Terminate

no

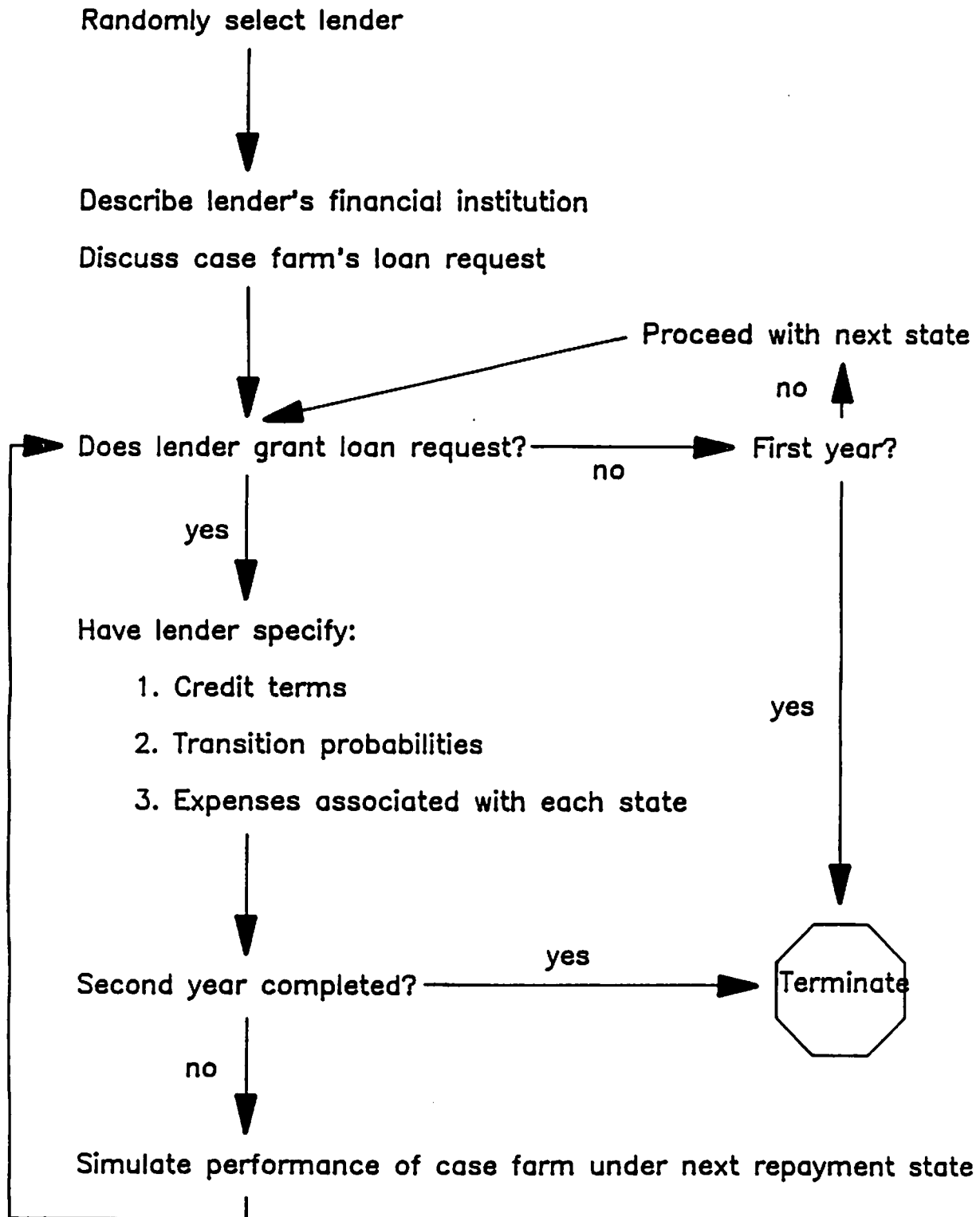Simulate performance of case farm under next repayment state

Figure 1. Experimental Procedure

state. After these data were elicited, the financial performance of the case farm was simulated again for each resulting repayment state.[7] One at a time, updated financial statements (illustrating the case farm's possible financial position and credit application one year hence) were provided to the lender and the experimental process repeated.

To minimize respondent burden, the experiment was only conducted for two consecutive periods. After the second session was completed, lenders were informally asked if third period expectations would significantly differ from those of the second period, given that additional information (more trials) would be available. All of the surveyed lenders stated additional information would not alter their expectations.

