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A SIMULATION STUDY OF THE EFFECTS OF CREDIT TERMS UPON MAXIMUM FEASIBLE FARM DEBT BURDENS

by

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ABSTRACT

Cash income data obtained from farm records is decomposed with a regression technique suggested by portfolio theory. Farm debt structure is simulated and maximum feasible relative debt burdens are estimated for several one and two enterprise farmtypes. Sensitivity of the maximum debt burdens to changes in credit terms is explored.

Introduction

The farmer that chooses to use credit faces two sets of issues: The first involving production management decisions with respect to size and type of debt leveraged investment, the second involving the negotiation of credit terms, i.e. loan maturity, interest rate, and repayment conditions. Agricultural economists have traditionally emphasized the importance of the role of production decision making (improving managerial ability) in the successful application of financial leverage. The focus in this paper is, however, upon the second set of credit issues. We shall suggest that the eventual success of debt useage can in some cases depend as much upon attention given to credit terms as upon the attention given to maximizing production efficiency.

In this study, estimated historic rates of return (ROR's) by farm enterprise are estimated from high quality farm records with a multiple linear regression technique.[1/] The estimated enterprise ROR's are employed in a cash flow simulation model that allows the imposition of varying levels of farm debt for precisely defined farm types. Maximum feasible relative debt burdens (i.e., the ratio of total farm debt to total farm assets) are found by discovering the amount of debt servicing obligations (a direct function of relative debt burden) that exhausts available cash flow. Sensitivity of estimated maximum debt burdens is then explored with respect to changes in interest rates, loan maturity terms, and alternative levels of satisfactory debt service.

The employment of recent historical production returns data in a simulation approach facilitates examination of a rich variety of questions, while subscribing to a reality that does not abstract from changing weather conditions, deviations from optimal, etc. Simulation results may serve as benchmarks upon which the individual observer may base his/her subjective estimate of conditions that will prevail in the near future. The estimation of maximum feasible debt ratios (MFDR) and their sensitivity to changes in credit arrangements can be of increasing informational value in an agricultural sector that has come to be characterized by rapid growth in debt financing and large changes in interest rate levels.

Methodology

Estimated enterprise rate of return parameters were obtained with multiple linear regression model suggested to us by portfolio theory, and indicated by equation 1 (see Sharpe, for portfolio theory reference). In this framework the whole farm ROR is decomposed into the weighted sum of the individual enterprise ROR's and an error term.[2/]

$$(1) \quad ROR_{\cdot jt} = \sum_{i=1}^{I} r_{i\cdot t} w_{ijt} + \varepsilon_{i\cdot t}$$

