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MAXIMUM FEASIBLE FARM DEBT BY FARM TYPE

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INTRODUCTION

Farm Income Variability

Sizable swings in U.S. farm prices occur frequently and are, in effect, guaranteed by an agricultural production sector that is; largely subject to the vagaries of changing weather conditions, tied to assets that are typically immobile, producing relentlessly in the face of excess carryover stocks, and buffeted by changing import policies of foreign governments. U.S. agricultural policies have not overcome the historical tendencies for agricultural prices to fluctuate more than agricultural quantities, for farm incomes to move directly with agricultural prices, and also for agricultural prices to fluctuate more than nonagricultural prices. Income on a per enterprise basis is even more variable at the individual farm level than it is in the aggregate. The effects of farm income variability tend to be, therefore, most keenly experienced by the individual producer and particularly by individual producers for whom only one or two farm enterprises are largely responsible for total sales.[1/]

Effects of Farm Income Variability Upon the Farm Firm

This paper explores the issue of how much debt could have successfully been serviced by various farm types during a recent period characterized by large income fluctuations (the 10 years studied include the high returns years 1972-73 and the generally low returns years 1966-70). While the impact of income instability upon debt capacity is direct, it is perhaps useful to briefly examine some of the linkages between income variability and other aspects of farm-firm performance as well.

Farm income instability may inhibit desired investment schedules or, on the other hand, unduly advance or "hurry" acquisition of desired investments. That one or a series of low-return years will cause farmers to cut back asset purchases, or actually disinvest, can be quickly

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1/ National farm income statistics involve too great a degree of aggregation or "averaging" to be very useful in identifying income variability effects upon individual farm firms.

appreciated by agricultural analysts. A series of uniformly high return years may lead farmers to drive up input prices as they compete with one another for limited short-run supplies. This tendency has been aggravated by a number of income tax reduction incentives that are especially important in high income years; sizable investment tax credits, cash accounting for tax purposes, and accelerated depreciation allowances. New machinery shortages and price hikes were well publicized following the high-income "food crisis" years of 1972-73. Also, Girao, Tomek, and Mount found that ". . . investment decisions of farmers with less stable incomes are more short run in character" (6, p. 149).

Farm income instability may also interfere with desired product marketing schedules. Expecting improved future prices, farmers may desire to postpone crop and livestock sales because of low current prices, but are in effect "forced" to sell in order to fulfill debt service obligations -- an altogether familiar pattern. When low prices occur in conjunction with drought conditions, securing credit may become doubly difficult as the liquidity position of agricultural banks becomes tight and credit is consequently restrained (7). As an example of this, drought-stricken farmers and ranchers were recently forced to liquidate substantial numbers of high quality breeding livestock.

Farm family consumption patterns may also be adversely affected by income instability. It is important to note the interaction between leverage effects upon "Bottom Line" profitability and permissible consumption claims upon profits. Should debt servicing requirements expand while profits remain stationary or worsen, residual consumption expenditures will be the likely candidate to bear the brunt of budgetary cuts. Traditionally, rural consumption rates have been markedly below urban levels, reflecting lower realized farm incomes. The boom in farm prices in the early 1970's enabled farm family consumption to expand with farm income and perhaps raised expectations that might be difficult to lower should incomes fall precipitously and remain at low levels for a period of two or more years. The 1972-73 income gains may serve to make farmers and farm wives less willing to "live poor" and then "die rich."

Thus planned investment, marketing, and consumption schedules are frequently frustrated by the enhanced financial risk that accompanies

widely fluctuating farm incomes. Formal and informal enterprise control systems (the success of which is built upon effective planning) become more difficult to implement the more variable the farm income stream. Financial leverage, which magnifies the effect of farm-income instability upon "Bottom Line" profitability[2/] becomes less feasible as the degree of income fluctuation increases. Enterprise specialization tendencies presently being observed in pork, beef, and feedgrain production lend further importance to income variability effects upon financing farm production and consumption.

Selected Previous Studies

In a study of Ohio dairy farms, Falls {4} , found that changes in interest rates had only slight effect upon maximum feasible debt levels; and also that large dairy farms could sustain greater debt ratios than

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2/ The following accounting identities indicate debt leverage effects upon before tax returns to owners equity:

(1) $r_e = r_A + (r_A - i)\frac{D}{E}$

(2) $\Delta r_e = \Delta r_A \left(1 + \frac{D}{E}\right)$

where $r_e = \frac{\text{net income before income tax}}{\text{owners equity}}$

r_A = operating rate of return on assets (before taxes)

$= \frac{\text{earnings before interest and taxes}}{\text{Assets}}$

i = average interest rate paid on debt (a constant)

D = total liabilities

E = owners equity

We observe from equation (1) that, should the interest rate exceed returns to assets, then the larger the debt/equity ratio, the lower the returns to equity. Equation (2) illustrates how a large debt/equity ratio "magnifies" changes in returns to assets into much larger changes in returns to equity.

small farms.[3/]

Wehrly and Atkinson {13} estimated that dairy-hog farms could service debt loads ranging from 46 - 60 percent of assets, dependent upon farm size and ability of the farm family to "live frugally." In a simulation growth study, Patrick and Eisgruber {9} found that managerial ability and long-term loan limts were the most important factors influencing farm growth. In a study using a multiperiod linear programming model, Boehlje and White {2} determined that maximization of net worth required the farm unit to undertake heavy debt loads. Girao, Tomek and Mount {6} observed that in spite of differences in income stability between dairy and non-dairy farms, consumption patterns were relatively stable, but investment decisions were influenced by income instability.

Although income variability has been widely recognized, it has not been frequently related to a "maximum feasible farm debt by farm type" concept in an analytically rigorous fashion. This results in part from the difficulty of obtaining earnings and asset data on a per enterprise basis. Another probable reason for this is that in the agricultural policy debates of the 1950's and early 1960's income swings (although of crucial importance on the downside to countless marginal farmers) took a back seat to discussion of continuing, generally depressed farm incomes. A leveling of income peaks and valleys in the 1950's would not have resolved the overriding fact of low returns to resources in agriculture. However, the dramatic upside as well as downside fluctuations that have thus far occurred in the 1970's will perhaps serve to focus more attention upon income variability.

Study Approach and Objectives

The current study was undertaken in order to accomplish the following objectives:

1. Estimate cash income variability by farm type during the

[3/] Debt ratios refers to (total debt) / (total assets), and may sometimes be referred to as D/A. Conventional lending practice does not commend meaning to debt ratios outside the unit interval; i.e. $0 \leq D/A \leq 1$.

period 1966-75 for

a. Dairy, cash grain, beef feeding, complete program hogs, hog finishing farm types, and

b. All two enterprise combinations of the above farm types.

2. Relate cash income level and variability to loan default conditions that are to be avoided. Two different default conditions are explored:

   a. No debt service deferral. This conditon requires that all principal and interest payments be met exactly as scheduled.

   b. Two year allowable recovery period. This condition permits the deferral of nonreal estate loan principal payments in a year of low income, provided that at the end of two years following the year in which the deferral took place, additional interest and principal payments are made so that all the originally scheduled loan servicing is once again on a current basis.

3. Determine historically safe (i.e., maximum feasible) debt loads by farm type that satisfy the above default conditions during the period 1966-75.

4. Test maximum feasible debt ratios for sensitivity to interest rates, rates of return on assets, mortgage terms, differences in enterprise "mix" (diversification), and farm size.

