Adjustable-Term Financing of Farm Loans

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Firm-level simulation is used to analyze farm financial performance with adjustable-rate, adjustable-term, and fixed-rate financing. Adjustable-term financing is accomplished by changing the term of the loan, instead of payment size, when interest rates change. Simulation results indicate that the adjustable-term loan is an innovation which reduces the cash flow destabilizing effects of volatile interest rates.

Key words: adjustable-term loan, cash flow, repayment risk, simulation.

Historically, fixed-rate loans have been the standard financing arrangement in agriculture. A number of credit innovations have been proposed as alternatives to conventional fixed-rate, constant payment loans (Baker; Lee; Tauer). There are four primary reasons for considering these alternatives: (*a*) fluctuating interest rates, (*b*) fluctuating repayment ability of borrowers, (*c*) tax implications for lenders and borrowers, and (*d*) discrepancies between finance charges and initial cash flow generated by debt-financed assets. Lee identified several categories of alternatives. These include flexible repayment mortgages, graduated payment mortgages, variable interest rate mortgages, and reverse mortgages. Flexible repayment mortgages allow borrowers to increase or reduce the amount of loan payments, within certain limits, in response to fluctuating repayment ability. Graduated payment mortgages (GPMs) provide for loan payments to be structured in a manner that allows initial payments to be less than under straight amortization. GPMs require payment size to gradually increase over the life of the loan. This type of arrangement is particularly beneficial to young and beginning farmers who are carrying heavy debt loads (Lee).

Variable-rate mortgages (VRMs) allow interest rates on loans to fluctuate with current market rates. Interest rates on these loans can change frequently (e.g., quarterly or monthly) and are often contractually tied to an index. This type of arrangement allows the lender to pass interest rate risk through to the borrower in the event of an unexpected rate increase while enabling the borrower to avoid locking in an extremely high interest rate if rates should fall. Adjustable-rate mortgages (ARMs) are similar to VRMs, however, they differ in how frequently the rate can be adjusted. ARMs change at predetermined intervals and are usually tied to an index (e.g., U.S. Treasury securities). Typically, both ARMs and VRMs have interest rate caps limiting the increase in the interest rate for each repricing period and over the life of the loan. Variable-rate loans made up 17% of all non-real estate agricultural loans in 1977 but rose to 61% by 1988 (Walraven and Rosine). Most of these loans were for feeder livestock and operating expenses. Variable-rate loans have been used primarily by larger banks but increasingly have been used at smaller banks as well (Melichar).

The expanded use of variable-rate loans contributes to an acceleration of the pace at which new higher rates are applied to existing loans (LaDue and Leatham). If rate risk is passed through to the borrower, it potentially increases the variability of cash flow and may

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reduce the debt-carrying capacity of the borrower's operation. The pass-through of interest rate risk to farm borrowers may also have adverse indirect effects on lenders through a higher rate of loan default and a lower rate of return on farm loans. LaDue and Zook estimated this risk of loan default was 8% higher with variable-rate loans than with comparable fixed-rate loans among a sample of dairy farms during 1978–81. Moe and Thompson found that variable interest rate loans were more detrimental to operating cash flows (after debt service) than fixed-rate loans when interest rates were increasing. However, the increases in simulated cash flow variability due to variable interest rates were not as great as expected due to tax deductibility of interest expense. Leatham and Baker investigated a farmer's choice between fixed-rate and adjustable-rate loans. Results for a representative farm indicated that farmers might willingly pay an interest rate premium up to 1.5 percentage points over the adjustable rate to receive a fixed-rate loan. The degree of borrower risk aversion was shown to have a significant effect on the optimal size of the rate premium.

More recently, adjustable-term financing has been suggested to allow the lender to pass interest rate changes through to borrowers without increasing the risk of default (Boehlje and Pederson). This could be accomplished by increasing the term of the loan (rather than the interest payment) when interest rates increase. Farm lenders have provided loan extensions in the past when a borrower was unable to make the scheduled payment. Similarly, farm machinery financing arrangements have added missed loan payments to the balloon payment at the end of the loan term. However, loan extensions and balloon payments have not been used to compensate for market rate risk and have not been reflected in the lending arrangement. An adjustable-term loan provides for the contingency of rising interest rates and provides an alternative means of managing repayment risk.

Cash Flow Model

The objective of this article is to evaluate the ability of the adjustable-term loan arrangement to control cash flow risk and modify loan repayment risk in alternative interest rate environments. The analysis begins with an identification of some basic cash flow relationships. Net cash flow (*NCF*) for the farm operator can be expressed as,

$$(1)\quad NCF = rA - (i_r + p_r)D_r - (i_n + p_n)D_n - C + O - T,$$

where A is the value of owned and rented assets; r is the cash rate of return on assets before interest and taxes; p_r and p_n are the rates of principal repayment on real estate and non-real estate debt, respectively; D_r and D_n are the levels of outstanding real estate and non-real estate debt, respectively; i_r and i_n are the average interest rates paid on real estate and non-real estate loans, respectively; C represents family consumption expenditures; O denotes off-farm cash income; and T is income taxes paid. Equation (1) can be written in more compact form as:

$$(2)\quad NCF = rA - a_rD_r - a_nD_n + K,$$

where a_r and a_n are amortization coefficients for real estate and non-real estate debt and K is off-farm income less taxes and consumption withdrawals.