A main disadvantage of the experimental method is the abstraction from actual decision situations. In an effort to validate the experimental approach, a research assistant made a incognito formal application for operating credit to one of the financial institutions selected for pretest. The supervisor of the loan officer (who was informed of the trial) was instructed to casually elicit the loan officer's subjective estimate of the applicant's probability of full, partial and no repayment if the loan application was forwarded for review and processing. Similar data to that of the case farm was used to complete the loan application.

One week later, the same loan officer was asked to participate in the experiment. In both instances, the loan officer granted the operating loan request and provided identical probability estimates. Although the loan officer may have offered rote responses, he did so in both real world and experimental settings.

Results

Data collected during the experiment are summarized in table 1. All institutions surveyed had assets of less than $100 million. The average number of agricultural operating loans granted annually per institution ranged from 42 to 250. The size of these operating loans averaged $84,636. Loan size was the only variable that differed statistically by region. Operating loans in the Red River Valley averaged $120,400, while operating loans granted to farmers in the East Central region averaged $54,833. This difference reflects the varying capital requirements of farms in each region. Assets of the representative Valley farm totaled $1.362 million versus $.566 million for the East Central farm. Profit margins on lender's operating loans averaged .77 percent after cost of funds, administrative costs and loan loss charges were deducted.

Farmers with operating loans at these institutions were expected to remain customers for nearly 20 years. Lenders explained that even in light of the recent financial crisis, farmers still used available profits to purchase additional assets and expand the size of their business as opposed to reducing existing debt levels.

TABLE 1. CHARACTERISTICS OF FINANCIAL INSTITUTIONS SURVEYED

Item	Mean	Standard Deviation
Number of operating loans outstanding	120	55
Average operating loan size (dollars)	84,636	60,858
Current interest charged on operating loans (percent)	11.71	1.02
Average cost of funds (percent)	7.85	.92
Administrative costs and loan losses (percent)	3.09	.72
Average length of time farmers remain customers of institution (years)	19.5	6.9

Elicited Repayment Probabilities

Subjectively estimated conditional probabilities of repayment elicited from the lenders are shown in table 2. After evaluating the representative new customer, all of the lenders decided to grant the case farm's operating loan request. Lenders expected full repayment with 87.8 percent probability, payment of interest only with 5.5 percent probability and default with 6.7 percent probability.

After granting operating credit for one period, lenders have more information to appraise the case farm's credit-worthiness. Lenders believe that if the case farm borrower repaid the previous operating loan, the farm is more likely to do so in the future as the expected probability of default drops from 6.73 percent to 1.00 percent. Similarly, if the farm defaults, it expected to do so again in the future. The probability of default given the borrower only pays interest on a previous operating loan, is not statistically different from that of a new borrower — although probability of full repayment is less. Unlike the uniform expectations lenders have for a case farm borrower that fully repays past loans, lender estimates of future repayment status are highly variable for a borrower that either partially repaid or defaulted on previous loans.

The probabilities elicited are stationary with respect to time. This is consistent with lender's statements that farmer's leverage positions and susceptibility to financial risks remain stable over time. For the population as a whole, expected probabilities of full, partial and no repayment in the second period are 89.8, 5.3 and 4.9 percent, respectively -- not statistically different from first period expectations.

TABLE 2. CONDITIONAL OPERATING LOAN REPAYMENT PROBABILITIES ELICITED
FROM SURVEY LENDERS[a]

Status of Case Farm Borrower	Probability of:		
	Full Repayment	Partial Repayment	No Repayment
	percent		
New Customer	87.82 (5.27)	5.45 (2.58)	6.73 (3.85)
Existing Customer that Repaid Previous Operating Loan:			
Fully	96.36 (1.92)	2.64 (1.57)	1.00 (1.04)
Partially	69.82 (19.71)	23.36 (15.98)	6.82 (7.40)
No Repayment	20.00 (22.58)	25.55 (19.93)	54.45 (28.83)

[a]Standard deviations are shown in parentheses.

Optimal Decision Rules

Given the case farm's expected probability of repayment, an average operating loan size of $84,636 and profit margins described above, a myopic decision rule which does not consider the value of future credit extensions is to deny the loan request. Single period expected gross returns are $611.85 but expected costs including those of default are $622.59 resulting in an expected payoff of $-10.74.

Optimal decision rules for granting operating credit over a finite horizon are obtained when the DP credit-granting model is estimated (Table 3). The expected payoff of following such a policy and granting operating credit to the case farm borrower is $1189.77. This value includes the present value of all future credit extensions and the possibility borrower patronage ceases.

