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Effect of Variable Interest Rates on the Financial Performance of Dairy Farm Businesses

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Effect of Variable Interest Rates on the Financial Performance of Dairy Farm Businesses

The increased variability of interest rates experienced during the early 1980s led many commercial banks to shift the interest rate they charge on farm loans from a fixed to a variable rate (Zook and LaDue). Although the Farm Credit System had used variable rates for a number of years, the index or mover for their rate was their average cost of funds, which is less volatile than some of the rate indices used by commercial banks. Further, counter to the situation when the Farm Credit Service switched to variable rates, the shift of commercial banks to variable rates left most farmers with no fixed rate general credit source, no matter how important a fixed debt service commitment might be to their business.

Given the disappearance of a fixed rate alternative for farm businesses, the impact of the variable rate and the differential impact of alternate indices or movers could become an important determinant of farm business success. The relative magnitude of these effects also influence the value of any innovation required to develop a new fixed rate source of funds for agriculture and the interest rate differential farmers would be willing to pay for a fixed rate alternative.

This paper presents an analysis of the impacts of variable rates on the ability of farmers to meet their debt service obligation. The first section describes the farm situation used and defines the interest rate plans compared. This is followed by a review of the method of analysis employed. Then the effect of variable rates on payment level and variability and on farmers' ability to meet debt service obligations are presented. Finally, some conclusions are drawn.

The Farms Studied

The studied farms were selected from those participating in Cornell University's Dairy Farm Business Summary project during 1977-81. A strata of farms were selected based on farm size and leverage. The three size categories were 40 to 60 cows, 85 to 115 cows and over 130 cows. In order to minimize the complicating effects of farm expansion, only farms which stayed within their size range during the entire five year period were selected.

Leverage was measured by the percent equity as of 1977. Three initial leverage ranges were used: 30 to 45 percent, 50 to 65 percent and 70 to 85 percent. These equity ratios correspond roughly to $2,500 to $3,500, $1,500 to $2,500 and $500 to $1,500 debt per cow, respectively. However, percent equity rather than debt per cow was used in order to accurately reflect the presence of nondairy enterprises on some farms.

The sample included 44 farms. There were six farms in each of the nine stratification cells except for some of the large-farm, low-equity combinations where fewer than six farms were available. All farms had complete balance sheet, income statement and production data for the entire five year period.

Interest Rate Plans

Nine different interest rate plans[1] were used in the analysis (table 1). All made use of one of three indices. Two bank related variable rate indices were employed: (1) the monthly average New York City prime rate and (2) the Federal Reserve discount rate. except for own-bank-prime, which generally moves with the New York City prime, these are the most frequently used variable rate indices used on agricultural loans (Zook and LaDue). The third variable rate index used was the Farm Credit Service effective rate on loans made in New York State.

Table 1. INTEREST RATE PLANS

Plan Description	Interest Rate Type	Index	Date Rates Set
1. Prime +1	Variable	Prime Rate	Monthly
2. Prime +1 with ceiling	Variable	Prime Rate	Monthly
3. Discount rate +4	Variable	Discount Rate	Monthly
4. Farm Credit	Variable	Average Cost of Outstanding bonds	Monthly
5. Renegotiable 1	Renegotiable and Variable	Prime Rate	Monthly, except long term on 1/1/75 1/1/78 and 1/1/81
6. Renegotiable 2	Renegotiable	Prime Rate	Monthly, except long term on 1/1/76 and 1/1/79
7. Renegotiable 3	Renegotiable and Variable	Prime Rate	Monthly, except long term on 1/1/77 and 1/1/80
8. Fixed Prime +1	Fixed	Prime Rate	Date loan originated
9. Adjusted Fixed	Fixed	Prime Rate	Date loan originated

Four different variable rate plans were used. The first three are frequently used by banks serving agriculture. The first, the prime rate plus one percent, is the rate most frequently used by banks. The second is the prime rate plus one percent but with a ceiling of 18 percent. This modification protects farmers from violent interest rate changes while requiring farmers to assume most of the interest rate risk. The third was the Federal Reserve discount rate plus four percent. The fourth variable rate was the average rate charged in New York State by the Farm Credit Service adjusted for the stock requirement. Short- and intermediate-term loans were set at the average Production Credit Association rate adjusted for a 10 percent stock requirement with automatic cancellation. Long-term loans were charged at the average Federal Land Bank rate adjusted for a five percent stock requirement with automatic cancellation. Use of automatic rather than end-of-period cancellation slightly underestimates actual FLB annual equivalent rates but adds greatly to computational ease.