enterprise $i = 1, 2 \ldots I$

farm $j = 1, 2 \ldots J$

year $t = 1, 2 \ldots T$

$ROR_{\cdot jt}$ = cash income_{jt} divided by total assets_{jt}

$r_{i\cdot t}$ = rate of return_{ijt}

w_{ijt} = value added_{ijt} divided by total value added_{jt}

$$w_{ijt} \geq 0, \; \sum_i w_{ijt} = 1$$

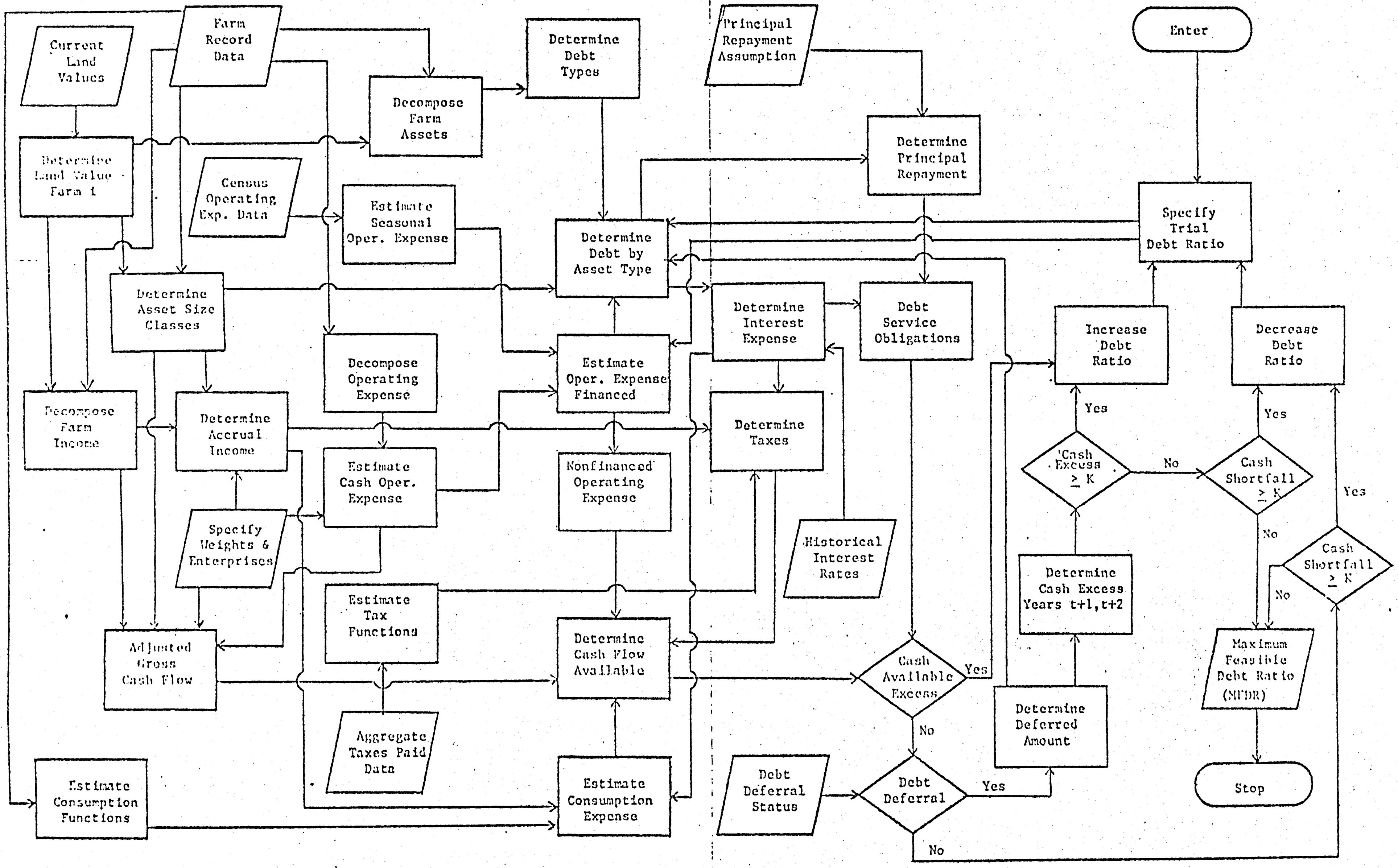
$$\text{cash income}_{jt} = \sum_i \text{value added}_{ijt} - \text{operating expenses}_{jt} + \text{miscellaneous farm income}_{jt}$$

Value added consists of cash sales less purchases plus adjustments for inventory change and transfers between enterprises. Operating expense includes purchases of nonbreeding livestock, feed, crop expense and hired labor. Miscellaneous income basically consists of work for other farmers and patronage refunds.

Our model interpretation is supported by standard portfolio theory if it can be presumed that value added per enterprise is proportional to resources invested in the enterprise.[3/] The formulation expressed by equation 1 permits greater flexibility, and at the same time greater precision in farm type classification and enterprise returns estimation, than does the traditional sales-formula farm type classification scheme.[4/] Regressions of somewhat more complex formulations of equation 1 were employed in order to test for size and enterprise interaction effects and also for the joint occurrence of both size and interaction effects among the sample farm records. However, F-test results (Chow) did not support rejection of the hypothesis that no size and/or interaction effects existed in the sample (see Hanson and Thompson, pp. 10-12 for details of the tests). Thus in the far left hand side of the model flow chart presented in figure 1, "decomposition" of farm income, refers to the method formulated by equation 1. Decomposition of farm assets into current, noncurrent chattel, and real estate assets, by enterprise, as well as decomposition of operating expenses by enterprise, were also carried out with regressions analogous to equation 1.

