ELICITING LIQUIDITY PREFERENCES FOR CASH AND INTERMEDIATE CREDIT RESERVES FROM CENTRAL ILLINOIS FARMERS

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Proceedings of Regional Research Committee
NC-161 Seminar

RESEARCH AND POLICY ISSUES IN
A PERIOD OF FINANCIAL STRESS

St. Louis, Missouri
October 9-10, 1985

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While it is important to consider a wide range of alternative responses to risk, in all likelihood the most common methods of risk response in modern agriculture are financial: the management of leverage, insurance, and liquidity (Barry, Baker, and Hopkin). Of particular interest and the central focus of this paper is liquidity management, specifically, farmers' demand for liquidity as expressed in values ascribed to reserves of unused cash and credit.

Baker and others have demonstrated the importance of liquidity management of risk on the farm (Baker and Bhargava; Baker and Hopkin; Barry and Baker; Kamajou and Baker; Vandeputte and Baker). In these studies reservation prices were found by varying parameters of functions reflecting assumed behavior of risk averse decisions makers. Such a procedure, however, attenuates validation of the model containing the assumed liquidity functions. What has been lacking is an empirical method for eliciting these risk response parameters. Such a need is the primary objective of the study reported here.

Vandeputte and Baker suggest that "the value of liquidity to the decision maker, provided by unused credit, increases in a continuous fashion and at an accelerating rate as credit absorption through borrowing approaches the credit limit" (p. 3). It seems plausible to assume a similar liquidity value behavior for the decision maker for unused cash. Applying this reasoning, an ancillary objective is to determine whether estimated liquidity value functions for cash and intermediate credit reserves are nonlinear and positively sloped.

Methodology

Projective Interview

Actual reservation prices easily could be determined if farmers could accurately specify minimum required rates of return (ROR'S) on cash and credit reserves. But any information obtained via direct questioning is likely to be suspect since farmers in general are not readily prepared to provide such information. How do we resolve this paradox? The procedure used here employs a projective technique.

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A projective consists of a situation with which the interviewer asks the respondent to associate him or herself in order to elicit a series of responses. It is a means of indirectly evoking information held subconsciously by individuals on prescribed topics and protecting against conditioned responses.

Our goal is to design a projective that is easy to understand, inexpensive to apply, and efficient in terms of time required to obtain answers. Adequacy of the procedure is important with respect to reliability and validity. Care is taken to keep details of the projective consistent among all interviews. A realistic approach also is sought that permits subjects to respond to familiar investment activities and decision making processes.

In the research reported here, eight central Illinois farmers are asked to complete the structuring of a simulated investment situation that forces them to make allocative decisions about their use of cash, intermediate term credit, and unpriced crop inventory. This simulation-type survey generates implied reservation price data for various levels of cash reserves and intermediate credit reserves held by each farmer. Communication is facilitated by presenting the problem of a farm equipment purchase: computer equipment.

Simulated Investment Game

The interviewer asks questions in conjunction with the form represented in figure 1, where per bushel corn price is arrayed across the page and intermediate credit in reserve (top) and cash in reserve (bottom) are arrayed vertically in 20 percent decrements. Prices are net of storage costs, interest charges, and other non-interest charges. Current price, the approximate actual market price on the day of the interview, was \$3.15. Moving left to right, prices increase at increments of three cents per bushel. Values in parentheses are the respective percentage changes in price above current price. Percentage changes reflect ROR's earned on unsold corn inventory. Rates of return are proxies for farmers' reservation prices on cash and intermediate credit. A corn price of \$3.40 per bushel, for example, reflects an eight percent appreciation in price above current corn price (\$3.15) or an implied reservation price of eight percent. Corn inventory is assumed to be a perfect substitute for cash and intermediate credit reserves owing to the fact that in the population of farmers sampled corn (and soybean) inventory constitutes a large part of liquid assets.