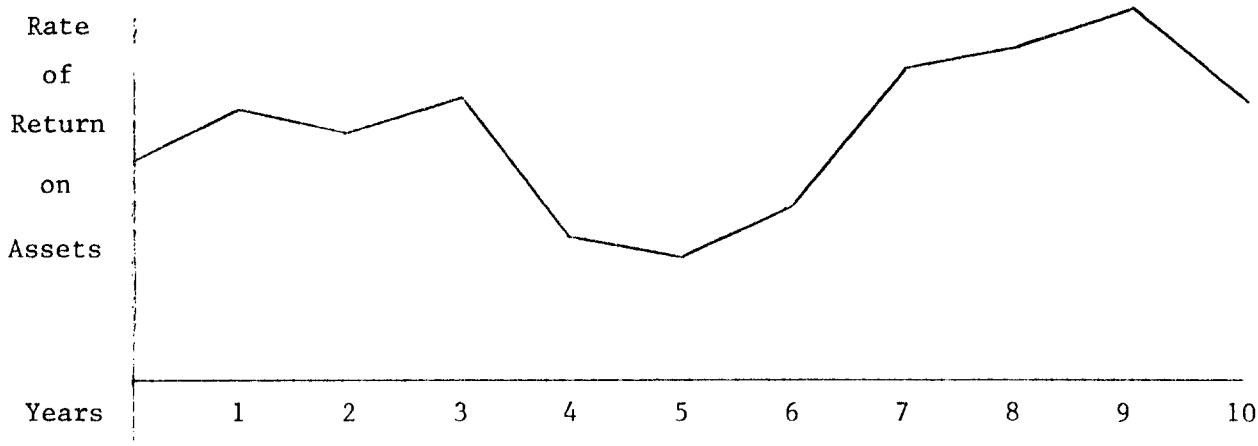
METHODOLOGY

When farm product prices are high, farmers have money in their pockets and a new-found enthusiasm for investment ideas - as they reflect upon how additional past asset expansion would have handsomely raised present profits. The investment ideas are not infrequently followed; farmers are relieved of their cash burdens and also typically committed to repay additional loans in the following years. When prices fall, farmers may in turn, regret having previously raised their debt load and would perhaps prefer a lower debt ratio for their operations.

Because it is the low return years that pose a real threat to debt servicing ability, we are interested in the debt burdens that can be

carried in during the periods of lowest income. For example, we would not be concerned with debt ratios that might have been carried in years 7, 8 and 9 in the following figure, nor do we average out earnings over the 10-year period to compute an average (period) debt ratio.

Figure 1.



Instead, we would focus attention upon the amount of debt that could be carried in the low returns years - such as years 4, 5 and 6. As previously indicated, recovery periods in this study are 0 and 2 years. We assume that there is a limit to a creditor's patience (as well as a limit to a borrower's patience with the organization of his productive unit) when scheduled loan repayments remain in arrears over an extended period of time. Instead, we would find the maximum debt burden that could be carried through the years of lowest income. In the case of Figure 1, as stated, the worst case no doubt occurs some time within the three year span of year 4 through year 6 (inclusive). For the no-deferral default condition, the critical year would most likely be year 5. For the 2 year allowable deferral default condition, which of those three years turns out to be the critical year will depend on the level of interest rates prevailing in each year and the level of returns that is achieved in the two succeeding years (during which the deferred payments must be made up).

The method that will be illustrated below was developed in the interest of probing the question: how much farm debt may be too much? Income, debt composition, loan default, and representative farm concepts

are operationally developed and applied to farm record data in an attempt to elicit maximum feasible D/A's for a recent 10-year period. In order to develop the mechanics of determining maximum feasible debt ratios in periods of low returns, it is convenient to establish the following notation.

Income by Farm Type

Let us begin by defining income and assets as determined from the farm records analyzed in this project.

1. Cash flow ROR_{jt} = adjusted net $income_{jt}$ / total $assets_{jt}$

2. Adjusted cash $income_{jt} = \sum_{i=1}^{I}$ value $added_{ijt}$ - operating $expenses_{jt}$ + miscellaneous $income_{jt}$

enterprise $i = 1,...I$

farm $j = 1,...J$

year $t = 1,...T$

Value added = cash sales + home consumption + ending inventory + value of units transferred out - purchases - beginning inventory - value of units transferred in

Miscellaneous income = co-op. patronage refunds + gas tax refund + labor and custom work for other farmers + other miscellaneous farm income

Operating expense = nonbreeding livestock purchases, miscellaneous livestock expense, feed bought fertilizer, insecticides, other miscellaneous crop expenses, custom work hired, repair of livestock equipment and farm buildings, machinery repairs, petroleum products bought, wages and board of hired labor, farm telephone and electricity expense, real estate tax

Total assets = current assets + noncurrent chattel assets + real estate

Current assets = the average of beginning and ending inventories of hogs, feeder cattle, sheep, poultry, crops, seed and feed.

Noncurrent chattel assets = the average of beginning and ending inventories of dairy cows, beef breeding cows, farm vehicles, machinery and equipment

Real estate = (land farmed X estimated market value) + the average cost value of beginning and ending building inventories.

NOTE: Machinery, buildings and breeding livestock are usually valued at purchase price less accumulated depreication. Nonbreeding livestock and land are valued at generally conservative current market prices. Land farmed is a mid-year quantity.

In addition to the above cash flow ROR, which includes the effects of inventory changes but which makes no deduction for "noncash" expenses such as depreciation, a similarly adjusted "accrual" income ROR which does deduct depreciation expense, was also estimated. Thus, the accrual income ROR differs from the cash flow ROR only in that a deduction for depreciation expense was made in its determination. Actual farm and household financial obligations are met with cash income. Hence, the need for a measure of cash flow or "cash income." The accrual income concept was primarily developed for use in estimating personal income tax liabilities. In this study, earnings and expenses are on a total farm basis with no division between operator and landlord shares. Thus, when maximum debt ratios are computed, they are (implicitly) being estimated for a farm unit based on full ownership by the operator. Maximum feasible debt ratios for tenant operators (should they differ) were not explored due to study limitations.

A multiple linear regression technique was used to estimate rates of return by farm enterprise. In the regression model the sum of the weighted enterprise returns is equated with the total farm rate of return, after making allowance for a disturbance term:

$$3.\quad ROR_{.jt} = r_{1\cdot t}w_{1jt} + r_{2\cdot t}w_{2jt} \cdots + r_{I.t}w_{Ijt} + e_{i.t}$$

where $w_{ijt} = \dfrac{\text{Value added by enterprise i of farm j in year t}}{\text{Total value added by farm j in year t}}$

$$w_{ijt} \geq 0 \text{ and } \sum_{i=1}^{I} w_{ijt} = 1$$

Thus, 4. $ROR_{.jt} = f(w_{ijt})$ where $ROR_{.jt}$ = the predicted rate of return for farm j in year t.

enterprise i = 1,...I
farm j = 1,...J
year t = 1,...T

In a multiple enterprise farm, there are simply no accurate accounting measures of the actual level of resources devoted to different enterprises. This is, no doubt, partly due to the difficulty of allocating certain resources that are "shared" by several different enterprises, and partly the result of a lack of minute detail available in existing farm record systems. Equation 3 (which was estimated separately for both cash flow and accrual income rates of return for each of the 10 years studied) represents an attempt to "decompose" the observed farm rate of return into a linear sum of the rates of return on each of the farm's enterprises. The rate of return on an individual enterprise is, of course, unobserved. The regression technique, by relating the farm rate of return to the observable value-added-by-enterprise variables, enables the estimation of enterprise rates of return as regression coefficients that attach to each enterprise (value-added) weight variable. This approach is buttressed by standard portfolio theory if it can be assumed that the fraction of a farm's total resources invested in an enterprise is directly proportional to the fraction of total farm value added that originates in the respective enterprise.[4/]

In fact, this method may be compared to computing the rate of return on a portfolio of securities, which is the weighted average rate of return of each of the securities comprising the portfolio. In this study the farm

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

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

where

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

w_{it} = the fraction of the total portfolios resources (based on beginning-of-period values) invested in the i^{th} investment.