At the end of the first period, expected future payoffs of granting operating credit another period to case farm borrowers that fully repaid, partially repaid and did not repay credit in the last period are $1882.35, $1178.28 and $-4584.98, respectively. Hence, an optimal policy at this stage is to deny credit if the borrower defaulted on previous operating

TABLE 3. PRESENT VALUE OF OPTIMAL CREDIT GRANTING POLICY AT EACH DECISION
STAGE

Year	Borrower's Repayment Status, Last Period		
	Full	Partial	Default
		dollars	
1		$1,190^1$	
2	1,882	1,178	$-4,585^2$
3	1,881	1,177	$-4,585^2$
4	1,880	1,176	$-4,585^2$
5	1,878	1,174	$-4,585^2$
6	1,875	1,172	$-4,585^2$
7	1,871	1,168	$-4,585^2$
8	1,865	1,163	$-4,584^2$
9	1,857	1,156	$-4,584^2$
10	1,846	1,146	$-4,584^2$
11	1,829	1,131	$-4,583^2$
12	1,806	1,110	$-4,583^2$
13	1,772	1,081	$-4,582^2$
14	1,723	1,038	$-4,580^2$
15	1,657	978	$-4,578^2$
16	1,561	893	$-4,575^2$
17	1,424	771	$-4,571^2$
18	1,229	598	$-4,566^2$
19	952	352	$-4,557^2$
20	557	-19.66^2	$-4,739^2$

[1]As borrower is a new customer, previous repayment status is unknown.
[2]Credit denied as present value of optimal policy is less than zero.

loans. As operating margins are small and costs of default high, defaulting borrowers are not given a second chance.

Lenders continue to grant the case farm credit until year 20 as long as farmers fully and partially repay. At that time, credit will only be granted if thhe fully repaid in year 19. Future payoffs from extending credit to borrowers that only partially repaid are insufficient to warrant credit extension during the last period.

The repetitive utilization of credit affects the initial credit-granting decision. One reason the myopic and optimal decision rules could differ is if probabilities of repayment for the population as a whole were not stationary with respect to time. However, as noted above, this is not the case. Granting credit to the case farm is only profitable if the borrower continues to patronize the institution in the future.

The value of the optimal policy is sensitive to changes in a lender's discount rate and assessment of a borrower's patronage (fig. 2). As a lender's discount rate increases or expectations of customer patronage decrease, the value of the optimal policy declines. These variables likely differ by lender. Hence, a lender's characteristics, in addition to those of a borrower, determine whether operating credit is granted.

Value of Credit Scoring

There is a second application of the DP credit-granting model. The recursive relationship $f(n,i)$ provides the present value of an optimal credit-granting policy from n to the horizon given repayment probabilities $p(n,i,j)$. The value of techniques employed by lenders when evaluating a borrower's creditworthiness, such as credit scoring and discriminate analysis, which lead to improved estimation of $p(n,i,j)$ can be ascertained with the recursive relationship.

After evaluating the representative new borrower, lenders in the survey expected default on the first year operating loan with 6.7 percent probability. Figure 3 illustrates how improved credit scoring techniques can influence the present value of an optimal credit granting policy. Such methods allow lenders to identify and deny credit to marginal borrowers — increasing the odds remaining customers will repay.

If improved evaluation techniques had led lenders to expect half the default rate, 3.4 percent rather than 6.7 percent, the value of the optimal policy would have risen $414 to $1604. This value would increase further if probability estimates of repayment beyond the first period were also revised upward. Given these payoffs, lenders, either individually or cooperatively with peer institutions, could devote more resources to the development of improved credit-scoring models and place less emphasis on the ad hoc methods of evaluation noted by Lufburrow et al.

Conclusion

Optimal credit-granting policy requires balancing the expected gains from extension against possible losses associated with default. Gains from extending credit not only include those of the current period but the present value of all future returns. Presented in this article is a stochastic dynamic programming model which quantifies the importance of those future returns in the lender's decision. Overall results demonstrate the sensitivity of an optimal policy's value to changes in a lender's discount rate, a borrower's future repayment status and patronage.