Reserve levels are arbitrarily set at 100, 80, 60, 40, 20, and 0 percent. Beginning cash and intermediate credit (100 percent reserved) reflect the approximate amount of cash and intermediate credit the farmer actually had at the time the simulated investment game was played (March 1983). The amount of cash and intermediate credit at other reserve levels is 80, 60, 40, 20, and 0 percent of beginning reserves, respectively.

An example illustrates how cash reserve amounts are determined and incorporated into the investment game. Similar procedures apply to the credit part of the simulated investment game. Assume a farmer has beginning cash reserves totaling $5,000. The amount of cash at other reserve levels is $4,000 (80 percent reserved), $3,000 (60 percent reserved), $2,000 (40 percent reserved), $1,000 (20 percent reserved), and $0.

Once amounts of cash and intermediate credit in reserve are determined, the value and item of investment are specified. The value of the computer equipment purchase equals 20 percent of beginning cash reserve. The kind of equipment investment reflects what can be realistically purchased for 20 percent of beginning cash in reserve. Following the above example, the investment amount is $1,000. The computer equipment purchased is software. The respondent is instructed that he will be able to buy the hardware to run the software during the credit component of the investment game. The value of the hardware is set at 20 percent of beginning intermediate credit. If a farmer already owns a computer, the investment decision is whether or not to upgrade his current system.

Cash balances are assumed to earn seven percent interest compounded annually. Borrowing cost is 13 percent interest annual percentage rate (APR). Borrowing cost and rate earned on cash in reserve reflect the prevailing interest rates at the time of the interviews. The respondent is instructed that the internal rate of return earned on the purchase of the equipment is sufficient to cover the cost of borrowing. This assumption is made in an attempt to insure that elicited reservation prices only reflect respondents' liquidity preferences, not their required return on assets or some combination of asset returns and liquidity preferences. Each respondent is told that the impending equipment purchase does not affect his operating and real estate credit. The value of these credit sources is unspecified.

Specifying the source of the ROR and the use for funds taken from reserve is done so subjects can respond to a familiar investment activity and decision making process. Operating and real estate credit are held constant in the elicitation procedure and cash and intermediate credit reserves are not mixed in order to keep the investment game format from becoming too complex and hence, unplayable.

After investment game parameters have been determined, the respondent farmer is presented with the array of corn prices in figure 1 and asked the following question:

> "What is the minimum required rate of return on your corn inventory that will persuade you to invest your cash (or intermediate credit) reserve in the purchase of a computer and supporting software?"

Thus, beginning with 100 percent of cash balances reserved ($5,000), the per bushel corn price (figure 1) is searched for that provides the minimum ROR associated with the last (marginal) dollar withdrawn from the reserve (the one thousandth dollar). Accordingly, the first reservation price discovered is associated with the 80 percent reserve level (or $4,000). Having determined the minimum ROR on corn inventory at the 80 percent reserve level, the question and search procedure is repeated at the margin for each subsequent reserve level. At the 80 percent reserve level, the subject has $4,000 in cash reserves and again is asked to select the corn price that provides the minimum ROR he is willing to accept in order to reduce his reserves from $4,000 to $3,000 for purchase of the computer software. Again, the inferred reservation price reflects the minimum return associated with the one thousandth dollar withdrawn and corresponds with the 60 percent reserve level (or $3,000). The cash component of the investment game ends when the respondent selects the minimum ROR on his corn inventory that compensates him for exhausting his cash reserves for purchase of the computer software. The credit part of the game is played in a manner similar to the cash component. In total, five cash and five intermediate credit reservation prices are determined for each respondent.

To illustrate the outcomes of a hypothetical simulated investment game, return to figure 1. Hypothetical cash responses (C's) indicate the following inferred reservation prices: 1.08, 1.09, 1.18, 1.22, and 1.34 for 80, 60, 40, 20, and 0 percent cash reserve levels, respectively. Drawing on hypothetical outcomes for the "credit" game, responses (CR's) indicate the following reservation prices for 80, 60, 40, 20 and 0 percent intermediate credit reserves: .09, .18, .22, .34 and .41, respectively.