The similarity to equation 3 is obvious.

firm is treated as a "portfolio" of, e.g., dairy, beef feeding, cash crops, investments (enterprises), etc. However, as indicated above, value added weights are proxies for actual amounts of resources invested in individual enterprises. A principal advantage of the "portfolio" approach is that it permits distinguishing between, for example, two dairy-hog farms, one of which is mostly dairy, the other mostly hogs. Thus, we believe the above outlined regression technique suggests a greater degree of preciseness to farm type classification than an arbitrary farm type classification rule based on e.g., sales.[5/]

Size and Enterprise Interaction Tests

In the case of a portfolio of investments (such as securities) typically there will be no "interaction" between the rate of return earned on one "investment" and the fraction of resources devoted to some other investment. Also the return earned on an investment is typically independent of the magnitude of that investment (e.g., the rate of return earned on an investment of 100 shares of General Motors stock will be the same as the rate of return earned on investment of 10,000 shares during a given period). In the case of farm enterprise returns such possibilities cannot be assumed away. There may be "complementarity" effects between certain enterprises that would cause the return earned on one enterprise

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5/ The classification scheme used by the farm management associations whose records were analyzed in this project, is as follows:

i. Specialized farms - 80 percent or more of cash income was from one enterprise or sources.

ii. Two enterprise farms - 80 percent or more of the income was from two enterprises, with a minimum of 20 percent from the the smaller of the two (8, Otis, p. 2).

From (ii) we see that a farm consisting of two enterprises, A and B, and which will be identified as an A & B combination enterprise farm, may have as much as 80 percent of its sales generated by enterprise A, or as little as 20 percent. In addition, a basically one enterprise farm with, for example, 90 percent of sales generally attributed to beef feeding and the remaining 10 percent hog sales, may become a two enterprise farm as defined in (ii) in a year of very high hog prices and very low beef prices -- this without changing the basic asset mix.

to be affected by the relative importance of another enterprise. Also, it is conceivable that the level of return on an enterprise may be affected by the scale of the farm operation.

In order to test the null hypothesis that both small and large farms experience equivalent (cash flow) rates of return vs. the alternative hypothesis that large farms experience a higher rate of return than small farms, the sample was first divided into farms with median or above asset levels and farms with below median level assets. Secondly, an F-test was made on the difference in variance explanation provided by the alternative models (3). On the basis of this test the null hypothesis could not be rejected.

During the 10-year period we found no consistent difference in cash flow rates of return between large and small farms.[6/]

If two enterprises are complementary, a higher ROR may be exhibited by the combined enterprises than the weighted sum of the two individual enterprise ROR's. To test the null hypothesis that no "interaction" effects occur, vs. the alternative hypothesis that there are earnings interactions between enterprises, an expanded model consisting of both individual and two-way (interaction) enterprise variables was developed as follows:

$$(6)\quad ROR_{.jt} = r_{1.t}w_{1jt} \cdots + r_{I.t}w_{Ijt} + r_{I+1,.t}w_{1jt}w_{2jt} \cdots + e_{i.t}$$

enterprise $i = 1,\ldots.I$
farm $j = 1,\ldots.J$
year $t = 1,\ldots.T$

If complementarity effects exist then the coefficients on the interaction (or cross product) terms should be significantly positive.

The data clearly do not support rejection of the null hypothesis. The hypothesis was also proposed that size and enterprise interaction effects occurred together in our sample, although neither was statistically

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6/ It was not our purpose to conduct an economies of size test; the cost concept appropriate for this study's purposes, does not encompass "owner" operator labor opportunity cost. Such costs would need to be deducted to arrive at a more suitable measure of net returns that would be appropriate for evaluating economies of large scale effects.

significant separately. To test this hypothesis, vs. the null hypothesis that combined size and synergism effects did not occur together, equation (6) was estimated separately for median and above asset farms and for farms with smaller than median level assets. Again our data do not support rejection of the null hypothesis for the 10 year period studied. Thus ROR coefficients in this study are estimated on the basis of the simple model, i.e., equation (3).

Debt Structure

The amount of debt a farm may service is based upon the difference between cash inflows and cash outflows (excluding interest and principal payments) after family living expense. In this study adjusted farm cash income[7/] is allocated for seasonal operating expenses, current debt, noncurrent, nonreal estate (term) debt and real estate mortgage payments. Because the farm record data used in this study do not provide debt composition information, a "representative" debt structure was formulated.

It is assumed representative farms carry seasonal, annual, term, and mortgage debt. Thus for farm type k in year t:

$$(7)\quad Debt_{kt} = \underbrace{SOEXPR_{kt}*OEXPR_{kt}*ASSETS_t}_{\text{(seasonal)}} + \underbrace{CRASTR_{kt}*D/A_{kt}*ASSETS_t}_{\text{(current)}} + \underbrace{NCRASTR_{kt}*D/A_{kt}*ASSETS_t}_{\text{(term)}} + \underbrace{RER_{kt}*D/A_{kt}*ASSETS_t}_{\text{(mortgage)}}$$

farm type $k = 1,....K$
year $t = 1,....T$

SOEXPR = seasonal operating expenditures/total operating expendtures

OEXPR = total operating expenditures/total assets

CRASTR = current assets/total assets

NCRASTR = noncurrent chattel assets/total assets

RER = real estate/total assets

ASSETS = current plus noncurrent plus real estate assets

Seasonal operating expenses (SOEXPR) consist of fertilizer, lime, seed, pesticides, and fuel expenditures and were estimated from Census of

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7/ Recall that "adjusted cash income" is defined as the sum of estimated accrual basis income plus depreciation expense or i.e., cash flow from farm operations.

Agriculture data (1, pp. 9) and USDC (11;12). Operating expenses (OEXPR) consist of livestock, crop, labor, and general farm expense (see p. 7). The operating expense ratio was estimated as a function of enterprise types from our farm record data by means of a regression technique analogous to that discussed earlier to estimate enterprise rates of return.

Current assets, noncurrent chattel assets, and real estate assets CRASTR, NCRASTR, RER defined on pages 7 and 8 were also estimated from the farm record data used in this study by regressing the respective asset ratios on value added enterprise variables. Thus:

$$(8)\quad OEXPR_{.kt} = f\ (w_{ikt})$$

$$(9)\quad CRASTR_{.kt} = f\ (w_{ikt})$$

$$(10)\quad NCRASTR_{.kt} = f\ (w_{ikt})$$

$$(11)\quad RER_{.kt} = f\ (w_{ikt})$$

Three (total) farm asset levels, the 25th, 50th and 75th percentiles of the distribution of total farm assets presented by the data base, were utilized in order to study farm size effects upon the ability to carry debt.

Seasonal debt finances planting and harvesting and is normally repaid following harvest. Current debt supplies credit funds that are almost invariably used to purchase nonbreeding livestock, crops, and feed. Ultimately, farm debt (as well as farm income and expenses) is a function of assets, and, therefore, debt repayment periods are based, in one way or another, upon asset longevity. Given these considerations, current debt is related in the following way to current assets.[8/]

$$\frac{\text{current debt}}{\text{total debt}} = \frac{\text{current assets}}{\text{total assets}}$$

And similarly,

$$\frac{\text{intermediate term debt}}{\text{total debt}} = \frac{\text{non-current, non-real estate assets}}{\text{total assets}}$$

$$\frac{\text{real estate mortgage debt}}{\text{total debt}} = \frac{\text{real estate assets}}{\text{total assets}}$$

8/ For study purposes, specific types of credit are to be applied entirely to certain express uses. For example, current and seasonal debt finance only annual operating expenses.

Funds provided by term debt usually finance breeding livestock, machinery, and other nonreal estate capital goods purchases. A five-year repayment period is assumed for term debt, and term debt is related (as indicated above) to intermediate term assets. Farm land, buildings, and improvements are financed with 20-year mortgage credit. In this model real estate debt is related to buildings valued at historical cost and real estate priced at estimated current value.

In summary, the fraction of a farm unit's total debt that is composed of long term (20 year) mortgage debt has been set to be exactly equal to that farm's ratio of real estate assets to its total assets; the fraction of the farm units total debt that is composed of short term (current) debt is equal to the farm's current asset to total asset ratio, etc.