A major limitation of this study relates to estimation of the transition probabilities $p(n,i,j)$. When solving any dynamic programming model for a nontrivial number of states, the number of parameters to be estimated soon exceeds available data. In this study, parameters could only be estimated for the first two stages of the problem. Thus, the greatest potential for improving the model would be collection of additional data
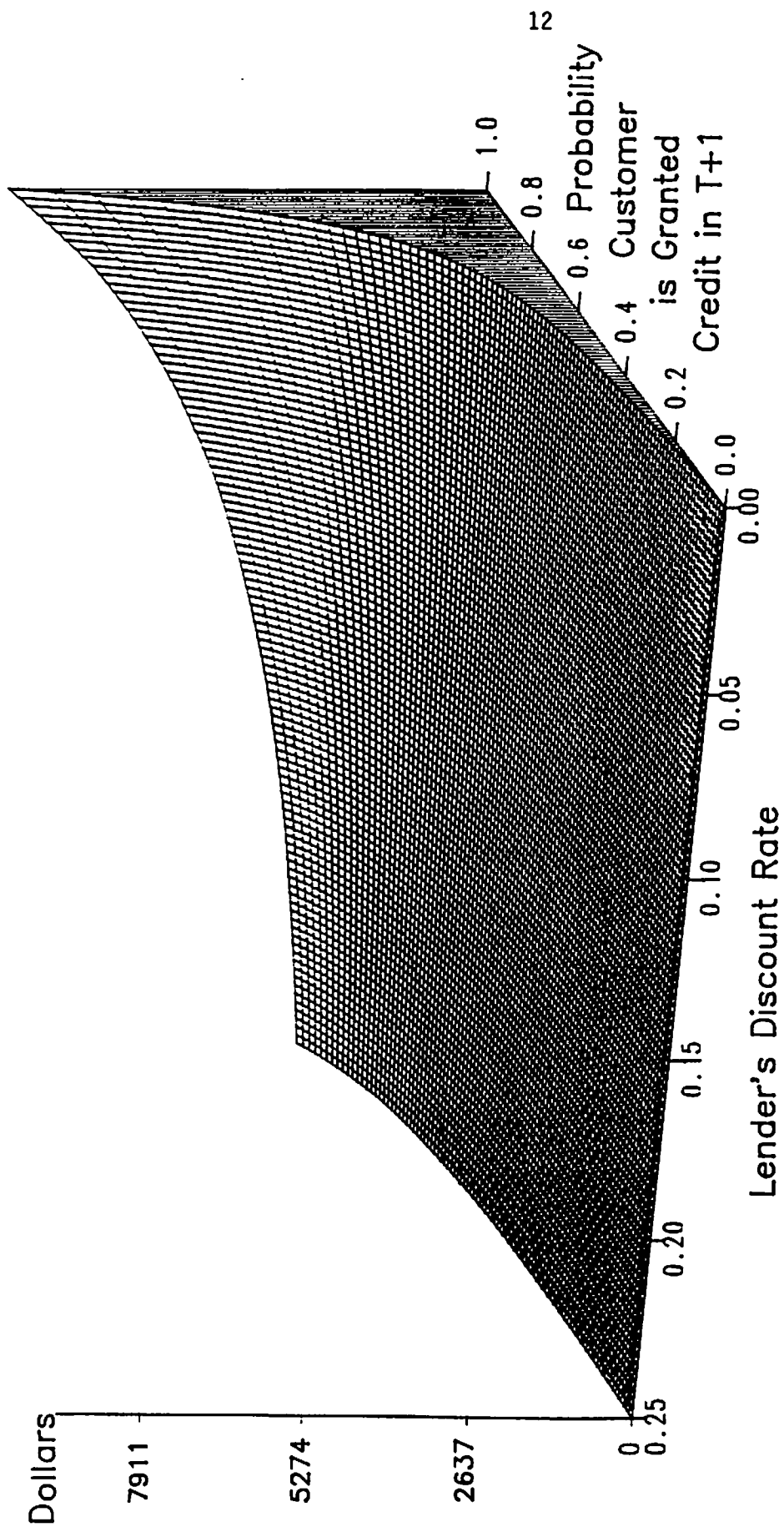
Figure 2. Value of Optimal Credit Policy When Lender's Discount Rate and Customer Patronage Vary
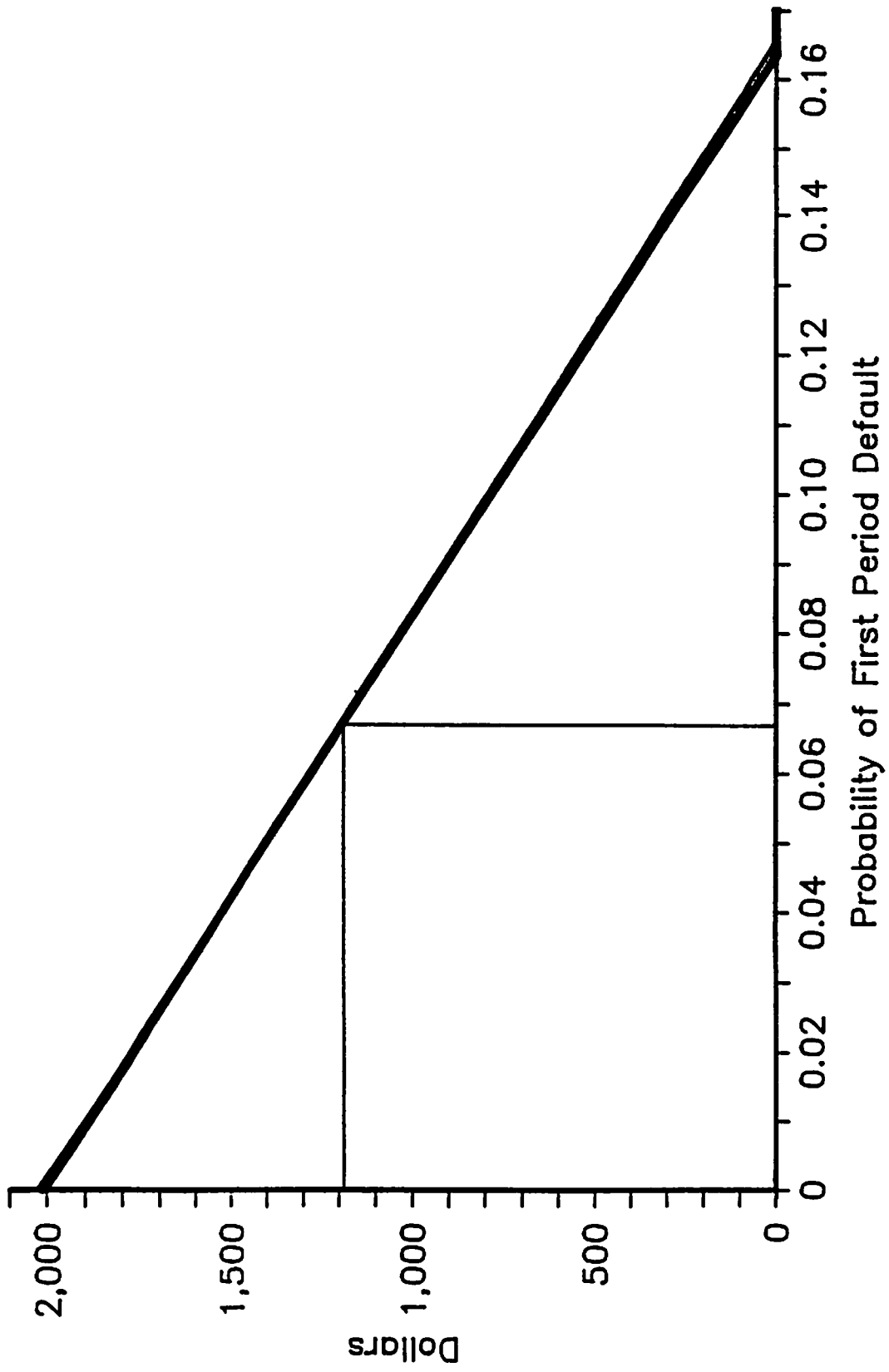
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Figure 3. Value of Optimal Credit Granting Policy Given Varying Probabilities of Default.