Upon completion of the investment game, the interviewer interprets aloud the respondent's answers and asks the respondent if he agrees with the interpretation. If the respondent does agree, the elicited ROR's are construed as the reservation prices he holds on cash and intermediate credit reserves. If the respondent disagrees, new reservation prices are sought.

Estimating Liquidity Value Functions

Having obtained reservation prices associated with each reserve level, liquidity value functions can be estimated for each respondent. Using an ordinary least squares estimator an equation is fitted to reservation prices elicited during the simulated investment game, with amount of reserves as the independent variable and reservation price as the dependent variable. The form of function fitted is initially determined by plotting the elicited reservation prices for the five percentage levels--80, 60, 40, 20, and 0--of cash and intermediate credit in reserve and drawing a curve through the observations. Regression statistics, (adjusted) $\bar{R}^2$'s and t-values, and visual inspection of predicted liquidity value curves are used to select the functional form most suitable for fitting the data.

Results

Inferred reservation prices are reported first. Then, estimated liquidity value functions for each subject are presented. Finally, predicted liquidity value curves are plotted and graphically compared among respondents.

Reservation Prices

Elicited reservation prices for cash and intermediate credit reserves are reported in table 1. Table 1 may be interpreted in the following manner. Reading down column A, for instance, the value of reserve cash for Farmer A (the 8 respondents are coded A through H, respectively) is \$1.07 for both the 80 and 60 percent levels of cash in reserve; \$1.10 for the 40 percent level of beginning cash in reserve; \$1.13 at the 20 percent reserve level; and at the 0 percent level of cash reserves, \$1.23. A similar interpretation applies to columns (farmers) B through H and to intermediate credit in reserve. Note the acceleration of liquidity value as the amount of cash and intermediate credit in reserve (liquidity) is reduced.

What does a particular reservation imply? Consider the reservation price, \$1.13, Farmer A holds at the 20 percent level of beginning cash balances in reserve or the 80 percent level of beginning cash reserves used: his response suggests that the next dollar of unused cash adds a net value of 13 percent. Or, a ROR of 13 percent would have to be expected to persuade the respondent to apply the next dollar to a non-reserve use.

Estimated Liquidity Value Functions

The liquidity value functions for cash reserves and intermediate credit reserves estimated for each subject for each of the three functional forms linear, quadratic, and exponential, are shown in tables 2 and 3, respectively. By the $\bar{R}^2$ criterion, the quadratic function provides the best fit for all except G (cash) and A (intermediate credit); the most suitable form is exponential for G and linear for A. For E (cash and intermediate credit), however, the gain in explanation associated with the quadratic form over the exponential form is slight and is poorer in terms of t-values. Note, however, that for particular farmers $\bar{R}^2$ values are nearly identical across certain functional forms with respect to cash reserves (E and G) and intermediate credit reserves (A and E).

Signs are as expected and most t-values indicate that the relationship of cash and intermediate credit reserves to reservation price is significant. In all cases except the credit function for A, the nonlinear equations result in higher R's than the linear equations.

Predicting Liquidity Value Curves

As a point of comparison among respondents, figures 2 and 3 graphically depict the predicted liquidity value curves associated with each respondent's best fit liquidity value function reported in tables 2 and 3. Predicted reservation prices are plotted for each appropriate functional form with a curve drawn connecting reservation price points. Reserve level (percent of) is presented along the horizontal axis. The vertical axis measures reservation price.

All subjects exhibit risk aversion to a greater or lesser degree over all or some range of reserves. Note, however, the negative slopes (respondents A, B, C and D, cash, and respondents F and G, intermediate credit) and constant slopes (respondents F and H, cash, and B and C, intermediate credit) which occur over the 80 to 60 percent segment of some liquidity value curves and suggest risk preference and risk neutrality, respectively. The risk behavior characteristics of the respondents indicate a risk pattern similar to risk preferences of individual agricultural producers reported in the literature: Most but not all of the farmers are risk averse.