Simulation Model

To avoid financial distress, a farm unit's annual cash inflows must meet or exceed the farm family's consumption expenses, income, and Social Security taxes, debt service obligations, and cash operating expenses. This relationship may be stated as follows:

(12) Adjusted gross farm receipts + interest income $\geq$

Minimum Household Expenditures + Nonfinanced Operating Expenses + Interest Expense + Debt Principal Payments + Taxes

+ Marginal Consumption Expenditures + Seasonal Debt Repayment

Where adjusted gross farm receipts are adjusted for inventory changes. Adjusted farm receipts minus total operating expenses is the measure of accrual cash flow discussed above. Seasonal debt repayment occurs when current borrowing plus seasonal borrowing exceeds operating expenses. (An algebraic formulation of equation 12 is provided in the Appendix.) Thus, estimated gross cash inflows must be $\geq$ estimated gross cash outflows. In order to determine maximum feasible debt loads, the above relationship is solved at equality. Equality is found by a computerized iteration technique that may either decrement or increment the D/A ratio by from several percent to one ten-thousandth of a percent in each iteration.

The process is applied for each farm type for each of the ten years in the sample period. However, as pointed out above, only the maximum debt ratios in the worst case (i.e., critical) years are, in fact, reported. Maximum feasible debt burdens (expressed as a percent of assets) that can be carried in other years exceed the "worst case" year debt burden. Thus, a financial structure represented by maximum feasible debt ratio for the worst case year would be safe for all other years in the sample period as well.

The Farm Records

The farm records analyzed in this study detail the production practices and results of approximately 250 farms located in the southern one-fourth of Minnesota. The farms belong to one of two farm management associations: Southeastern Minnesota Farm Management Association or Southwestern Minnesota Farm Management Association. Farmers participating in the management associations receive assistance in completing and analyzing business records for their operations. In addition to management advice, member farmers receive tax preparation assistance and also (for comparative purposes) receive annual summaries of production and profit performance of all record-filing farms in their respective management association. Table 1 indicates combined association membership, records submitted by members, completed returned records, and records analyzed during the ten years examined in this research effort.

From Table 1 we see that an annual average of approximately 250 records were used in this project. An average of about 13 percent of the submitted records were either not returned or not completed in sufficient detail for inclusion in association annual report analysis. Approximately three to four percent of the completed and returned records were not utilized in this study because of (1) missing asset data, or (2) unusually large unidentified income.

Farmers belonging to the management associations are believed to generally be somewhat above average in management abilities compared to local management standards. While acres farmed increased about 42% during the study period (from 324 to 459 acres) the farms are considered to be of "average" size for southern Minnesota.

Table 1. Farm Records examined in this project and Farm Management Association membership, by year

Total members	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Total members	a/								355	346
Records analyzed in this study	296	262	253	234	245	253	263	252	248	230
Completed and returned records b/	300	274	268	248	253	259	270	262	257	241
Records submitted	333	320	301	286	290	306	309	299	303	287

a/ 1966-73 unavailable at this time

b/ After records are completed by staff at the University of Minnesota, they are returned to farmers to provide tax filing information. Farmers are requested to send records back to the University of Minnesota after taxes have been filed, although some do not.

SOURCE: "Annual Reports, 1966-1975," Southeastern Minnesota Farm Management Association, Southwestern Minnesota Farm Management Association.

Land was valued at estimated current "value" (as opposed to sale prices of parcels recently sold) during each year of the study period. The estimates were on a county-wide basis and covered the period January 1 to July 1 of each year. The estimates were obtained from questionnaires sent by Professor P. M. Raup and associates at the University of Minnesota to real estate brokers, bankers, agricultural loan specialists, and county officials in each Minnesota county.

Income Variability by Farm Type

Estimated cash ROR's by farm enterprise are indicated in Figure 1. As defined previously the "cash income" ROR indicates a return before depreciation, interest, and income taxes that has been adjusted to reflect changes in inventory as well as sales. A brief scan of Figure 2 will reveal the following:

1. Rapidly increasing real estate values during the 10 year period did not result in generally declining cash ROR's between 1966 and 1975. That is, the trend appears close to horizontal in spite of the marked returns rise of 1972-73 and the precipitous decline for all five single enterprises in 1974. This perhaps

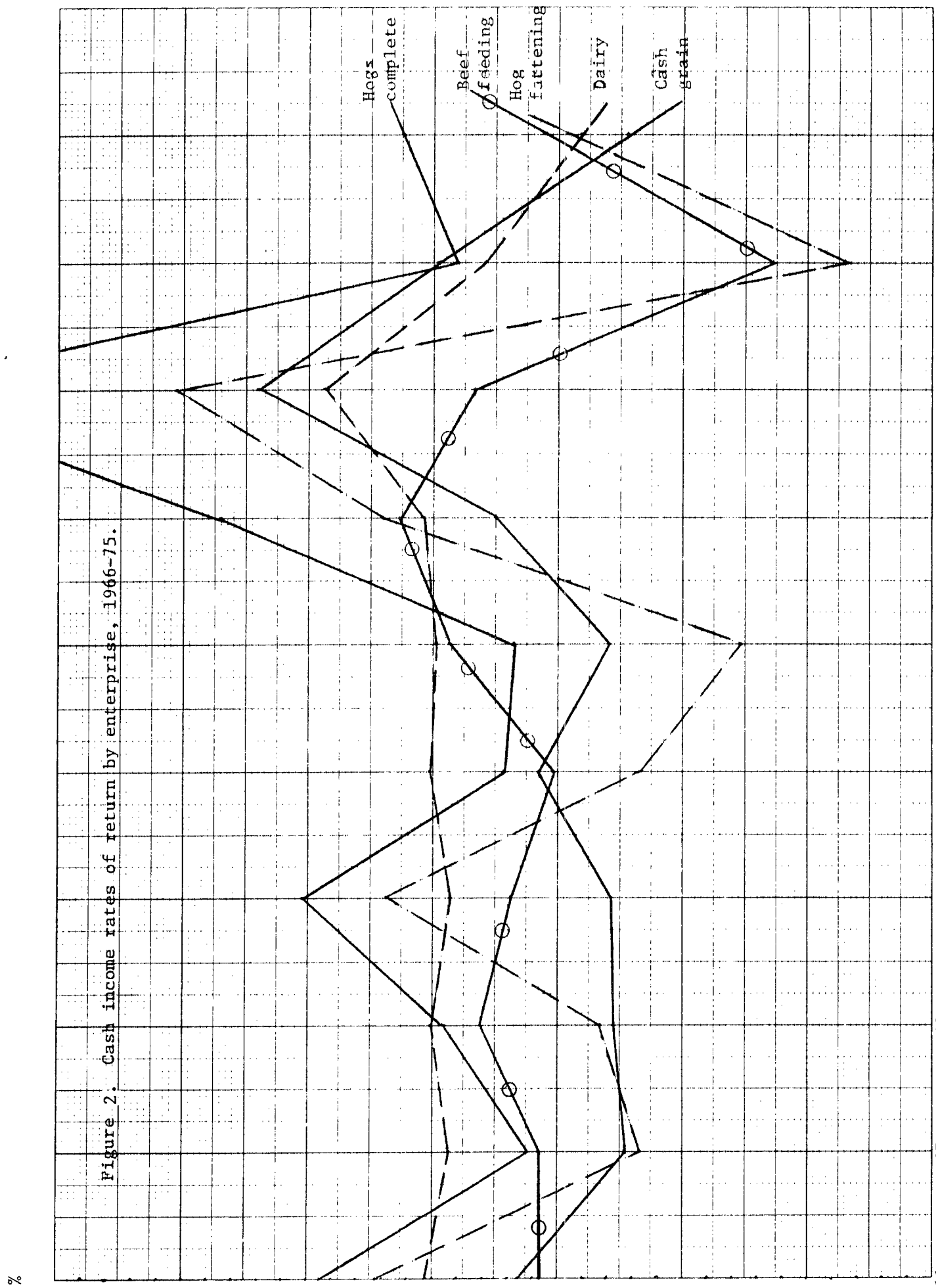

Figure 2. Cash income rates of return by enterprise, 1966-75.

indicates that the +200 percent land inflation during the study period served to maintain ROR's at or only slightly above historical levels. In other words, between 1966 and 1975 the seemingly "mad" scramble for land was instead the rational response of investors seeking to "maintain" a constant ROR in the following equality:

$$\text{capitalized value} = \frac{\text{income}}{\text{ROR } (= c_t)}$$

As income increased, it appears that cash flow rates of return remained about constant (c_t), which in turn, directly implies increases in the capitalized value.