Next, we allow r, a_r, a_n, O, and T to be stochastic. The rate of return on assets is stochastic due to price and yield variability. Debt amortization coefficients are stochastic due to assumed randomness of interest rates. Taxes are stochastic since they are a function of farm and nonfarm earnings and deductibility of interest expense. The farmer's expected net cash flow is,

$$(3)\quad E(NCF) = E(r)A - E(a_r)D_r - E(a_n)D_n - E(K).$$

If we assume the covariance between the rate earned on farm assets and the interest rate on farm debt is zero, the resulting variance of net cash flow becomes,[1]

$$(4)\quad \begin{aligned}\mathrm{Var}(NCF) = {} & \mathrm{Var}(r)A^2 + \mathrm{Var}(a_r)D_r^2 \\ & + \mathrm{Var}(a_n)D_n^2 \\ & + 2D_rD_n\mathrm{Cov}(a_r, a_n) + \mathrm{Var}(K).\end{aligned}$$

Equation (4) can be used to compare the cash flow effects of adjustable-rate and adjustable-term financing alternatives. If interest rates rise, the expected amortization coefficients would also rise with adjustable-rate financing and expected net cash flow would decrease. In com-

[1] The assumption of a zero covariance would appear to be reasonable at the farm level of analysis given that the rate earned on farm assets includes just the current return.

Table 1. Relationship between Loan Term and Interest Rate ($10,000 Principal, 10% Original Interest Rate, Fixed Annual Payment)

Annual Payment	Annual Interest Rate (%)				
	8	9	10	11	12
($)	Loan Term (In Years)				
2,638	4.70	4.84	5.00	5.17	5.35
2,296	5.57	5.77	6.00	6.25	6.52
2,054	6.41	6.69	7.00	7.35	7.74
1,874	7.23	7.59	8.00	8.47	9.02
1,736	8.02	8.48	9.00	9.62	10.37
1,627	8.79	9.34	10.00	10.80	11.80
1,539	9.53	10.19	11.00	12.01	13.34
1,467	10.23	11.02	12.00	13.26	15.02
1,407	10.91	11.83	13.00	14.57	16.88
1,357	11.56	12.62	14.00	15.93	19.01
1,314	12.18	13.39	15.00	17.36	21.52
1,174	14.85	16.86	20.00	26.41	[a]
1,101	16.83	19.70	25.00	62.14	[a]
1,060	18.23	21.89	30.00	[a]	[a]

[a] Interest payment is greater than fixed annual payment.

parison the expected net cash flow would remain stable with adjustable-term financing, since the amortization coefficients would remain constant when interest rates rise. Therefore, variability of net cash flow would be greater with adjustable-rate financing than with adjustable-term financing.[2] With fully adjustable-term loans, the values of $\text{Var}(a_r)$, $\text{Var}(a_n)$, and $\text{Cov}(a_r, a_n)$ are theoretically zero, and the variance of net cash flow is only attributable to the variability of the return on farm assets, off-farm earnings, and tax expense. These variance and covariance components are potentially significant sources of cash flow risk with adjustable-rate loans.

The repayment implications of adjustable-term financing can be illustrated further with the use of the standard loan amortization equation:

$$A = i_0 B/[1 - (1 + i_0)^{-n_0}], \tag{5}$$

where A represents the annual principal and interest payment, B is the loan balance, i_0 is the initial interest rate, and n_0 is the initial loan term. This equation can be used to solve for the adjusted term of a loan (n_1) when the interest rate changes to i_1 and the annual payment is held constant:

$$n_1 = -[\log(1 - (i_1 B/A))]/\log(1 + i_1). \tag{6}$$

Equation (5) is then used to compute the new loan repayment schedule. If interest rates rise, the effect is to reduce the current principal payment (by shifting principal into the future) and to replace it with payment of interest. The capacity to shift principal in this way depends on the underlying initial term of the loan. For example, longer term real estate loans typically have proportionately smaller initial principal payments. This reduces the ability to shift an adequate amount of annual principal when interest rates rise sharply. As loans mature, the proportion of principal rises, and there is greater ability to hold payment size constant, given a significant interest rate increase.

Table 1 demonstrates the term adjustment that would occur if the interest rate changes prior to the first annual payment while holding the annual total payment constant. In this illustration the initial annual payment is calculated using the loan term specified in the 10% interest rate column. For example, if the initial interest rate is 10% and the initial term of loan is 10 years, the annual payment is $1,627. An increase in the interest rate to 12%, holding the annual payment at $1,627, requires the term of the loan to increase to 11.8 years. If the initial term of the loan were 20 years, an increase in the interest rate from 10% to 12% could not be absorbed by a term adjustment alone. This is because the fixed annual payment is smaller than the interest payment required at a 12% rate.

The adjustable-term concept is applied to non-real estate debt in this study by using a combination of the adjustable-rate and adjustable-term methods. The combination is used to accommodate sharp interest rate increases. Initially, a maximum upward term adjustment is specified for the life of the loan to reflect lender concerns that the term not be extended longer than the useful life of the asset. An interest rate increase that is sufficiently large to require a term extension in excess of the maximum term adjustment is accommodated by reamortizing the remaining loan balance using the remaining term plus the maximum term adjustment. The result is an increase in the size of the annual payment, but an increase which is smaller than that of a corresponding adjustable-rate loan. In the year(s) following a payment increase, a decline in the interest rate

[2] While cash flow variability is reduced with adjustable-term financing, it should be recognized that once the adjustable-rate loan is fully repaid the adjustable-term loan may have a remaining balance. This could alter the corresponding comparison of cash flow distributions in subsequent years.