It is instructive to compare each respondent's best fit liquidity value curve to others. To facilitate comparisons, liquidity preference data for the eight respondents are pooled, and the predicted liquidity value curves associated with the most suitable pooled functional form for each source of liquidity are graphed (see figures 2 and 3). To further aid analysis, only the 60 percent to 20 percent reserve level segment of each curve is examined. Following this convention, it can be observed that the liquidity value curves for respondents D, E and G lie above those for B, C and F for both cash and intermediate credit reserves over the range of reserve levels examined. The simulated investment game succeeds in consistently separating the more risk averse group of respondents from the other respondents.

Conclusions

The methodology developed to measure farmers' reservation prices for cash and intermediate credit reserves succeeds in associating reservation prices with the preferences of farm decision makers according to an anticipated pattern of behavior; that is, reservation prices increase as cash and intermediate credit reserves diminish. In other words, each respondent exhibits a positive risk-return trade-off: each requires an ever higher expected return on unused reserves as reserve amounts decrease. Moreover, in all but one case, the most suitable functional form that captures the relationship between respondents' reservation prices and the magnitude of cash and intermediate credit in reserve is nonlinear and in all cases, the functional form is positively sloped.

No doubt the general level of the inferred reservation prices can be accepted with more validity than can any particular reservation price. It seems likely that absolute values of reservations overstate risk averse behavior for several reasons. First, this study assumes that decision makers attempt to respond to risk solely through maintenance of liquidity reserves. Inasmuch as production and marketing responses to risk exist for central Illinois farmers, it is likely these alternatives exert a "leveling" influence on elicited risk responses. Second, the projective elicitation procedure as applied does not allow the mixing of cash and intermediate credit reserves as a liquidity response to risk nor does it incorporate operating and real estate credit as part of total liquidity reserves. These constraints and omissions likely cause elicited reservation prices for the specific liquidity sources to be inflated relative to "actual" reservations held by farmers.

Financial management research as well as educational activities with farmers and lenders must consider decision making under uncertainty. Elicited reservation prices may offer greater insight into this process and provide added information for use in capital budgeting.

An interesting question not adequately addressed in this paper is why slopes and heights of liquidity value curves vary among respondents. With an efficient and valid method of obtaining reservation prices, it should be possible to sample and estimate liquidity value curves for larger numbers of farm decision makers. Using regression methods, it also should be possible to test for hypothesized relationships between reservation prices (dependent variable) and particular farm and decision maker characteristics (independent variables). Certain hypotheses might focus on relationships between risk preferences and structural form, in particular, farm size, enterprise-type, and legal form of ownership. For example, are larger or more diversified or corporate farmers generally less risk averse than small or specialized or individual proprietorship farmers? Other hypotheses might examine the frequently assumed positive relationship between accounting measures of financial ability to bear risk and willingness to bear risk. From tests of these hypotheses it may be possible to examine structural and financial implications of risk in agriculture as well as public policies to reduce income variability.

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Net Corn Price ($/bu)	$3.15	3.25 (3.0%)[1]	3.28 (4.0)	3.31 (5.0)	3.34 (6.0)	3.37 (7.0)	3.40 (8.0)	3.44 (9.0)	3.47 (10.0)	. . .	3.72 (18.0)	3.75 (19.0)	3.78 (20.0)	3.81 (21.0)	3.85 (22.0)	3.88 (23.0)	3.91 (24.0)	3.94 (25.0)	3.97 (26.0)	. . .	4.22 (34.0)	4.26 (35.0)	4.29 (36.0)	4.32 (37.0)	4.35 (38.0)	4.38 (39.0)	4.41 (40.0)	4.44 (41.0)	4.48 (42.0)	4.51 (43.0)
CREDIT (13%)																														
100%																														
80								CR[2]																						
60											CR																			
40															CR															
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CASH (7%)																														
100%																														
80							C[2]																							
60								C																						
40											C																			
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[1] Respective percentage change in price above $3.15 per bushel.