2. The most striking earnings performances were exhibited by hogs. The complete hog program ROR never fell below 11 percent and ranged to nearly 38 percent. While complete program hogs provided highest or second highest earnings in 9 of the 10 years, hog finishing generated second highest earnings in four years and lowest or second lowest earnings in six years. Thus while complete program hogs displayed singularly high ROR's, hog finishing earnings were extraordinarily variable.[9/]
3. Briefly note the high and also remarkably level dairy earnings during the first seven years of the period. The unusually low

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9/ In addition, the difference between the earnings of the two hog enterprises appears to increase through the 10 years. Perhaps this may be partially explained by the following observations (partly conjecture): (i) Timing of feeder pig purchases becomes more critical as markets become more volatile. Purchase of high priced feeders a few weeks or months before a strong market weakens would depress hog finishing earnings vis-a-vis those of complete program operations. Also, perhaps hog finishing producers buy more feed inputs. (ii) Recent technological advances have focused primarily on the farrowing operation, tending to benefit farrow-to-finish earnings in a high demand situation more than feeder earnings (especially during the initial years following the technical breakthroughs). (iii) Farmers less committed to hog production, with poorer facilities and less production know-how, may commence hog operations via purchase of feeder pigs, while the more efficient hog finishing producers may have tended to switch to farrow-finish as the period progressed. Thus, the sample composition with respect to management ability of hogs fattening vs. hogs complete program producers may have changed during the 10 year period.

returns of 1975 correspond to the period when dairy numbers fell dramatically and much publicity was given in Wisconsin and Minnesota to the plight of the dairymen.

4. With the exception of 1974, feeder cattle cash flow returns fluctuated in a fairly tight range between 10-16 percent. The steady and modestly successful beef earnings picture was punctured by a low 1.3 percent ROR in 1974.
5. The high livestock, compared to grains, returns of 1966-72 indicates the possibility that the currently low cash grain/livestock returns ratio better reflects historical patterns than the 1972-74 cash grain "heyday."
6. In general, the bottoming out of curves in 1974 indicates a recent problem year for livestock borrowers while 1967 and/or 1970 begin 1-3 year earnings troughs for all farms with the exception of dairy.

ROR's for two-enterprise farms are hybrid forms of those in Figure 2; they have not been graphed for convenience but will be treated in the discussion of the following tables.

Table 2 translates the ROR's graphed in Figure 2 into cash income as follows:

$$\text{cash income}_t = \text{cash flow ROR}_t \times \text{median farm asset size}_t$$

$$\text{years } t = 1966, 1967, \ldots 1975$$

For two enterprise farm types, cash income ROR's for each enterprise were equally weighted. For example, cash grain-dairy earnings in 1966 were calculated with the cash grain ROR 11.7%; the dairy ROR 15.2%; and the 1966 median farm assets of 137,000 as follows:

$$\{ .5 (.117) + .5 (.152) \} \times 137{,}000 = 18{,}446$$

The coefficients of variability and mean income rankings are provided in Table 3.

A quick glance at the annual cash incomes by farm type shows the 1974 income bust depicted in the above figure. Complete program hog cash income soared to over $100,000 in 1973 and then fell by nearly half in 1974. Cash income from hog finishing plummeted more than $80,000 to approximately a negative $7,000 level between 1973-74.

Table 2. Annual cash incomes by farm type, 1966-75, for medium sized farms. (Two enterprise farms derive 50% of total value added from each enterprise.)

	Farm Types				
Year	Cash Grain	Dairy	Beef Feeding	Hogs Complete	Hog Finishing
1966	16,071	20,820	14,707	26,719	23,537
1967	10,711	21,214	15,919	16,327	10,154
1968	12,784	24,808	21,640	24,311	13,081
1969	14,711	26,724	22,372	37,809	31,620
1970	21,602	30,236	20,360	24,166	13,208
1971	16,647	31,273	30,030	24,956	5,515
1972	29,497	36,180	38,588	56,164	39,946
1973	64,936	56,924	38,993	110,753	74,214
1974	59,324	51,712	5,220	56,604	-6,924
1975	34,435	43,508	50,749	77,159	43,278

Year	Cash Grain-Dairy	Cash Grain-Beef Feeding	Cash Grain-Hogs Complete	Cash Grain-Hog Finishing	Dairy-Beef Feeding
1966	18,446	15,389	21,395	19,804	17,763
1967	15,963	13,315	13,519	10,433	18,567
1968	18,796	17,212	18,548	12,933	23,224
1969	20,718	18,542	26,260	23,165	24,548
1970	25,919	20,981	22,884	17,405	25,298
1971	23,960	23,338	20,802	11,081	30,652
1972	32,839	34,043	42,831	34,722	37,384
1973	60,930	51,965	87,844	69,575	47,959
1974	65,518	32,272	57,964	26,200	28,466
1975	38,971	42,592	55,797	38,857	47,128

Year	Dairy-Hogs Complete	Dairy-Hog Finishing	Beef Feeding-Hogs Complete	Beef Feeding-Hog Finishing	Hogs Complete-Hog Finishing
1966	23,770	22,178	20,713	19,122	25,128
1967	18,771	15,684	16,123	13,037	13,241
1968	24,559	18,944	22,975	17,360	18,696
1969	32,266	29,173	30,090	26,996	34,714
1970	27,201	21,722	22,263	16,784	18,687
1971	28,115	18,394	27,493	17,772	15,236
1972	46,172	38,063	47,376	39,267	48,055
1973	83,839	65,569	74,873	56,604	92,484
1974	54,158	22,394	30,912	-852	24,840
1975	60,333	43,393	63,954	47,014	60,218

Turning to Table 3, dairy cash incomes show the least variation which, while not unexpected given the influence of federal market orders that dampen milk price fluctuations, is still a rather surprising finding for a single enterprise farm type. The dairy-beef combination farm nearly matched the ability of the dairy operation to generate steady cash flows, with a coefficient of variability of 0.20 (or 20%). The advantage of dairy and beef clearly goes to the beef producer, for the combination provides much less income variation and much higher income than enjoyed by a pure beef feeding operation. Dairy and dairy combinations in general provide the lowest cash income variability (types 1-5). Cash grain-beef feeding, the one low variability farm type with no dairy component, accomplished much of what an ideal diversification scheme is intended to do. The relatively high cash grain and beef feeding coefficients, .478 and .475 respectively, are almost halved to .259 in the combination cash grain-beef feeding operation. In addition, cash income stays essentially the same 26,965 vs. 28,071 and 25,858 for cash grain and beef feeding respectively. Low grain prices, no doubt, spur feeding profits while high grain prices depress feeding returns and increase income returns from cash grain sales.

An upper range of cash income variability is comprised by hog finishing operations and combinations (types 12-15) involving hog finishing. Other than the combination of (high return) complete program hogs with hog finishing, we see that hogs finishing and combinations suffered poor income as well as high income variability. However, the pure hog finishing coefficient of variation of .956 is almost in a class by itself, so that for the hog finishing producer there is a very large benefit accruing to a diversification plan.[10/]

The middle range of income variability, types 6-11, is populated by complete program hogs and combinations, hog finishing and dairy, and three one enterprise farm types, complete program hogs, beef feeding, and cash

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10/ A two-enterprise farm consisting of hog finishing and complete program hogs may be somewhat unusual. The above-mentioned results perhaps indicate why this may be so.