Table 2. Alternative Repayment Schedules for a $200,000 Non-Real Estate Loan

Year	Interest Rate (%)	Years Remaining	Beginning Balance ($)	Annual Payment ($)	Annual Principal ($)	Annual Interest ($)
	Panel A: Adjustable-Term Loan, 10-Year Initial Term, 10-Year Maximum Adjustment					
1	10.17	10.00	200,000	32,794	12,444	20,350
2	12.29	10.47	187,555	32,794	9,739	23,054
3	14.98	11.99	177,816	32,794	6,152	26,642
4	16.58	13.20	171,613	32,794	4,327	28,467
5	15.74	11.11	167,286	32,794	6,459	26,334
6	12.68	8.15	160,826	32,794	12,396	20,397
7	13.28	7.37	148,430	32,794	13,078	19,716
8	13.09	6.32	135,352	32,794	15,073	17,720
9	12.37	5.18	120,278	32,794	17,909	14,884
10	10.40	3.97	102,368	32,794	22,139	10,654
	Panel B: Adjustable-Rate Loan, 10-Year Term					
1	10.17	10	200,000	32,794	12,444	20,350
2	12.29	9	187,555	35,591	12,537	23,054
3	14.98	8	175,018	38,981	12,758	26,222
4	16.58	7	162,260	40,869	13,962	26,907
5	15.74	6	148,297	39,971	16,626	23,345
6	12.68	5	131,671	37,146	20,447	16,699
7	13.28	4	111,224	37,613	22,839	14,773
8	13.09	3	88,385	37,491	25,920	11,571
9	12.37	2	62,464	37,142	29,412	7,730
10	10.40	1	33,052	36,492	33,052	3,440

may allow the annual loan payment to decrease to the initial payment level. Once at the initial payment level, decreases in the interest rate provide an opportunity to increase the amount of annual principal repaid (by shifting principal from future payments) without changing the size of the loan payment. Thus, when interest rates are falling, the lender receives faster repayment with an adjustable-term loan than with an adjustable-rate loan, and the remaining term of the loan continues to decline. If interest rate decreases are sufficiently large, the adjustable-term loan could be totally repaid prior to the original term of the loan.

Table 2 contains illustrative repayment schedules for a 10-year adjustable-term loan with a 10-year maximum term adjustment (Panel A) and a 10-year adjustable-rate loan (Panel B). Interest rates are assumed to rise through year 4 and then fall in years 5–10. This rate series reflects the average intermediate-term loan rate available to farmers through Production Credit Associations in the St. Paul Farm Credit District during 1978–87. An annual payment of $32,794 is required to amortize the 10-year loan with a first-period interest rate of 10.17% and a beginning balance of $200,000. As a result of the interest rate increase in year 2, the term of the adjustable-term loan is increased to 10.47 years. This is 1.47 years more than would be the case under a straight amortization. Because the maximum term adjustment has not been reached, the annual total payment remains constant. In the third period the interest rate increases to 14.98% and the term of the loan increases to 11.99 years. The annual payment remains at $32,794 with the adjustable-term loan, which is lower than the $38,981 payment with an adjustable-rate loan. The annual payments in years 4–9 remain substantially lower than the corresponding annual payments under the adjustable-rate loan. The loan repayment schedules illustrate that the interest payment for the adjustable-term loan is equal to that of the adjustable-rate loan in the first two periods and greater in each of the next eight years. This is due to the lower annual principal payment made in years 2–10.

The adjustable-term loan maintains a higher outstanding principal balance after the first two years of the illustration. The cumulative effects of smaller annual principal payments under

the adjustable-term loan are seen by comparing the beginning loan balances in years 3–10 of the repayment schedule. The remaining balance at the beginning of year 10 with the adjustable-rate loan is $33,052, while $102,368 remains to be repaid under the adjustable-term loan with 3.97 years remaining to repay the debt. The unpaid balance of the adjustable-term loan (after the principal payment in year 10) is $80,229 or 40% of the initial principal. This feature of an adjustable-term loan in a rising interest rate environment is a potential concern to the lender. To reduce some of the implied credit risk exposure, the lender may require that larger principal payments be made in years when cash farm income is adequate to do so. This prepayment requirement could be a provision of the adjustable-term loan arrangement. Secondly, the lender could anticipate the larger loan balance and require additional collateral for the loan at the beginning or in years when interest rates increase significantly.

Simulation Model

An accounting model is used to simulate the cash flows and related financial performance of representative farms over a 10-year period under alternative financing methods. The three financing methods we analyze are fixed-rate, adjustable-rate, and adjustable-term financing. The simulation model is a modified version of an existing computer program that is used for long-range farm financial planning (Hawkins et al.). Farm financial statements are updated each year by applying cash from operations to the cash account or the operating debt of the farm. If a cash surplus is produced, operating debt is first reduced and then the cash account is increased. If a cash deficit is incurred, the cash account is first reduced to a minimum of $1,000 then operating debt is increased. No maximum is set on the cash account balance or operating debt. Interest is earned on the cash account. Debt service and principal payments for operating, intermediate-, and long-term debt are made annually.