Since the farm records did not indicate debt composition, equation 2

Figure 1.



Current Land Values
Farm Record Data
Determine Debt Types
Principal Repayment Assumption
Enter
Decompose Farm Assets
Determine Land Value Farm i
Census Operating Exp. Data
Estimate Seasonal Oper. Expense
Determine Principal Repayment
Specify Trial Debt Ratio
Determine Debt by Asset Type
Determine Asset Size Classes
Determine Interest Expense
Debt Service Obligations
Increase Debt Ratio
Decrease Debt Ratio
Decompose Operating Expense
Estimate Oper. Expense Financed
Decompose Farm Income
Determine Accrual Income
Determine Taxes
Yes
Yes
Estimate Cash Oper. Expense
Nonfinanced Operating Expense
Cash Excess ≥ K
No
Cash Shortfall ≥ K
Specify Weights & Enterprises
Historical Interest Rates
No
Yes
Cash Shortfall ≥ K
Determine Cash Excess Years t+1, t+2
No
Estimate Tax Functions
Adjusted Gross Cash Flow
Determine Cash Flow Available
Cash Available Excess
Yes
Maximum Feasible Debt Ratio (MFDR)
No
Determine Deferred Amount
Aggregate Taxes Paid Data
Debt Deferral Status
Debt Deferral
Yes
Estimate Consumption Functions
Estimate Consumption Expense
Stop
No

represents the formula employed to structure representative debt by the estimated longevity of current, noncurrent chattel and real estate components of total assets.

$$\text{(2)} \quad \text{Debt}_{kt} = \text{Seasonal operating expense}_{kt} + \text{current assets}_{kt} \times \text{D/A}_{kt} + \text{Term assets}_{kt} \times \text{D/A}_{kt} + \text{Real estate assets}_{kt} \times \text{D/A}_{kt}$$

farm type k = 1, 2 ... K

year t = 1, 2 ... T

Seasonal operating expense = fertilizer, lime, seed, pesticides, fuel.

Current assets = nonbreeding livestock, seed, feed, inventories.

Noncurrent chattel assets = dairy and beef cows, machinery, vehicles, and equipment.

Real estate = land (priced at current value) and buildings inventories.

The equation indicates that total debt for farm type k in year t consisted (respectively) of seasonal, annual, term, and mortgage components. Debt composition by maturity type, with the exception of seasonal debt, was posited to be proportional to asset composition by length of asset life (the proportion of total debt that is in the form of mortgages is equal to the ratio of real estate to total assets etc.).

Term debt is assumed to be repaid over 5 years with level principal payments and real estate mortgage credit repaid over 20 years with constant principal and interest payments. In determining asset values, land was priced at estimated current value rather than historical cost. Model debt determination is illustrated in the middle section of figure 1.

Representative farms are specified in terms of enterprise configuration, size, and a specific relative debt load. Satisfactory debt service performance levels are also defined. The model then imposes the constraint that available cash flow meet or exceed required debt service amounts, consumption and personal taxes as specified in equation 3.

$$(3)\quad \begin{matrix}\text{Adjusted}\\ \text{Gross}\\ \text{Cash Flow}\end{matrix} \geq \begin{matrix}\text{Minimal}\\ \text{Household}\\ \text{Expenditures}\end{matrix} + \begin{matrix}\text{Marginal}\\ \text{Consumption}\end{matrix} + \begin{matrix}\text{Nonfinanced}\\ \text{Operating}\\ \text{Expense}\end{matrix} + \begin{matrix}\text{Interest}\\ \text{Expense}\end{matrix} + \begin{matrix}\text{Debt}\\ \text{Principal}\\ \text{Expense}\end{matrix} + \begin{matrix}\text{Income}\\ \text{Social Security}\\ \text{Taxes}\end{matrix}$$

MFDRs are found by first finding the relative debt burden that makes equation 3 hold at equality, for each farm type, for each of the ten years in the sample period (actually, cash excess or shortfall must be less than a constant "k" set at $100 in this study; see figure 1 lower right). The MFDR that is reported is the minimum one observed in that ten year period.[5/] (When the inputs indicated at the beginning of this paragraph have been specified, the right hand side of Figure 1 illustrates determination of MFDR).