[2] Hypothetical reservation prices for cash balances (C's) and intermediate credit reserves (CR's).

Figure 1. Investment Game Design

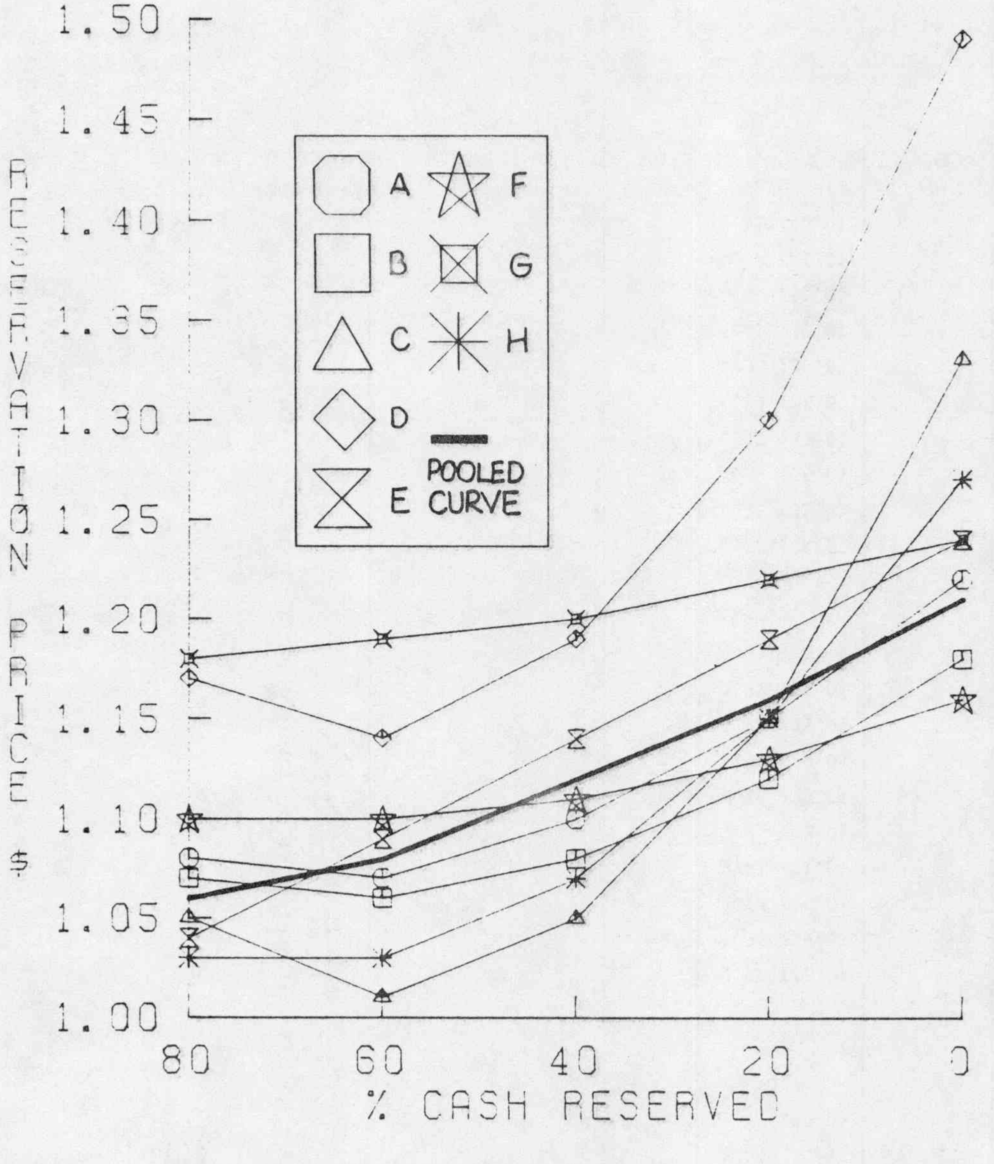

Figure 2. Best Fit Liquidity Value Curve for Each Case Study Farm's Cash Reserves