Intermediate-term debt is initially amortized as a constant annual (principal and interest) payment for the adjustable-rate and fixed-rate lending arrangements. As interest rates change, the adjustable-rate loan balance is reamortized at the new rate over the remaining years of the original loan term.[3] For example, if the interest rate increases (decreases) at the beginning of year 2 of the simulation, the remaining principal balance is reamortized at the higher (lower) rate over the remaining nine years. This reamortization approach increases (decreases) the size of the total annual payment and changes the proportions and amounts of annual principal and interest payments. Although principal is slightly adjusted, changes in loan payment size are predominantly due to changes in interest expense.

Marketing and production risk aspects are incorporated into the analysis by drawing price and yield combinations for corn and soybeans from historical distributions. Individual farm-yield data from southwest Minnesota during 1962–87 are detrended and used as the basis for the distributions. Deflated monthly price data for Minnesota during 1979–87 are used in the creation of the corn and soybean price distributions. The mean corn yield of 111 bushels (bu.) per acre is annually increased by 2.3 bu. per acre. The limits on the corn yield distribution are 50 and 163 bu./acre. Soybean yields are estimated to increase by .8 bu./acre each year. The soybean yield distribution has a mean of 35 bu./acre and bounds of 15 to 56 bu./acre. Deflated corn prices range from $1.32 to $3.32/bu. and deflated soybean prices range from $4.48 to $9.45/bu. Prices are deflated using the Index of Prices Paid (1987 = 100). Price-yield pairs are drawn sequentially for 10 years and the process is repeated 30 times.[4] Each price-yield pair is applied across all three financing methods.

We analyze the performance of a hypothetical commercial-size, cash grain farm in southern Minnesota. The farm is a 1,600-acre operation divided equally between corn and soybeans with the majority of the land farmed on a cash rent basis.[5] Initially, the farm has

[3] Credit officers in the Farm Credit Bank indicated that when interest rates increase, the size of the interest payment is commonly increased (without reamortizing). When rates decline, annual interest payments are reduced in size or the loan may be reamortized over the remaining term if requested by the borrower.

[4] Crop prices and yields are assumed to be independently distributed at the farm level.

[5] Cash rents and farm asset prices are held constant in the simulation model. Stochastic cash rents and asset values would not qualitatively change the comparisons between financing alternatives since their individual and joint randomness would be common to all three financing options. Cash flow distributions would generally be more widely dispersed if random cash rents were modeled. Stochastic asset values would play a role in the selection of a financing alternative only if differential asset collateral requirements were applied. We abstract from these considerations.

$20,000 of short-term, $200,000 of intermediate-term and $100,000 of long-term liabilities. Initial equity is $245,000 and represents about 43% of total assets.

The simulation model requires interest rate information for cash-on-hand, operating and intermediate-term debt, and long-term debt. The interest rate series reported in table 3 are constructed from historical interest rates. The annual rate series for interest earned on cash assets is derived from the reported discount yields on six-month U.S. Treasury bills (Federal Reserve Board of Governors). The interest rate series for operating and intermediate-term loans is based on the average annual variable-rate available to farmers in southern Minnesota through their local Production Credit Associations. This rate series varies slightly from average district-wide rates. The rate series for long-term debt is based on the average annual variable rate offered by the local Federal Land Bank Associations.

Cash flow and repayment risk are modeled under different stochastic interest rate environments. Various 10-year historical interest rate scenarios are identified from rates that occurred during 1970–90. Those rate scenarios are: a rising rate scenario (1972–81), a rising-then-falling rate scenario (1977–86), and a gradually falling rate scenario (1981–90). The standard deviations of the cash rates and operating/intermediate-term rates reported in table 3 are the result of modeling those rate series as first-order autoregressive processes. This is done by regressing each historical series of annual rates on their one-year lagged values and then using the forecasted standard errors as estimates of the annual standard deviations. The historical mean rates and the estimated standard errors are used to generate 30 joint-normally-distributed random interest rates for each series in each year over the simulation period.[6] Long-term (real estate) debt is repaid under an annually adjusted, variable-rate loan from the Federal Land Bank Association.[7] In each simulation the interest rate on the fixed-rate alternative is set at 125 basis points over the initial year variable rate.[8]

Table 3. Historical Means and Estimated Standard Deviations Used to Generate the Stochastic Interest Rate Series

	Cash Assets		Operating and Intermediate-Term Loans		
Year	Mean[a]	Estimated Std. Dev.	Mean[b]	Estimated Std. Dev.	Long-Term Loans[b]
	(%)				
1972	4.98	2.18	7.72	2.24	7.08
1973	7.71	2.89	8.89	2.90	7.17
1974	9.04	2.17	11.11	2.32	7.79
1975	6.56	1.96	10.06	2.41	8.50
1976	5.66	2.35	10.15	2.43	8.50
1977	6.20	2.53	9.76	2.98	8.25
1978	8.68	2.16	10.48	2.33	8.25
1979	10.81	2.14	12.31	2.41	9.02
1980	12.21	2.62	14.98	2.45	10.17
1981	15.17	2.99	16.76	3.04	11.08
1982	12.63	2.29	16.49	2.40	12.50
1983	9.30	2.20	12.94	2.47	11.50
1984	10.37	2.59	13.80	2.46	11.63
1985	8.19	2.95	12.78	3.02	12.44
1986	7.02	2.11	14.09	2.35	11.29
1987	6.46	1.93	11.83	2.45	10.30
1988	7.66	2.30	11.96	2.74	10.42
1989	8.45	2.42	12.43	2.80	10.75
1990	8.40	2.83	12.43	2.87	10.75

[a] Source: Federal Reserve Board of Governors.
[b] Source: Farm Credit Bank of St. Paul.