Table 3. Rankings of farm types by income variability and mean income levels, 1966-75.

Farm	Type	Coefficient of Variability	Mean Cash Income	Mean Income Ranking
1	Dairy	.181	34,340	6
2	Dairy-beef feeding	.200	30,099	8
3	Cash grain-beef feeding	.259	26,965	11
4	Cash grain-dairy	.313	31,206	7
5	Dairy-complete program hogs	.325	39,918	2
6	Beef feeding-complete program hogs	.391	35,677	4
7	Cash grain-complete program hogs	.430	36.784	3
8	Dairy-hog fattengin	.450	29,551	9
9	Complete program hogs	.463	45,497	1
10	Beef feeding	.475	25,858	3
11	Cash grain	.478	28,071	10
12	Cash grain-hog finishing	.572	26,417	12
13	Hogs complete-hog finishing	.617	35,129	3
14	Beef feeding-hog finishing	.664	25,310	14
15	Hog finishing	.956	24,763	15

NOTE: Coefficients of variability = standard error around the linear trend divided by the mean adjusted for the linear trend.

grain. This group may be said to be characterized by moderately fluctuating but relatively strong incomes in general.

Mean cash incomes range from $45,497 to $24,763, a large difference for a mean measure. Complete program hogs and farm combinations involving this enterprise have the highest mean income, followed by dairy and combinations, cash grain and combinations, beef feeding and combinations, with hog finishing registering the lowest income. In sum, the 15 farm types surveyed exhibited both widely differing mean income and income variability levels in the 1966-75 time period. In general, diversification from one to two enterprises reduces income variability markedly. Those with the foresight to produce dairy and/or farrow-to-finish hogs did best during the study period.

Maximum Feasible Farm Debt by Farm Type

Maximum feasible debt ratios provide a relative measure of income variability. A high feasible debt ratio results from (1) high returns or (2) stable income or (3) a combination of (1) and (2). To a certain extent high return levels will compensate for unstable incomes and vice versa at a given debt ratio level. This juggling of the twin goals of steady incomes and high incomes is illustrated in Tables 4A and 4B which list maximum feasible debt ratios by farm type and recovery period for small, medium, and large sized farms.

Farm Size Sensitivity Test

When all debt service obligations are required to be fulfilled as scheduled (Table 4A) for medium sized farms we find that among the single enterprise farm types, complete program hogs may feasibly finance 47.1 percent of assets with debt funds while dairy may service debt equal to 41.4 percent of its asset base. As we have seen, dairy income was much more stable than complete program hogs, yet the poorest year for dairymen, 1975, provided less debt capacity than the poorest returns year for farrow-to-finish hogs (1967). Thus as indicated above, in that our model searches for worst-case years, a high stable income is preferred to a high average income where considerable fluctuation occurs. Cash grain was slightly less stable than beef feeding, yet beef feeding can support no debt in its poorest year while cash grain can support a debt burden

Maximum feasible debt ratios by farm type and farm size.

Table 4A. No deferral of loan payments allowed.

Farm type	Critical Year	Farm Size*		
		Small	Medium	Large
Cash grain	1967	.098	.228	.330
Dairy	1975	.348	.414	.455
Beef feeding	1974	.0	.0	.0
Hogs complete	1967	.356	.471	.560
Hog finishing	1974	.0	.0	.0
Cash grain-dairy	1967	.305	.406 1/	.455 1/
Cash grain-beef feeding	1967	.220	.351	.452
Cash grain-hogs complete	1967	.232	.355	.450
Cash grain-hog finishing	1971	.018	.130	.198
Dairy-beef feeding	1974	.233	.307	.363
Dairy-hogs complete	1967	.41	.51	.588
Dairy-hog finishing	1974	.137	.21	.265
Beef feeding-hogs complete	1974	.316	.403	.468
Beef feeding-hog finishing	1974	.0	.0	.0
Hogs complete-hog finishing	1971	.143	.253	.320

*Small, medium, and large sized farms are defined respectively as farms with assets equal to 25th, 50th and 75th percentile sample assets.

1/ Critical year = 1975.

NOTE: All principal and interest payments made as scheduled.

Table 4B. Two year (or less) deferral of non-real estate loan payments allowed.

Farm type	Critical Year	Small	Medium	Large
Cash grain	1967	.147	.282 [1/]	.376 [1/]
Dairy	1967	.477	.554 [1/]	.57 [1/]
Beef feeding	1974	.283	.362	.403 [2/]
Hogs complete	1967	.652	.77	.803 [2/]
Hog finishing	1974	.15	.222	.258
Cash grain-dairy	1967	.342	.452	.526
Cash grain-beef feeding	1967	.301	.435	.526
Cash grain-hogs complete	1967	.415	.542	.625
Cash grain-hog finishing	1967	.235	.358	.438
Dairy-beef feeding	1974	.414	.484	.525
Dairy-hogs complete	1967	.555	.652	.723
Dairy-hog finishing	1974	.351	.414	.452
Beef feeding-hog complete	1967	.565	.665 [1/]	.707 [1/]
Beef feeding-hog finishing	1974	.212	.287	.326
Hogs complete-hog finishing	1970	.446	.548	.611

[1/] Critical year = 1974.

[2/] SDR condition > 0.

Note: Non-real estate principal and interest payments may be initially delayed for up to two years.

equal to 22.8 percent of assets in its poorest returns year.

Summarizing the debt ratios of Table 4A for medium sized farms we briefly observe the following:

1. Beef feeding, hogs finishing and the combination of the two cannot service any debt without defaulting under the strict default condition. Thus, under the stringent default conditions, 100 percent equity financing is necessary.
2. The dairy-complete program hogs combination farm type maintains the highest debt ratio of any farm type, 51 percent of assets. This farm type was capable of safely using about one dollar of debt for each dollar of equity financing.
3. Beef feeding-complete program hogs and cash grain-dairy did almost as well as dairy, each being able to service slightly better than 40 percent debt.
4. Hog finishing combinations were not able to service more than about a 25 percent debt load at best.

Under the stringent default condition, heavy reliance upon equity financing is necessary. Only five of the medium sized farm types were able to service debt loads of more than 36 percent. For large farms, seven farm types were able to service debt burdens in the 45-59 percent range. At the same time, increased size does not change the inability of hog finishing-beef feeding and hog finishing to maintain a positive level of debt. Small farms, on the other hand, could service debt burdens from 0-13 percent less than those of medium sized farms. Five small farm types show maximum debt ratios in the 30-41 percent range, five in the 13-23 percent range, and five could sustain less than 10 percent debt. Moving from small to large asset levels increased debt ratios up to 23 percentage points for cash grain and cash grain-beef feeding and about 10 percentage points for dairy. As asset size is increased, debt carrying capacity (if initially greater than 0.0) increases at a decreasing rate for all 15 farm types, reflecting, in part, an increasing or graduated effective tax rate. The larger jump in debt ratio levels between small to medium sized farms reflects also the diminishing effect of the large minimum family consumption expenditure level built into the model. The enhanced ability of cash grains and beef-feeding to service more debt

as assets increase, as compared to dairy, derives in large part from smaller term debt principal payments of the first two farm types as opposed to dairy. Principal payments are not deductible (as is interest) in determining taxable income. Dairy farms, with their large investment in dairy cows, pay very sizable term debt principal payments.

Table 4B presents maximum feasible debt ratios under a more lenient default condition that permits deferral of nonreal estate principal payments (or a portion of them), provided that such deferrals are repaid with interest within two years. Under this default condition, a bad year followed by two strong years will suport debt by "averaging" across the three years.

Summarizing the debt ratios of medium sized farms in Table 4B we observe briefly:

1. All farm types may service more than 22 percent debt, and 12 can safely service 35 percent or more debt.
2. Complete program hogs can sustain the largest debt ratio (77%).
3. Roughly equal shares of debt and equity financing are viable for most farm types.