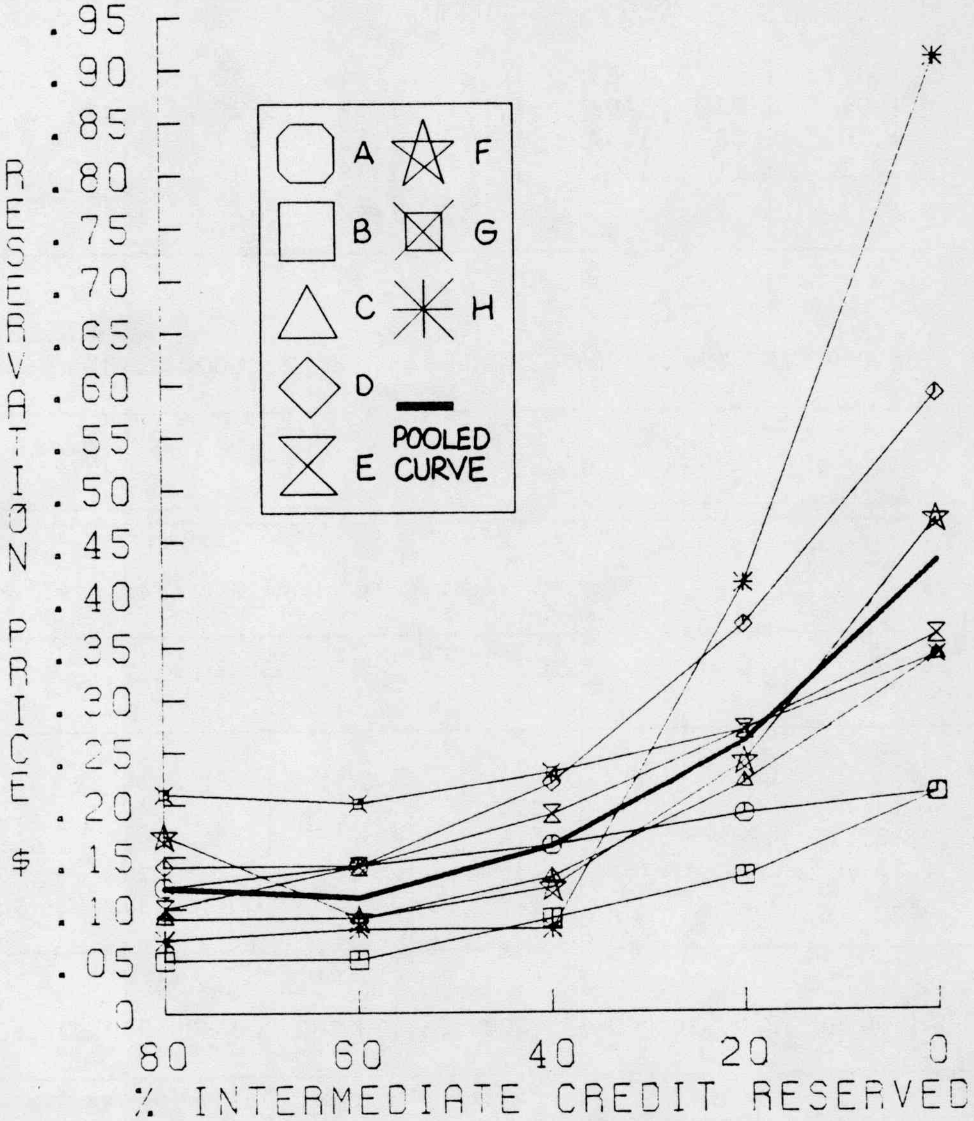

Figure 3. Best Fit Liquidity Value Curve for Each Case Study Farm's Intermediate Credit Reserves

Table 1. Cash and Intermediate Credit Reservation Prices Implied from the Simulated Investment Game[a]