Simulation Results

The focus of our analysis is on the cash flow and debt repayment implications of the alternative financing arrangements. We summarize the simulation results in terms of the distributions of cash surplus (deficit) and the cash flow coverage ratio. Cash surplus (deficit) is computed as net cash farm income (before interest expense), plus nonfarm income, minus the sum of family living expenses, total annual principal and interest payments, taxes (federal and state income tax and social security tax), and cash required for asset replacement. Thus, the definition of cash surplus (deficit) coincides

[6] The correlation between the historical cash and operating/intermediate-term interest rate series was found to be .85 during 1970–90, which is used in the generation of the random interest rate series.

[7] The long-term interest rate is treated deterministically since the simulation analysis is focused on the risk characteristics of alternative financing arrangements for intermediate-term debt only. Stochastic long-term rates would not add to the analysis or qualitatively change the comparison across financing alternatives.

[8] The 125 basis point premium reflects the increased interest rate risk the lender would face over that on a variable-rate loan and is consistent with the historical rate premium charged by the St. Paul Farm Credit Bank on fixed-rate real estate loans.

closely with net cash flow as shown in equation (1). One can readily obtain the annual net cash flow amount by adding the cash required for asset replacement to the annual cash surplus (deficit). The cash-flow coverage ratio (CCR) is a liquidity indicator of repayment capacity. It is equal to the cash surplus (deficit) divided by total annual principal and interest payments on intermediate- and long-term debt (Barry, Hopkin, and Baker). The CCR measures the extent to which excess cash generated by the farm business provides a repayment cushion for meeting these debt obligations. A larger positive CCR indicates stronger debt repayment capacity. A negative ratio is interpreted as inadequate cash flow to pay scheduled principal and interest (and, therefore, loan default). Since different historical rate intervals are used, our comparisons of cash flow effects will be restricted to those occurring across financing alternatives within each rate scenario.

Cash Flow Effects

Simulation results in table 4 demonstrate that adjustable-term financing generally improves cash flow performance when interest rates are stochastic and increasing. The simulated series of annual cash surpluses (deficits) reflect randomness and changing levels of commodity prices, yields, and interest rates over time. When compared across financing methods, however, the differences in cash surplus (deficit) are attributable to interest rate volatility and differences in financing method only. The mean cash surplus is larger (deficit is smaller) for the adjustable-term loan than for either the adjustable-rate or the fixed-rate financing alternative in simulated years 1973–81. However, the standard deviations of the cash surplus (deficit) distributions are quite similar across financing methods. If one is to compare relative cash flow risk, the coefficient of variation (standard deviation/mean) is a useful summary statistic. The absolute values of the coefficients of variation (not reported) of the simulated distributions confirm that relative cash flow risk is typically smaller with the adjustable-term loan. These simulation results illustrate that the adjustable-term financing method provides an advantage in controlling cash flow risk over that of adjustable-rate and even fixed-rate financing when interest rates are generally rising.

Since farmers and farm lenders may gauge cash flow performance based on the chance that cash deficits would occur, we also report the percentage of cash deficit outcomes. As interest rates rise, the percentage of cash deficits remains lowest with the adjustable-term loan arrangement. Interestingly, the percentage of cash deficits is slightly lower for the adjustable-term loan than for the fixed-rate loan in some years. This is primarily due to the lengthened loan term and the resulting lower principal and total loan payments with the adjustable-term loan in the latter years of the simulation.

The CCR statistics in table 4 provide additional evidence that the capacity of the farm business to repay principal and interest is enhanced with the adjustable-term loan. In each year of the simulation, the distribution of the CCR indicates higher average cash flow coverage and lower standard deviation of the coverage ratio with the adjustable-term financing scheme. Repayment risk (in relative terms) can also be summarized by the coefficients of variation of the CCR distributions. Comparison of the coefficients of variation (not reported) shows that repayment risk is relatively lower with adjustable-term financing in most years of the simulation.