Sensitivity of MFDR's to changes in credit terms.

In this study both strict and flexible debt servicing conditions were explored. Under the strict default condition (where all principal and interest payments were required to be made as scheduled), it was found that hog finishing and beef feeding farmtypes were unable to service positive debt loads in the critical year(s), and that very heavy reliance upon equity financing was necessary for most farmtypes. In the interest of brevity, only detailed results from the flexible debt service condition will be reported here. This comparatively lenient and perhaps more realistic condition permits the deferral of nonreal estate loan principal payments in a year of low income, provided that at the end of a two year period following the year in which the deferral of principal payments took place, additional interest (on the deferred payments) and principal payments are made so that all originally scheduled loan servicing is once again on a current basis.

Table I illustrates the impact upon MFDR levels of interest rate changes of one and two percent above and below the average historical levels that obtained during the sample period.[6/] The more highly leveraged the farm, the greater the effect of a 1% change in interest rates upon maximum feasible debt levels. For the farms with base conditions MFDRs greater than .65, an interest rate rise of one percentage point reduced debt ratios 2-4 percentage points, and for beef feeding-complete program hogs, an interest rate increase of 4% (from the historical rate less 2% to the historical rate plus 2%) decreased the maximum feasible debt ratio 14.1 percentage points, a rather substantial decline.

While it appears that small changes in interest rates in the sample period were of only very limited consequence to moderately leverage farms, a change in interest rates of several percentage points may significantly alter the MFDR of highly leveraged farms.

The increase in MFDRs, resulting from the extension of the real estate mortgage term to 40 years, averaged between 6-7 percentage points with most of this increase attributable to the first ten years of the 20 year extension (Table II). Farms with a cash grain component, and for whom consequently real estate was an especially large component of assets, particularly benefited (their debt ratios tended to increase by about 20%, or from 6.6

Table I: Interest rate sensitivity test.

Farm Type	Critical Year	Interest Rate Levels -2%	-1%	Historical	+1%	+2%
Cash Grain	1967	.312	.297	.282	.269	.256
Dairy	1975	.589	.572	.554	.538	.521
Beef Feeding	1974	.410	.385	.362	.34	.321
Complete Program Hogs	1967	.812 1/	.800 1/	.77	.735	.701
Hog Finishing	1974	.251	.236	.222	.209	.197
Cash Grain - Beef Feeding 2/	1967	.486	.459	.435	.412	.39
Cash Grain - C.P. Hogs 2/	1967	.597	.569	.542	.516	.492
Dairy - C.P. Hogs 2/	1967	.712	.684	.652	.632	.607
Beef Feeding - C.P. Hogs 2/	1974	.74	.702	.665	.631	.599

1/ Critical year = 1974.

2/ C.P. Hogs refers to complete program hogs. Two enterprise farms are assumed to derive 50% of their value added from each enterprise.

Table II. Debt maturity sensitivity test.

Farm Type	Critical Year	Real Estate Mortgage Term (years) 20	30	40	7 Years Term. (Real Estate Mort. Term - 20 yrs.)
		(Interm. Term = 5 Yrs.)			
Cash Grain	1967	.282	.325	.348	.308
Dairy	1974	.554	.594	.611	.641 1/
Beef Feeding	1974	.362	.394	.408	.391
Complete Program Hogs	1974	.770 2/	.818	.828	.821
Hogs Finishing	1974	.222	.240	.248	.247
Cash Grain - Beef Feeding 3/	1967	.435	.488	.515	.479
Cash Grain - C.P. Hogs 3/	1967	.542	.608	.642	.604
Dairy - C.P.Hogs 3/	1967	.652	.713	.739	.766
Beef Feeding - C.P. Hogs 3/	1974	.665	.725	.744	.725

1/ Critical year = 1975.

2/ Critical year = 1967.

3/ C.P. Hogs refers to complete program hogs
Two enterprise farms are assumed to derive 50% of their value added from each enterprise.

to 10 percentage points). On the other hand, increasing the length of term debt from 5-7 years favored farms with dairy enterprises, which tended to have a larger than average investment in term assets (e.g. dairy cows). With respect to maximum debt ratios an increase in interest rates of 4% for dairy farmers would appear to have been more than offset by an increase in term debt maturity from 5 to 7 years. Likewise, a 20-year increase in mortgage length would have neutralized a 3-4% increase in average interest rates for cash grain farmers.