Only one basic renegotiable rate plan was assessed. This plan allowed the interest rate to be changed every three years with no limits on the amount or frequency of change. Prime plus one was used as the index. Since the rate paid on these loans depends on when the loan was initiated, three renegotiable interest rate plans were developed from this one basic plan with the three differing only when the initial loan was originated: 1975, 1976 or 1977. Under this plan only long term rates were handled on a renegotiable basis. Short- and intermediate-term loans were variable and were based on prime plus one.

The seven variable rate plans were compared to two fixed rate alternatives. Under the first of these, rates were set at prime plus one as of the date of each loan's origination. This implies that a borrower can obtain a fixed rate at the same initial rate that would be paid for a variable-rate loan. The second fixed rate scenario adjusted these rates based on the relationship between fixed and variable rates charged on farm loans over the 1977-81 period (Zook and LaDue). These fixed rates were above initial variable rates when rates were expected to rise and below such rates when rates were expected to decline.

The basic interest rate environment under which the interest rate plans were compared was the actual 1977-81 experience. The interest rate pattern over this period was widely fluctuating but with an upward trend. To assess the differential effect of various rate plans under alternate interest rate environments, the prime plus one fixed rate was also compared with variable rate plans under two alternate interest rate environments. The first alternate was the reverse of the 1977-81 experience. This represented a fluctuating rate pattern but with a downward trend. The second alternate pattern was a fluctuating rate with no trend. In this case, the rates fluctuated about the mean rate experienced during 1977-81 but there was no general trend in interest rates (Zook).

Analysis Procedure

The analysis procedure involved establishing the initial debt level and loan repayment schedule for each farm as of January 1, 1977 and then simulating the farm's financial situation through time based on the interest rate environment, the interest rate plan, and the farm's operating results.

The initial repayment schedule was based on the actual outstanding debt on the farm on January 1, 1977 and an assumption that all intermediate term debt had just been refinanced with maturities of five years. This assumption is consistent with the situation on a large proportion of farms, 54 percent of the 1982 Cornell Dairy Farm Business farms either had only one intermediate-term loan or, if more than one was reported, all had approximately the same maturity, facilitated computation and placed all farms in a similar historical interest rate position.

Payments on all loans were scheduled monthly because the farms studied were dairy farms. Operating loans with six month maturities and April 30 initiation dates were used to finance crop expenses. Since the principal for these loans was included in operating expenses, only the interest payments were counted in debt service requirements.

A new five-year intermediate-term loan was used for each year's capital purchases, as well as any real estate improvements actually financed by the farmer on an intermediate term basis. These loans were initiated on June 30. All purchases were completely debt financed resulting in zero cash payments on machinery and building purchases.

The outstanding long term debt, as of January 1, 1977 was assumed to have 15 years remaining on an original loan term of 20 years. Payments were scheduled to be made monthly. Any new real estate purchases or improvements actually financed with a long-term loan by the farmer were assumed to be financed with a 20 year loan beginning on January 1 of the year in which the purchase was made.

Monthly debt service requirements were calculated for each individual loan and summed. All loans required level principal and interest payments with complete amortization of the loan over its term.

The amount of cash the farmer had available for making debt payments was calculated for each year. First, the amount available for debt payments and family living expenses was computed by subtracting total cash farm expenses from total cash farm receipts and adding back in the amount of interest included in cash farm expenses. Machinery, livestock and real estate purchases and improvements were assumed to be debt financed resulting in zero cash investment. Sales of capital items, primarily machinery and real estate provide an additional source of cash for farmers so this figure was added to the amount of cash available for debt payments and family living expenses.

To adjust reported farm cash flow to actual cash flows, the amount available for debt service and family living was adjusted for changes in accounts payable. An increase in accounts payable represented expenses incurrred but not paid for and, thus, decreased cash available. Similarly a decrease in accounts payable increased cash available.