Percent of Cash in Reserve	Percent of Cash Used	Value of Reserve Cash ($) Farmer A	B	C	D	E	F	G	H	AVG[b]
80	20	1.07	1.07	1.05	1.11	1.04	1.10	1.17	1.05	1.08
60	40	1.07	1.07	1.06	1.15	1.09	1.10	1.20	1.05	1.10
40	60	1.10	1.08	1.07	1.19	1.13	1.11	1.20	1.11	1.12
20	80	1.13	1.11	1.11	1.27	1.18	1.13	1.20	1.13	1.16
0	100	1.23	1.18	1.35	1.51	1.25	1.17	1.25	1.29	1.28
Beginning cash in reserve[c]		$5,000	$25,000	$5,000	$25,000	$5,000	$5,000	$5,000	$5,000	

Percent of Credit in Reserve	Percent of Credit Used	Value of Reserve Intermediate Credit ($) Farmer A	B	C	D	E	F	G	H	AVG[b]
80	20	.13	.06	.09	.11	.10	.13	.18	.00	.10
60	40	.13	.06	.12	.14	.14	.13	.20	.05	.12
40	60	.18	.09	.14	.20	.20	.13	.22	.19	.17
20	80	.18	.14	.20	.35	.28	.16	.24	.32	.23
0	100	.22	.21	.35	.59	.34	.50	.34	.98	.44
Beginning Credit in reserve[d]		$34,400	$31,200	$26,000	$32,400	$33,600	$32,800	$30,800	$27,600	

[a]Reservation prices indicate the net value of the next dollar of unused reserves.

[b]Average reservation prices for the eight farmers.

[c]Average amount of beginning reserves determined by directly questioning each respondent.

[d]Beginning reserves determined by calculationg farmer's leverage ratio and estimating the effect of his leverage ratio on his expected amount of loan (see Sonka et al., Figure 2, p. 569).

Table 2. Respondents' Liquidity Value Functions for Cash Reserves

Farmer and Functional Form[a]	Liquidity Value Functions[b]	Constant (t-values)	X (t-values)	X^2 (t-values)	Adjusted R^2
A1	$Y = 1.196 - .000038X$	(47.58)	(-3.80)		.761
A2[c]	$Y = 1.225 - .000095X + .000000014X^2$	(105.74)	(-6.15)	(4.35)	.966
A3	$Y = .078 - .000014X$	(8.44)	(-3.87)		.776
B1	$Y = 1.154 - .0000052X$	(58.89)	(-3.25)		.705
B2[c]	$Y = 1.176 - .000014X + .00000000046X^2$	(184.95)	(-8.56)	(6.32)	.979
B3	$Y = .062 - .000002X$	(8.34)	(-3.32)		.715
C1	$Y = 1.258 - .000065X$	(19.22)	(-2.43)		.551
C2[c]	$Y = 1.328 - .00021X + .000000035X^2$	(30.50)	(-3.64)	(2.83)	.866
C3	$Y = .098 - .000024X$	(4.25)	(-2.53)		.574
D1	$Y = 1.430 - .000019X$	(24.91	(-3.93)		.783
D2[c]	$Y = 1.493 - .000045X + .0000000014X^2$	(43.57)	(-4.72)	(3.23)	.948
D3	$Y = .155 - .0000065X$	(8.96)	(-4.40)		.821
E1	$Y = 1.240 - .000051X$	(168.94)	(-17.00)		.986
E2	$Y = 1.247 - .000065X + .0000000036X^2$	(196.00)	(-6.55)	(1.98)	.993
E3[c]	$Y = .094 - .000019X$	(43.42)	(-22.07)		.992
F1	$Y = 1.156 - .000017X$	(106.42)	(-3.84)		.774
F2[c]	$Y = 1.169 - .000043X + .0000000064X^2$	(519.56)	(-14.25)	(10.08)	.993
F3	$Y = .063 - .0000065X$	(15.33)	(-3.90)		.780
G1	$Y = 1.236 - .000016X$	(100.25)	(-3.18)		.695
G2	$Y = 1.242 - .000027X + .0000000028X^2$	(73.43)	(-1.13)	(.59)	.611
G3[c]	$Y = .092 - .0000057X$	(20.98)	(-3.21)		.699
H1	$Y = 1.238 - .000056X$	(32.27)	(-3.58)		.747
H2[c]	$Y = 1.278 - .00014X + .00000002X^2$	(45.78)	(-3.64)	(2.52)	.909
H3	$Y = .092 - .000021X$	(6.80)	(-3.80)		.770