This suggests that because of the substantial favorable impact of increasing loan lengths (in part a result of the deductibility of interest from taxable income that is allowed by the IRS), attention may be profitably given to the negotiation of loan terms. It appears quite possible that both a dairy farmer and his lender may mutually benefit from the negotiation of longer length term loans with slightly higher interest rates. Extending term loan length from 5 to 7 years resulted in an average increase in MFDRs of about 5.5 percentage points, while doubling real estate mortgage length (20 to 40 years) increased debt ratios by an average of 6.7 percentage points. Thus, a two year term debt maturity extension appears to be only slightly less high-powered than a much longer real estate extension.[7/]

Concluding Comments

In this study size and variability of individual enterprise returns, covariances of enterprise returns (as reflected in the whole farm RORs of two-enterprise farm types) and proportions of enterprises in the portfolio (i.e. elements of portfolio risk) are processed in a simulation model in order to generate maximum feasible debt ratios (MFDR's). Only downside variability is of critical concern in portfolio risk analysis; and since the MFDR approach takes cognizance of this crucial distinction, we believe this approach is a particularly appropriate (although perhaps non-traditional) application of portfolio theory.

Within the framework of this study, a flexible repayment agreement was found to be generally essential for heavy reliance upon debt financing. A repayment agreement permitting deferrment of nonreal estate principal payments for up to two years following default permitted MFDRs ranging from .282 to .77 for the nine farm types analyzed, with an average of nearly .60 for the four dual enterprise farms. Thus with a liberal repayment agreement, and with land valued at current prices, very substantial debt leverage was feasible for many farm types in the years 1966-75.

Interest rate changes of 1-2 percentage points above average historical rates did not in general appear to lower MFDRs more than a few percentage points. However, an increase in interest rates of about four percentage points would appear to reduce MFDRs by 10-15 percentage points for heavily leveraged farm types. Extending mortgage and/or intermediate term debt maturities appear to be potentially effective strategies to neutralize increases in interest rates, especially for cash grain and dairy farm types.

While increasing returns to production management has generally been found to be a high-powered factor affecting maximum feasible debt burdens, a marginal increase in production efficiency may increase debt capacity far less than obtaining, e.g., extended real estate and intermediate term debt maturities. This suggests that the investment of a relatively small amount of time in focusing upon the finance details of a loan agreement and negotiating favorable credit terms may yield a very substantial return to the farmer seeking to make maximum use of debt financing.

Footnotes

1/ Farms supplying the records employed in this research are all "full-time" and are located in southern Minnesota. Study results are on a whole farm basis with no division of landlord/tenant shares.

2/ The rate of return earned on a portfolio of investments in time period t is a dollar weighted average of the rates of return earned on each of the investments that comprise the portfolio. That is:

$$ROR_{portfolio_t} = r_{1t}w_{2t} + \ldots + r_{nt}w_{nt}$$

r_{it} = the rate of return on the i^{th} investment in period t.

w_{it} = the fraction of the total portfolio's resources invested in the i^{th} investment.

The similarity to Equation (1) is obvious.

3/ A strong but not unreasonable assumption that warrants empirical investigation. Alternatively, this approach can be viewed as a means to control for variations in enterprise composition of mixed enterprise farms.

4/ In schemes where farm records are classified as two enterprise farms if, e.g., at least 80% of sales derive from two enterprises together, and at least 20% from each enterprise, it is frequently unclear whether sales are approximately evenly divided or one enterprise predominates.

5/ A financial structure represented by the MFDR obtaining in the worst case year(s) would be safe for other years in the sample period as well, since debt repayment demands made by the critical MFDR would be less than available cash flows in years of better returns.

6/ The current interest rate is an annual average of southern Minnesota PCA interest rates; the intermediate term interest rate is a 5 year average of PCA loan rates (all rates adjusted for stock purchase requirements.) The real estate mortgage is assumed to be in the third year; 5 year average FLB interest rates were used.

7/ The authors recognize that extending term debt maturities may possibly limit future growth.

References

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