The final calculation to determine the amount of cash available for debt service was the subtraction of family living expenses. These expenses were estimated using a family living function specified as a base living allowance plus four percent of cash receipts. This formula has been employed in Farm Business Summaries for a number of years (Smith

and Putnam). The base living allowance is specified on a per operator basis and is adjusted annually for inflation in living costs using the Consumer Price Index (CPI). This base amount was $6,387, $6,976, $7,650, $8,700 and $9,600 in the years 1977-81, respectively.

The difference between debt service requirements and the amount available for debt service resulted in either an annual surplus or deficit which influenced the debt service burden through deficit financing, or the cash available in future years through surplus carryover. Where a surplus of repayment capacity resulted, it was assumed that the surplus accumulated evenly over the year beginning with January 1. Since banks do not pay the same rate on deposits as they charge on loans, the interest rate earned on each year's average outstanding surplus was assumed to be one-half the average interest rate paid on loans for that year, unless this rate was less than 5.25 percent. In that case, 5.25 percent interest was earned. The surplus could be used to help make up any shortfalls in repayment capacity in future years.

When a deficit occurred in repayment capacity, interest was charged on the deficit amount as it accumulated over the year. This was done by assuming that the deficit accumulated evenly over the year beginning with the end of January since payments were assumed to be made at the end of each month. The interest rate charged was the average interest rate paid on loans for that year. At the end of the year the total amount of the deficit, including the interest on it, was financed over the next 12 months, unless this total was more than 20 percent of the next year's total cash receipts. In the latter case, it was assumed that the lender would refinance the deficit with an intermediate-term loan of five years to give the borrower a better chance of making the required payments.

Payment Level and Variation

The direct effect of the various interest rate plans is shown through the resulting level and variation in debt service requirements. When evaluated over the 1977-81 period the variable rates based on the discount rate and the prime rate had the highest mean monthly payment for all farm groups, averaging 17 percent higher than fixed rates (table 2). The variable rate with an 18 percent ceiling had the next highest mean followed by the three renegotiable rates. Average payment under the renegotiable rate was only 10 percent above fixed rates. The two fixed rate scenarios generally had the lowest mean with the unadjusted scenario slightly lower than the adjusted one. The FCS plan normally ranked higher (five percent) than the fixed rates but below all other variable and renegotiable rates.

The variable rate based on prime had the highest average standard deviation among the nine plans. This was true for all but one of the nine size/equity farm groups. The only exception was for the large herd size/low percent equity group where the renegotiable rate set every three years beginning in 1975 had a higher standard deviation. This renegotiable rate also had the second highest degree of variability for all farms.

Contrary to conventional wisdom, the discount rate also resulted in a high degree of variability in debt payments. Renegotiable long term rates resulted in significant reductions in variability only in some cases. In those cases where rates are reset when

interest rates are high, variability is little affected. When they are set before an interest rate surge and hold throughout a rate peak, variability is reduced. However, since they normally apply only to long term debt, the degree of debt service stability provided is modest. Variability was lowest for the two fixed rate plans, followed closely by the Farm Credit Service rates.

Table 2. LEVEL AND VARIABILITY OF REQUIRED DEBT PAYMENTS[a]
44 New York Dairy Farms
1977-1981 Interest Rate Environment

Interest Rate Senario	Mean Monthly Payment	Standard Deviation	Maximum Monthly Payment
		---Dollars---	
Prime Rate +1	5603	2519	10308
Prime Rate +1 with ceiling	5492	2365	9580
Discount Rate +4	5677	2393	9909
Farm Credit Service Rates	5035	1984	8573
Renegotiable 1 (1975 Base)	5471	2450	10216
Renegotiable 2 (1976 Base)	5272	2170	9074
Renegotiable 3 (1977 Base)	5205	2290	9293
Prime Rate +1 Fixed-rate	4683	1826	7963
Adjusted Fixed-rate	4815	1855	8103

[a]Average for all nine herd size/percent equity groups.