[a]The letter indicates the respondent; the number indicates the functional form fitted to the observations where 1 is linear, 2 is quadratic, and 3 is exponential.

[b]Y is the reservation price, X represents the amount of cash in reserve, and X^2 represents the amount of cash in reserve, squared. The exponential form is expressed in semi-log form: $Y = \log a + X \log b$. Five observations are taken to derive each function.

[c]Best fit liquidity value function for each case study farm.

Table 3. Respondents' Liquidity Value Functions for Intermediate Credit Reserves

Farmer and Functional Form[a]	Liquidity Value Functions[b]	(t-values) Constant	X	X^2	Adjusted R^2
A1[c]	Y = .214 - .0000027X	(19.70)	(-5.20)		.866
A2	Y = .218 - .0000037X + .000000000014X^2	(14.31)	(-1.35)	(.495)	.821
A3	Y = -.664 - .0000070X	(-23.18)	(-5.12)		.863
B1	Y = .188 - .0000049X	(9.80)	(-4.85)		.849
B2[c]	Y = .211 - .000011X + .00000000019X^2	(93.73)	(-27.30)	(17.9)	.999
B3	Y = -.713 - .000019X	(-13.67)	(-6.86)		.920
C1	Y = .300 - .0000092X	(8.26)	(-4.05)		.793
C2[c]	Y = .340 - .000022X + .00000000047X^2	(16.16)	(-4.93)	(3.35)	.953
C3	Y = -.515 - .000022X	(-11.54)	(-7.70)		.936
D1	Y = .512 - .0000014X	(8.31)	(-4.66)		.838
D2[c]	Y = .585 - .000032X + .00000000056X^2	(43.33)	(-14.33)	(9.51)	.995
D3	Y = -.268 - .000032X	(-5.94)	(-10.94)		.967
E1	Y = .336 - .0000074X	(35.82)	(-16.22)		.985
E2	Y = .345 - .0000094X + .000000000061X^2	(38.29)	(-5.61)	(1.68)	.991
E3[c]	Y = -.442 - .000016X	(-23.51)	(-17.84)		.987
F1	Y = .364 - .0000094X	(3.77)	(-1.96)		.414
F2[c]	Y = .465 - .000034X + .00000000075X^2	(6.82)	(-3.72)	(2.62)	.801
F3	Y = -.499 - .000015X	(-3.52)	(-2.18)		.484
G1	Y = .308 - .0000047X	(13.61)	(-3.90)		.780
G2[c]	Y = .331 - .000011X + .00000000019X^2	(18.38)	(-3.35)	(2.24)	.906
G3	Y = -.512 - .0000082X	(-16.77)	(-5.07)		.861
H1	Y = .752 - .000032X	(4.62)	(-3.39)		.715
H2[c]	Y = .928 - .000083X + .0000000018X^2	(8.90)	(-4.05)	(2.88)	.921
H3	Y = -.053 - .000069X	(-0.45)	(-10.07)		.962

[a]The letter indicates the respondent; the number indicates the functional form fitted to the observations where 1 is linear, 2 is quadratic, and 3 is exponential.

[b]Y is the reservation price, X represents the amount of intermediate credit in reserve, and X^2 represents the amount of intermediate credit in reserve, squared. The exponential form is expressed in semi-log form: Y = log a + X log b. Five observations are taken to derive each function.

[c]Best fit liquidity value function for each case study farm.