When interest rates follow a generally falling path (table 5), the cash flow results indicate that the adjustable-rate loan facilitates a larger mean cash surplus (smaller cash deficit) than the adjustable-term loan in most years. The relatively higher mean cash surplus with the adjustable-term loan in the last two years reflects the decrease in loan term and the acceleration of principal payments in the preceding years, which was brought about by falling interest rates. The standard deviations of the simulated cash surplus (deficit) distributions are nearly identical for the adjustable-rate and adjustable-term methods in most years. Fixed-rate financing results in comparatively smaller mean cash surpluses (larger cash deficits) and greater cash surplus (deficit) variability in most years when rates are falling. Since the standard deviations of the cash surplus (deficit) distributions are similar for the two adjustable financing methods, we conclude that the adjustable-term loan provides a means of controlling cash flow and repayment risk in absolute (dollar) terms and does not result in significantly increased risk even when rates are

Table 4. Cash Surplus (Deficit) and Cash-Flow Coverage Ratio Results for the Rising Interest Rate Scenario

		Cash Surplus (Deficit)			Cash-Flow Coverage Ratio		
Year	Measure	Adjustable Rate	Adjustable Term	Fixed Rate	Adjustable Rate	Adjustable Term	Fixed Rate
1972	Mean	$(10,755)	$(10,755)	$(11,906)	(0.27)	(0.27)	(0.28)
	Std. Dev.	$94,498	$94,498	$94,891	2.35	2.35	2.27
	Pct. < 0	50	50	50			
1973	Mean	$(3,695)	$(1,914)	$(3,707)	(0.09)	(0.09)	(0.13)
	Std. Dev.	$76,676	$76,778	$76,635	1.79	1.87	1.79
	Pct. < 0	47	43	43			
1974	Mean	$(18,828)	$(14,304)	$(17,154)	(0.30)	(0.24)	(0.29)
	Std. Dev.	$87,630	$87,684	$87,060	1.78	1.94	1.85
	Pct. < 0	50	47	50			
1975	Mean	$20,229	$23,986	$21,211	0.50	0.61	0.53
	Std. Dev.	$57,199	$57,244	$56,813	1.22	1.36	1.28
	Pct. < 0	33	33	33			
1976	Mean	$15,337	$19,520	$16,632	0.42	0.51	0.43
	Std. Dev.	$94,116	$93,598	$93,584	2.06	2.14	2.05
	Pct. < 0	53	50	50			
1977	Mean	$11,160	$15,541	$12,436	0.23	0.32	0.24
	Std. Dev.	$88,408	$87,767	$87,617	1.78	1.76	1.81
	Pct. < 0	37	33	33			
1978	Mean	$6,022	$11,413	$7,860	0.15	0.26	0.17
	Std. Dev.	$74,877	$74,124	$73,851	1.60	1.76	1.67
	Pct. < 0	47	40	43			
1979	Mean	$29,556	$37,004	$31,910	0.64	0.85	0.71
	Std. Dev.	$73,706	$73,441	$73,434	1.54	1.63	1.56
	Pct. < 0	47	27	43			
1980	Mean	$43,035	$53,393	$46,698	0.76	1.08	0.90
	Std. Dev.	$72,468	$72,165	$71,636	1.42	1.68	1.57
	Pct. < 0	27	23	23			
1981	Mean	$4,156	$18,008	$9,602	0.18	0.49	0.28
	Std. Dev.	$88,475	$87,481	$86,795	1.63	1.93	1.78
	Pct. < 0	50	37	43			

falling.[9] The similarity of reported percentages of cases where cash deficits occurred for adjustable-rate and adjustable-term arrangements confirms this result.

Summary statistics for the CCR indicate that differences in repayment performance among financing alternatives are small when rates are falling. Mean CCR levels are only slightly better (more positive and less negative) with the adjustable-rate loan in the first eight years of the simulation. The adjustable-term loan generates significantly improved average debt payment coverage in the final two years. Comparison of the CCR distribution statistics and the percentages of negative CCRs in table 5 leads us to conclude that repayment risk is essentially the same regardless of the choice of financing method when interest rates follow the pattern during 1981–90.

Other interest rate scenarios were simulated to evaluate the performance of these financing arrangements when interest rate movements reverse direction during the 10-year simulation period. The 1977–86 (rising-then-falling) rate series produced results which were qualitatively quite similar to those obtained using the 1972–81 (rising) rate series. A hypothetical falling-then-rising rate series yielded simulation results which were essentially the same as

[9] Cash flow would be reduced if the cash rate of return on farm assets were to positively covary with interest rates in this scenario, since loan payments remain constant in the adjustable-term financing method. We do not address the problem of prepayment risk with the fixed-rate loan when interest rates are falling.

Table 5. Cash Surplus and Cash-Flow Coverage Results for the Falling Interest Rate Scenario