The highest maximum monthly payment for the majority of the farm groups occurred with the variable rate based on prime, although the variable rate based on the discount rate was highest for two groups. Again, the plans with the lowest monthly payments were nearly always the FCS plans and the two with fixed rates.

The effects of the different types of interest rates were generally size and equity neutral (table 3). There was no consistent pattern of change in relative payments as herd size or percent equity increased. Further, the relative variability of payments, as indicated by the coefficient of variation, is not materially different for different herd size or equity levels. The coefficient consistently increases as herd size increases but the increase is .05 or less for all loan types and increases for fixed- as well as variable-rate loans. There is no consistent pattern in the coefficient of variation for changes in equity.

Table 3. DIFFERENCES IN MEAN MONTHLY PAYMENT BY HERD SIZE AND PERCENT EQUITY
44 New York Dairy Farms
1977-1981 Interest Rate Environment

Description	Fixed-rate Plan	Alternative Interest Rate Type		
		Variable[a]	Renegotiable[b]	Farm Credit Service
	dollars	---Percent Higher Than Fixed-rate---		
Herd Size:				
40 - 60	2552	17	11	5
85 - 115	4878	13	6	1
more than 130	7015	18	11	7
Percent Equity:				
30 - 45	7139	17	9	6
50 - 65	4385	16	11	4
70 - 85	2921	25	9	4

[a]Prime plus one.
[b]Initial rates set in 1976.

From the results generated under the 1977-81 interest rate environment it is clear that the index used can seriously effect both the magnitude and variability of debt payments when a variable interest rate is employed. Not all variable rates are alike. Prime plus one resulted in higher payments and variability than did other variable rates. The Farm Credit System rates, though variable, generate both level and variability of payments that are more like fixed rates than variable rates based on other indices.

To observe the impact of variable rates in other environments the farms were simulated through two alternate interest rate environments: (1) the reverse of the 1977-81 experience and (2) the fluctuating, no trend environment. Prime plus one fixed and variable rate plans were compared under these environments.

Under the reverse 1977-81 environment the variable rate was better than the fixed rate from the borrowers' perspective. The mean monthly payment, the standard deviation of monthly payments and the maximum monthly payment were all lower for the variable rate than for the fixed rate (table 4).

Table 4. LEVEL AND VARIABILITY OF REQUIRED DEBT PAYMENTS
44 New York Dairy Farms
Alternate Interest Rate Environments

Interest Rate Environment and Plan	Mean Monthly Payment	Standard Deviation	Maximum Monthly Payment
		---Dollars---	
Actual 1977-81 Environment:			
Variable Prime +1	5603	2519	10308
Fixed Prime +1	4683	1826	7963
Reverse 1977-81 Environment:			
Variable Prime +1	6148	1734	9020
Fixed Prime +1	6614	2266	10254
Fluctuating, no Trend Environment:			
Variable Prime +1	5749	1971	9117
Fixed Prime +1	5661	1956	8912

For this analysis it was assumed that no refinancing of fixed-rate loans with high interest rates occurred when market rates declined. Farmers and other borrowers have frequently refinanced loans in the past; this practice enabled them to borrow money when rates were high and then, after rates dropped, refinance at a lower interest rate. It is likely, however, that future fixed-rate loans will carry prepayment penalties that limit the benefits of refinancing. Otherwise, lenders are carrying the upside interest rate risk without being able to benefit from any possible declines in market rates.

In an environment where interest rates fluctuate with no trend, the differences between variable- and fixed-rate loans were minimal. The mean monthly payment, the standard deviation and the maximum monthly payment were only slightly less with a variable than with a fixed rate. The small difference in the standard deviation between the two rate plans results from the fact that the rates in this scenario fluctuated evenly around the historical mean of 13 percent. This, combined with the time pattern of new borrowings, resulted in very similar standard deviations for the two plans.

Repayment Ability

The most relevant test of the effect of variable rates on farm businesses is their impact on the frequency with which all debt payments can be met. The repayment ability and cash carryover for each year were compared to the corresponding debt service requirements. From this comparison the frequency with which debt payments could be made was determined.