Comparing 4A and 4B it may be immediately observed that the zero level permissible debt burdens characterizing beef feeding and hog finishing have been replaced by feasible debt ratios ranging to 40.3 percent in the case of beef feeding on large farms. In fact, with the two year recovery period, beef feeding can sustain more debt than cash grain operations reversing the ordering under the more stringent default condition. Comparison of Tables 4A and 4B also reveals a dramatic increase in virtually all maximum, feasible debt ratios. We find that a small farm with flexible creditors may, in general, sustain proportionately as much debt as a large farm with inflexible creditors. Also, a large farm with a two year recovery period may typically sustain debt burdens of more than 52 percent (in 9 of the 15 cases) and between 61-80 percent for the five farms with a hog enterprise. Note that the SDR condition discussed on page 14 applies to the large complete program hogs farm type. The complete program hog producer could have carried about 4 percentage points more debt, i.e., a debt ratio of 84.3 percent rather than 80.3 percent had the level of current debt been allowed to exceed current operating expenses.

The two-year recovery period tends to benefit farm types with widely fluctuating earnings, rather than farm types with fairly level earnings. This is most notably observed by comparing the marked increases that result in moving from the no deferral condition to the two-year deferral condition in small farm debt ratios for beef feeding (0.0 to .283), complete program hogs (.356 to .652) and hogs finishing (0.0 to .150) as opposed to the modest increases for the more stable cash grain (.098 to .147; note that in figure 1 cash grain returns were relatively stable but low until 1972) and dairy (.348 to .477) operations. Finally, observe that moving from the zero to two-year recovery period widens the range of feasible debt ratios for single enterprise farms while narrowing the range of ratios for two enterprise farms, an averaging effect one would expect.

The following observations are in order before proceeding from the farm size sensitivity test to the diversification share analysis:

1. Equity assets must assume the major share of the financing burden for basically all farm types and farm sizes when a zero year recovery period is imposed. Or, said another way, creditors must expect occasional payment deferrals if they are going to do much in the way of providing farm credit.
2. Labor intensive dairy and complete program hog operations could sustain large debt loads during the study period.
3. A two-year recovery period dramatically increases the debt financing capability of farms with incomes that fluctuate widely.
4. Large farms may, in most cases, sustain higher debt ratios than small farms, when a zero year recovery period is mandated and in all cases when a two-year recovery period is in effect.
5. For most farm types, i.e., 10 of 15, a small asset base with a flexible recovery period can sustain a larger debt ratio than a farm with a large asset base and an inflexible recovery period.

Enterprise Shares Sensitivity Test

The estimated maximum feasible debt ratios that obtain when enterprise value added "mix" is varied are given in Tables 5A and 5B. The feasible debt ratios that obtain when a two-year recovery period is allowed (5B) are invariably larger than the ones that obtain when no deferral of loan payments is allowed (5A). Again, the gains are dramatically higher for livestock farms that are characterized by consistently fluctuating returns (complete program hogs, hog finishing, beef feeding as illustrated in Figure 1). We may also observe that because of markedly superior complete program hog earnings during the study period, diversification does not benefit complete program hogs under the liberal default condition.

Perhaps the most interesting trends in the feasible debt ratios presented in Tables 5A and 5B are that while the largest debt ratios in each farm type row tend to occur in the one enterprise columns - that is enterprise share of 100/0 or 0/100 - (in 8 of the 10 farm types), the ratios for evenly diversified farm types are consistently in the upper half of the row range. For example, for cash grain-dairy in 5A, the 50/50 ratio of .406 is markedly closer to the highest debt ratio, .413 (for a 0% cash grain, 100% dairy operation) than to the lowest, .227 (for a 100% cash grain, 0% dairy operation). Moving from both the left hand and the right hand columns to the middle column of 5B, we find that the debt ratios tend to stabilize more or less around .45 to .55. A 50/50 asset split, in general, reduces risk better than a 75/25 or 25/75 split and much better than a 100/0 or 0/100 asset division, i.e., single enterprise farm. The comparative success of the 50/50 asset split is especially striking in the zero year recovery period for cash grain-dairy, cash grain-beef feeding, dairy-beef feeding, dairy-complete program hogs, and beef feeding-complete program hogs. The message then is: If one wishes to diversify in order to reduce risk, this will in general best be accomplished by approaching a division of resources between enterprises in a manner such that each enterprise contributes equally to the farm total value added. (This is an elementary finding, but one that may bear repeating).

Maximum feasible debt ratios by deviation of enterprise mix, median sized farms.

Table 5A. No deferral of loan payments allowed.

Farm type	Critical Year	Enterprise Mix 100/0	75/25	50/50	25/75	0/100
Cash grain-dairy	1975	.227[1]	.329[1]	.406	.410[4]	.413[4]
Cash grain-beef feeding	1967	.227	.288	.350	.172[4]	.000[4]
Cash grain-hogs complete	1967	.227[1]	.292[1]	.355	.414	.471
Cash grain-hog finishing	1971	.227[5]	.215[5]	.130	.042	.000
Dairy-beef feeding	1974	.413[4]	.443[4]	.307	.137	.000
Dairy-hogs complete	1967	.413[5]	.523[4]	.510	.492	.471[3]
Dairy-hog finishing	1974	.413[5]	.398	.210	.000	.000[3]
Beef feeding-hogs complete	1974	.000	.170	.403	.473	.471
Beef feeding-hogs finishing	1974	.000	.000	.000[3]	.000[4]	.000[3]
Hogs complete-hog finishing	1967	.471	.400	.253[3]	.000[4]	.000[3]

Table 5B. Two year deferral of non-real estate loan payments allowed.

Cash grain-dairy	1967	.282	.376	.452	.514	.554[4]
Cash grain-beef feeding	1967	.282	.358	.435	.447	.362[4]
Cash grain-hogs complete	1967	.282	.417	.542	.659[4]	.770[4]
Cash grain-hog finishing	1967	.282	.322	.358	.329[4]	.222[4]
Dairy-beef feeding	1974	.554[4]	.513	.484	.429	.362
Dairy-hogs complete	1967	.554[4]	.610	.658	.711	.770
Dairy-hog finishing	1974	.554	.480	.415	.323[1]	.222[1]
Beef feeding-hogs complete	1974	.362	.517	.665	.731[1]	.770[1]
Beef feeding-hog finishing	1974	.362	.323	.287[2]	.254[4]	.222[4]
Hogs complete-hog finishing	1967	.770	.677	.548[2]	.396[4]	.222[4]

[1] Critical year = 1967.
[2] Critical year = 1970.
[3] Critical year = 1971.
[4] Critical year = 1974.
[5] Critical year = 1975.

Rates of Return Sensitivity Test

Looking at Tables 6A and 6B, we find that a one percent increase in the cash income return to assets typically permits an increase in debt ratios of 5.5 to 7 percentage points (in the absence of SDR), a not inconsiderable gain. Under the inflexible default condition, however, a two percent ROR advance was not sufficient to enable hog finishing and hog finishing in combination with beef feeding to successfully utilize credit in the worst case year. Thus, even an above average manager would have defaulted on scheduled debt payments had he been 100 percent invested in either of the above farm types. On the other hand, a very good cash grain manager might have maintained a debt load several times larger than a poor manager (the -2 to +2 percent rate of return difference results in an increase of about 29 percentage points in maximum feasible debt ratios under both recovery conditions).

Interestingly enough, we observe essentially no decline in the absolute size of the increment in debt ratios that results from changes in rates of return as we move from below average to above average returns (except for complete program hogs where current borrowing was limited to the level of current production expenses). This is primarily because higher rates of return permit expanded borrowing that, in turn, results in large income tax deductions that tend to limit the expected increase in income tax burdens. Thus the progressivity of the model's income tax rate function is counteracted by leveraged growth effects on taxable incomes. Had farm debt not been permitted to expand as earnings increased, taxes would have risen much faster.

A Few Summarizing Comments:

1. A one percent rate of return increase generates, on the average, a 6.5 percentage point increase in maximum feasible debt ratios.
2. The four percent increases (from average minus 2 to average plus 2 percent) in ROR's enabled three of the one enterprise farm types to double or triple debt loads and three of the two enterprise farm types to do likewise (with a two-year recovery period).