		Cash Surplus (Deficit)			Cash-Flow Coverage Ratio		
Year	Measure	Adjustable Rate	Adjustable Term	Fixed Rate	Adjustable Rate	Adjustable Term	Fixed Rate
1981	Mean	$(23,797)	$(23,797)	$(25,285)	(0.41)	(0.41)	(0.42)
	Std. Dev.	$98,235	$98,235	$98,630	1.69	1.69	1.65
	Pct. < 0	53	53	53			
1982	Mean	$(18,595)	$(18,813)	$(20,326)	(0.31)	(0.32)	(0.33)
	Std. Dev.	$80,077	$79,805	$80,374	1.32	1.30	1.27
	Pct. < 0	50	50	50			
1983	Mean	$(28,356)	$(33,259)	$(33,643)	(0.36)	(0.43)	(0.42)
	Std. Dev.	$91,862	$91,191	$93,146	1.55	1.38	1.36
	Pct. < 0	50	53	53			
1984	Mean	$9,879	$5,321	$4,821	0.27	0.18	0.17
	Std. Dev.	$61,358	$61,699	$63,094	1.06	0.99	0.98
	Pct. < 0	50	53	53			
1985	Mean	$5,048	$(1,007)	$(1,634)	0.19	0.08	0.07
	Std. Dev.	$96,841	$96,873	$98,562	1.70	1.51	1.48
	Pct. < 0	57	63	63			
1986	Mean	$(4,393)	$(9,870)	$(10,220)	(0.07)	(0.16)	(0.16)
	Std. Dev.	$87,275	$86,880	$88,598	1.38	1.25	1.24
	Pct. < 0	43	43	43			
1987	Mean	$(7,678)	$(15,279)	$(15,502)	(0.11)	(0.21)	(0.20)
	Std. Dev.	$77,451	$77,510	$79,173	1.37	1.22	1.20
	Pct. < 0	53	57	53			
1988	Mean	$17,699	$10,853	$9,475	0.39	0.29	0.21
	Std. Dev.	$77,550	$77,853	$79,018	1.37	1.45	1.15
	Pct. < 0	50	50	50			
1989	Mean	$31,887	$40,364	$23,071	0.48	0.97	0.30
	Std. Dev.	$72,221	$74,281	$72,934	1.29	2.00	1.15
	Pct. < 0	36	27	40			
1990	Mean	$(12,510)	$17,240	$(23,376)	(0.13)	1.11	(0.25)
	Std. Dev.	$87,448	$87,501	$88,822	1.43	4.03	1.25
	Pct. < 0	50	40	63			

those already reported in the falling rate scenario.[10]

Stochastic interest rates imply differences in the distributions of annual loan payments and years to repay intermediate-term debt as reported in table 6. Total principal and interest payments of the adjustable-term loan remain constant through year 9 in the rising rate scenario. This illustrates the cash flow stabilizing role of adjustable-term debt amortization which was identified in equation (4). By comparison, the annual loan payments with the adjustable-rate loan are larger and exhibit significant levels of variability in each year of the simulation. Since the adjustable-term method shifts principal into the future when interest rates are rising, annual principal payments (not reported) tend to be smaller and more variable than those of the adjustable-rate loan. Thus, the adjustable-term loan stabilizes total debt payments, but allows annual principal payments to become more variable when interest rates are stochastic and generally rising. Observe that the extension of years to repay the adjustable-term loan results in a mean of 4.12 years remaining in year 10. We note, however, that the mean number of years gradually falls in each year of the rising rate scenario. The standard deviations of years remaining to repay adjustable-term debt indicate that some sequences of interest rates result in relatively large loan extensions.

Falling interest rates result in constant total payments through year 7 with the adjustable-term loan (table 6). Average size of the adjustable-term loan payments are larger than adjustable-rate payments in most years but begin to fall in year 8 reflecting the accelerated rate of principal repayment in prior years and

[10] These simulation results are available from the authors on request.

Table 6. Means and Standard Deviations of Simulated Loan Payments and Years Remaining to Repay Intermediate-Term Debt

		Rising Interest Rate Scenario			Falling Interest Rate Scenario		
		Adjustable Rate	Adjustable Term		Adjustable Rate	Adjustable Term	
Simulation Year	Measure	Principal and Interest ($)	Principal and Interest ($)	Years Remaining to Repay Principal	Principal and Interest ($)	Principal and Interest ($)	Years Remaining to Repay Principal
1	Mean	29,177	29,177	10.00	42,433	42,433	10.00
	Std. Dev.	0	0	0.00	0	0	0.00
2	Mean	30,958	29,177	10.47	42,214	42,433	9.26
	Std. Dev.	3,711	0	2.58	3,487	0	1.65
3	Mean	33,498	29,177	10.78	37,528	42,433	6.67
	Std. Dev.	2,846	0	2.32	3,268	0	0.89
4	Mean	32,357	29,177	8.94	38,513	42,433	5.82
	Std. Dev.	2,685	0	1.62	3,014	0	0.79
5	Mean	32,429	29,177	7.96	37,457	42,433	4.66
	Std. Dev.	2,561	0	1.60	3,382	0	0.68
6	Mean	32,133	29,177	6.94	38,628	42,433	3.78
	Std. Dev.	3,001	0	1.80	2,709	0	0.71
7	Mean	32,595	29,177	5.96	36,844	42,433	2.64
	Std. Dev.	2,322	0	1.51	2,447	0	0.63
8	Mean	33,624	29,177	5.25	36,901	40,646	1.63
	Std. Dev.	2,135	0	1.56	2,169	5,310	0.59
9	Mean	34,802	29,177	4.72	37,108	24,619	0.67
	Std. Dev.	2,186	0	1.94	1,788	16,627	0.52
10	Mean	35,350	28,805	4.12	37,102	4,251	0.10
	Std. Dev.	2,378	1,932	2.50	1,636	7,977	0.18

the smaller remaining principal balance in years 8–10. The corresponding relatively larger standard deviations of total loan payments under the adjustable-term financing method are attributable to falling interest rates and the term adjustment feature. Extreme interest rates result in large variations in both the amount of principal being repaid annually and the remaining balance of intermediate-term debt. The rapid decrease in the mean number of years to repay debt indicate that adjustable-term financing accomplishes faster debt repayment when interest rates are generally falling.