In general, low equity farms were unable to make their payments during the 1977-81 rising interest rate period (table 5). As expected, increases in equity raised the frequency with which payments could be made. However, the different types of interest rates had a relatively modest effect on the frequency for all equity levels. On average, use of a variable rate reduced the frequency with which payments could be made by only 0.4 years out of five, or eight percentage points. Use of renegotiable rates had slightly less effect. The frequency with which payments could be made under Farm Credit Service rates was very close to that observed with fixed rates.

The use of variable rates had more effect on small and medium sized farms than large ones. This occurred because the large herd size/high percent equity farms could make all their payments every year, and none of the large herd size/low equity farms could make them in any years regardless of the interest rate plan. For these farms, factors other than the type of interest rate were more important in determining the frequency with which payments could be made.

When comparing any sequence of years like this, the frequency with which payments can be made can be materially influenced by the first year. That is, a large deficit in the first year could limit the possibilities of making payments in future years. To assess this, ability to meet debt payments was redefined to include any case where standard debt payments (operating, intermediate- and long-term loan payments) could be made out of the current year's cash flow. This definition excluded payments on previous years' deficits and carryover of excess cash. The change in definition slightly increased (0.2 to 0.3 years

in five) the frequency with which low equity farms could make their payments and reduced the frequency (0.1 to 0.6 years out of five) for medium and high equity farms. The average effect of variable rates was only modestly greater (0.1 year in five).

Table 5. AVERAGE NUMBER OF YEARS ALL DEBT PAYMENTS CAN BE MADE BY HERD SIZE AND PERCENT EQUITY[a]
44 New York Dairy Farms
1977-1981 Interest Rate Environment

Description	Interest Rate Type			
	Fixed	Variable	Renegotiable	Farm Credit Service
		---Number of Years out of Five---		
Herd Size:				
40 - 60	2.4	1.9	2.0	2.2
85 - 115	2.0	1.5	1.6	1.8
more than 130	2.5	2.4	2.5	2.5
Percent Equity:				
30 - 45	0.2	0.1	0.1	0.1
50 - 65	2.5	1.8	2.1	2.3
70 - 85	4.2	3.9	3.9	4.1
All Farms:				
Average	2.3	1.9	2.0	2.2

[a]Includes the use of any cash reserve to help meet cash flow shortfalls.

Thus, it is not the cumulative effects of a first-year deficit that caused these farmers to be unable to make their required debt payments in a majority of the years. Under both definitions the average number of years in which debt payments could be made

as greatest for the fixed rate scenario and least for the variable rate. Variable-rate loans, thus, do make it more difficult for farmers to meet their required debt payments. However, the magnitude of this difference is small.

The effect of type of interest rate on debt repayment under the alternate interest rate environments was even less than that observed during the 1977-81 period (table 6). The frequency with which payments could be made was very similar for both fixed and variable rates with both the reverse 1977-81 and the fluctuating environments.

Table 6. AVERAGE NUMBER OF YEARS ALL DEBT PAYMENTS CAN BE MADE BY HERD SIZE AND PERCENT EQUITY
44 New York Dairy Farms
Alternate Interest Rate Environments

Description	Interest Rate Type			
	Reverse 1977-81		Fluctuating	
	Fixed	Variable	Fixed	Variable
	---Number of Years out of Five---			
Herd Size:				
40 - 60	0.9	1.0	1.3	1.4
85 - 115	0.8	0.8	1.2	1.2
more than 130	1.7	1.7	2.3	2.2
Percent Equity:				
30 - 45	0.1	0.1	0.1	0.1
50 - 65	0.1	0.1	1.3	0.9
70 - 85	3.2	3.2	3.8	3.7

The low absolute frequency with which payment ability exceeds cash available has at least three partial explanations. First the stratification procedure that was used insured a more than proportional representation of low equity farms. Second, many farmers have more liberal credit terms than the five years on intermediate-term and 20

years on long-term loans than was used in this analysis. Third, a number of farms had other serious problems limiting their repayment ability. For many farmers in the sample this was the most important determinant of the results and indicates that variable rates are not likely to be the primary cause of repayment difficulties on most farms.