that tests whether repayment probabilities beyond the second period are constant. The findings of this study could also be broadened by replicating the study in other geographic areas and time periods.

Footnotes

[1]With a "master" loan, lenders have the option of denying credit and adjusting intermediate loan terms annually.

[2]Melichar discusses risks associated with patronizing a weak financial institution. Problems faced by credit-worthy farm borrowers when their lender fails include inconvenience, lower credit availability, and capital losses (if the institution's stock was required to be purchased as part of the original loan agreement). Borrowers who are delinquent and in a weak financial condition face greater risks including possible foreclosure.

[3]Lenders frequently reduce interest rates, reschedule payments and extend maturities in an attempt to avoid a borrower's default. As Gustafson et al. show, these actions are still very costly to lenders.

[4]Costs associated with credit analysis are considered sunk costs because they are incurred regardless of the lending decision.

[5]The selected model was the Farm Financial Simulation Model (FFSM) developed by Schnitkey, Barry and Ellinger. FFSM is a multiyear spreadsheet of a farm's financial performance that reports results in terms of a set of coordinated financial statements.

[6]One additional lender in the Wahpeton area and two in the Valley City – Jamestown area were contacted but removed from the sample because they did not grant operating credit to farmers.

[7]Following Gustafson, yields, commodity prices, farm income, and asset values of the case farms were randomly varied between the first and second year decision situations in order to add an element of uncertainty to the simulation.

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