Profitability Effects

Farm profitability is largely unaffected by the choice between the two adjustable-financing alternatives. This is illustrated in table 7 by a comparison of the simulated distributions of net farm income for adjustable-rate and adjustable-term financing.[11] This was not the case for the fixed-rate lending arrangement. As expected, mean net farm income was larger and the standard deviation was smaller for the fixed-rate loan in the rising rate scenario than for either the adjustable-rate or the adjustable-term loan. Although differences in mean net farm income are noted, the size differences are relatively small when compared with the standard deviations of the net farm income distributions. Clearly, price and yield risk influence the variability of net farm income more dramatically than interest rate increases or the choice of financing method. When rates are generally falling, mean net farm income is lower with the fixed-rate loan, since the fixed interest rate remains higher than that of either adjustable financing alternative. The percentages of negative net farm incomes (not re-

[11] Net farm income was computed as net cash farm income (after interest expense) minus annual depreciation expense.

Table 7. Simulated Net Farm Income

Simulation Year	Measure	Rising Interest Rate Scenario			Falling Interest Rate Scenario		
		Adjustable Rate	Adjustable Term	Fixed Rate	Adjustable Rate	Adjustable Term	Fixed Rate
		($)					
1	Mean	33,306	33,306	30,806	9,634	9,634	7,134
	Std. Dev.	120,108	120,108	120,108	120,108	120,108	120,108
2	Mean	39,874	39,874	39,899	14,471	14,471	11,397
	Std. Dev.	98,604	98,604	98,772	98,450	98,450	97,992
3	Mean	22,693	22,683	26,510	10,207	10,224	618
	Std. Dev.	110,876	110,862	110,755	113,923	113,944	112,823
4	Mean	69,893	69,783	71,998	54,395	54,485	45,821
	Std. Dev.	84,959	84,849	85,025	88,114	88,181	88,749
5	Mean	72,519	72,314	74,734	58,060	58,223	47,898
	Std. Dev.	136,288	136,263	135,408	136,719	136,858	137,003
6	Mean	73,197	72,950	74,944	49,873	50,374	41,339
	Std. Dev.	119,522	119,648	118,640	113,525	113,652	113,072
7	Mean	62,661	62,428	65,068	46,704	47,270	36,064
	Std. Dev.	105,798	105,902	105,245	105,801	105,845	106,442
8	Mean	97,343	97,107	101,122	85,213	85,845	74,962
	Std. Dev.	112,803	112,694	112,205	115,291	115,388	115,159
9	Mean	123,853	123,325	128,903	111,801	112,683	102,538
	Std. Dev.	109,135	108,991	108,829	107,101	107,054	106,980
10	Mean	75,441	74,788	80,290	56,997	57,684	48,891
	Std. Dev.	123,710	123,982	122,707	119,654	119,780	119,979

ported) are highly similar across all three financing methods in each of the interest rate scenarios. This supports our conclusion that differences in the profitability effects of these financing methods are quite minor.

Conclusions

The adjustable-term loan concept represents a potential farm financing innovation. It provides a means of reducing the cash flow destabilizing effects of changing interest rates through a flexible approach to principal amortization. An adjustable-term loan is shown to be relatively more effective for loans with shorter initial maturities. Farm-level simulation is used to demonstrate that cash flow risk and repayment risk are significantly reduced by adjustable-term financing when interest rates are stochastic and generally rising over time. In exchange for reduced cash flow and repayment risk, adjustable-term financing results in a larger unpaid principal balance at the end of the initial loan term. If interest rates are generally falling, use of adjustable-rate financing results in only modestly better farm cash flow performance in the early years of the loan. In the later years the adjustable-term loan leads to stronger cash flow results. Given that farm borrowers and their lenders may not know which direction interest rates will move, or how volatile rate changes may be, an adjustable-term loan is shown to provide significant control over cash flow variability without leading to significant adverse effects on debt repayment capacity in either rate environment. In addition, the farm profitability effects are found to be relatively insignificant when adjustable-rate and adjustable-term financing are compared. Fixed-rate financing has significant adverse effects on net farm income when rates are falling, but leads to an expected improvement in farm income when rates are generally rising over time. Various other interest rate scenarios were evaluated and produced qualitatively similar results to those which were reported.

Adjustable-term financing may be more practical as a lending alternative if it is targeted toward certain groups of farm borrowers. Beginning farmers with relatively higher levels of short- and intermediate-term debt and more fragile liquidity positions may benefit most from adjustable-term financing. Only crop farms were simulated in this study, but ad-

justable-term loans could also be advantageous to livestock farmers with a larger proportion of intermediate-term debt. Operations with significant investments in facilities and equipment may be particularly well-suited to this type of financing arrangement. Lenders may want to exercise caution when applying adjustable-term financing to certain classes of depreciable assets since the underlying asset value may be declining (implying a lower collateral value) during a period in which the loan term is being extended. In this situation the lender may choose to limit the term extension and/or require additional security on the loan.

Adjustable-term loans may provide an additional marketing tool to farm lenders. In an uncertain interest rate environment, farm borrowers may choose to use an adjustable-term loan due to its structured refinancing feature and generally favorable cash flow implications. Lenders could experience some difficulties with adjustable-term loans when matching the maturities of assets and liabilities. Thus, there may be a need to hold more liquid assets to meet cash flow demands when principal payments from borrowers are reduced. The acceptability of adjustable-term financing to farm lenders and their regulators is an open question. Further exploration and refinement of this financing innovation are merited.

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