Debt Carrying Capacity

An alternate measure of the effect of variable rates is debt carrying capacity. Debt carrying capacity is the debt level that would exactly exhaust the farm's annual repayment capacity given the amount of cash required to service an average dollar of debt in any given year. This was calculated by determining the total debt service payments required during the year for intermediate- and long-term loans separately. Then the average payment per dollar of outstanding loan volume is determined by dividing these payment amounts by the average outstanding balance for the year for each term. A weighted average of these two rates is then calculated using the total outstanding principal balances as weights. This average is the amount required to service an average dollar of debt. Debt carrying capacity is calculated by dividing the amount generated by the business for debt payments by the amount required to service an average dollar of debt.

Under the actual 1977-81 interest rate environment the amount of debt that a farm business could carry was 12 percent less under a variable rate regime than with fixed rates (table 7). Not surprisingly, under the reverse 1977-81 interest rate environment fixed rates were at an 11 percent disadvantage compared to variable rates. Debt carrying capacity under a fluctuating interest rate with no trend is identical under both fixed and variable rates.

Table 7. MEAN DEBT CARRYING CAPACITY
44 New York Dairy Farms
Three Interest Rate Environments

Interest Rate Environment	Interest Rate Type		Percent Change From Fixed
	Fixed	Variable	
	---Thousand of Dollars---		
Actual 1977-81	181	159	-12
Reverse 1977-81	141	156	+11
Fluctuating	157	157	0

Conclusions

The index used to adjust variable rate loans significantly influences both the level and variability of loan payments. Of rates frequently used on farm loans, a variable rate specified as prime plus one percent resulted in the greatest variability and maximum payment within the interest rate environment experienced during 1977-81. Placing a ceiling on interest rates at approximately six percentage points above the mean only modestly reduced total payment variability and amount but significantly reduced the maximum payment made over the five year period. Counter to commonly held expectations the discount rate plus four percent resulted in the highest average payment as well as high variability in payment amounts.

The use of renegotiable rates on long-term loans can reduce payment volatility and, in a rising interest rate environment like 1977-81, also reduce average payments. However, the actual effect depends on the coincidence between rate change dates and the peaks and valleys of interest rate movements. When rate change dates coincide with peaks and valleys, variability will be high compared to changes that occur at medium level rates and remain constant through peaks and valleys.

Farm Credit System rates, although variable, resulted in payment levels and variability that were more like fixed rates than the variable rates that other lenders would normally use. Use of the average cost of funds as the index, rather than a marginal cost which is frequently used by banks, adds a higher degree of stability to the rates and, thus, average payments that farmers must pay.

Although the absolute amount required for debt service varies by farm size and equity levels, relative payment levels and variability are quite constant over normal ranges of both size and equity. The coefficient of variation showed no trend over various equity ratios and only modest increases with farm size increases.

As would be expected based on theoretical considerations the relative advantage of fixed versus variable rates depends upon the interest rate environment. In the highly variable but generally rising interest rate environment experienced during the 1977-81 period, variable rates reduced the debt carrying capacity of farm businesses by about 12 percent. The frequency with which these businesses were able to make their payments declined eight percentage points (46 to 38 percent).

With a reverse 1977-81 environment (variable with a generally declining trend) variable rates provided an advantage over fixed rates roughly similar to the disadvantage experienced during the 1977-81 period. A fluctuating environment with no trend produced similar results over the five year period with either fixed or variable rates.

In a period such as 1977-81 when interest rates were rising, variable interest rates definitely reduced the frequency with which farmers were able to meet their debt commitments. However, this effect was modest compared to the sum of all other factors limiting repayment. With fixed rates the group of farms studied were able to make their payments only about half of the time. Although the stratification procedure used to

select the farms and the rather stringent credit terms used in the analysis contributed to this average result, the most important factor causing farms to be unable to meet debt service commitments was inability to generate sufficient cash flow, or too much debt for the business, rather than the imposition of variable instead of fixed rates.

FOOTNOTES

1. Interest rate type refers to the basic kind of interest rate used i.e., fixed, variable or renegotiable. Interest rate index is the mover that specifies the level and/or adjustments that can be made in rates charged. Interest rate plan specifies the exact rate at any point in time and reflects such factors as the relation of the rate to the index (i.e., prime plus one) and the frequency of rate changes (i.e., quarterly).

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