Maximum feasible debt ratios by deviation of rate of return on assets from sample average, median sized farms.

Table 6A. No deferral of loan payments allowed.

Farm type	Critical Year	Rate of Return on Assets -2%	-1%	Historical Sample Average	+1%	+2%
Cash grain	1967	.08	.155	.228	.301	.373
Dairy	1975	.312	.363	.414	.463	.512
Beef feeding	1974	.0	.0	.0	.0	.071
Hogs complete	1967	.342	.406	.471	.535	.598
Hog finishing	1974	.0	.0	.0	.0	.0
Cash grain-dairy	1975	.287	.347	.406	.464	.522
Cash grain-beef feeding	1967	.203	.277	.351	.423	.496
Cash grain-hogs complete	1967	.217	.286	.355	.423	.49
Cash grain-hog finishing	1971	.0	.065	.13	.193	.255
Dairy-beef feeding	1974	.191	.25	.307	.364	.419
Dairy-hogs complete	1967	.398	.454	.51	.566	.622
Dairy-hog finishing	1974	.092	.152	.21	.266	.321
Beef feeding-hogs complete	1974	.266	.335	.403	.47	.536
Beef feeding-hog finishing	1974	.0	.0	.0	.0	.0
Hogs complete-hog finishing	1971	.13	.192	.253	.313	.372

Table 6B. Two year deferral of non-real estate loan payments allowed.

Farm type	Critical Year	Rate of Return on Assets -2%	-1%	Historical Sample Average	+1%	+2%
Cash grain	1967	.134	.209	.282	.355	.421
Dairy	1975	.467	.511	.555	.597	.639
Beef feeding	1974	.224	.293	.362	.430	.499
Hogs complete	1967	.643	.707	.77	.81*	.829*
Hog finishing	1974	.01	.161	.222	.283[1/]	.343[1/]
Cash grain-dairy	1967	.333	.393	.452	.51	.568
Cash grain-beef feeding	1967	.289	.362	.435	.507	.578
Cash grain-hogs complete	1967	.406	.474	.542	.609	.676
Cash grain-hog finishing	1967	.225	.292	.358	.423	.488
Dairy-beef feeding	1974	.368	.427	.484	.538	.591
Dairy-hogs complete	1967	.547	.603	.652	.712	.766
Dairy-hog finishing	1974	.302	.359	.415	.47	.522
Beef feeding-hogs complete	1974	.533	.599	.665	.731	.768*
Beef feeding-hog finishing	1974	.158	.223	.287	.352	.416
Hogs complete-hog finishing	1970	.419	.484	.548	.61	.663[1/]

*SDR.

[1/] Critical year = 1974.

Maximum feasible debt ratios by deviation of interest rate levels from historical levels, median sized farms.

Table 7A. No deferral of loan payments allowed.

Farm Type	Critical Year	Interest Rate Levels				
		-2%	-1%	Historical Estimate	+1%	+2%
Cash grain	1967	.253	.24	.228	.216	.201
Dairy	1975	.445	.43	.414	.398	.383
Beef feeding	1974	.0	.0	.0	.0	.0
Hogs complete	1967	.522	.495	.471	.448	.426
Hog finishing	1974	.0	.0	.0	.0	.0
Cash grain-dairy	1975	.442	.424	.406	.389	.373
Cash grain-beef feeding	1967	.394	.371	.351	.331	.313
Cash grain-hogs complete	1967	.394	.374	.355	.337	.32
Cash grain-hog finishing	1971	.147	.138	.13	.122	.116
Dairy-beef feeding	1974	.338	.322	.307	.293	.28
Dairy-hogs complete	1967	.557	.533	.51	.489	.468
Dairy-hog finishing	1974	.232	.22	.21	.20	.19
Beef feeding-hogs complete	1974	.451	.426	.403	.381	.361
Beef feeding-hog finishing	1974	.0	.0	.0	.0	.0
Hogs complete-hog finishing	1971	.282	.267	.253	.24	.228

Table 7B. Two year deferral of non-real estate loan payments allowed.

Farm Type	Critical Year	Interest Rate Levels				
		-2%	-1%	Historical Pattern	+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
Hogs complete	1967	.812[1]*	.800[1]*	.77	.735	.701
Hog finishing	1974	.251	.236	.222	.209	.197
Cash grain-dairy	1967	.489	.47	.452	.434	.416
Cash grain-beef feeding	1967	.486	.459	.435	.412	.39
Cash grain-hogs complete	1967	.597	.569	.542	.516	.492
Cash grain-hog finishing	1967	.396	.377	.358	.34	.323
Dairy-beef feeding	1974	.527	.505	.484	.463	.442
Dairy-hogs complete	1967	.712	.684	.652	.632	.607
Dairy-hog finishing	1974	.455	.434	.415	.396	.378
Beef feeding-hogs complete	1974	.74	.702	.665	.631	.599
Beef feeding-hog finishing	1974	.325	.305	.287	.271	.256
Hogs complete-hog finishing	1970	.609	.578	.548	.52	.493

*SDR.

[1] Critical year = 1974.

3. Dairy and dairy combination farm types, because of the relatively large increase in term debt principal payments (that accompanies any increase in the unit's debt ratio), which are not tax deductible, were least able to expand debt as returns improved in the sensitivity test.
4. Tax management practices suggest rapid expansion of the farm asset base at even low and moderate cash income rates of return.
5. Proportional debt capacity of large farms with average earnings (Table 4B) is, in general, slightly inferior to the debt capacity of medium sized farms with returns one percentage point greater than average (Table 6B, ROR column 4). Medium sized farms with two percent superior earnings could sustain markedly higher debt ratios than large size farms with average earnings.

Interest Rates Sensitivity Analysis

Proceeding from inspection of the response of maximum feasible debt ratios to changes in rates of return on assets to an analysis of debt ratio response to interest rate changes (as detailed in Tables 7A and 7B) one is struck by the relative diminished impact of interest rate changes on debt carrying capacity. Whereas the sensitivity test of a four percentage point change in ROR's generally produced a change of about 25 percentage points in debt capacity, the variation of interest rates from 2 percent below to 2 percent above the historical estimate changed debt ratios by only 6-9 percent in most cases. A decrease of 2 percentage points from the historical rate does not improve the inability of hog finishing beef feeding and combination to sustain positive debt loads under the strict default condition.

Current, term, and real estate interest rates were varied simultaneously in the interest rate test. The likelihood of a joint one or two percent change in all three interest rates has been limited in the past. Widespread adoption of variable interest rates may make all farm interest rates more flexible in the future. Although a large increase in interest rates would clearly reduce debt capacity, from the preceding rate of return analysis we may note that a slight decrease in returns to assets would provoke similar debt capacity reduction.

Mortgage Term Sensitivity Analysis

The basic model with a 20-year real estate mortgage is estimated for a medium sized farm in column 3 of Tables 8A and 8B. (Note that in the seven year term debt test real estate mortgage maturity was again set at 20 years). With a 30-year real estate mortgage, debt ratios generally rise about 3.5 to 4 percentage points for cash grain, dairy and complete program hog combinations under the inflexible default condition and increase from 4-6 percent under the flexible default condition. The increases in maximum debt ratios for hog finishing, beef feeding and their two enterprise combination farm operation are dampened by losses in the critical income years. Thus, the discouragingly familiar rows of zeros in Table 8A and the 2-3 percent increases for these farms in 8B. Increases in debt ratios continue when the mortgage term is set at 40 years as opposed to 30, though the increment is now usually 1-2 percent in both Tables 8A and 8B. The smaller increments that result from the 30-40 year maturity expansion compared to the 20-30 year mortgage lengthening are as expected. This is due largely to the mathematics of compound interest, i.e, there is a very small present value attached to payments due 30 to 40 years from the time a mortgage is initiated.

The three farm types with the largest real estate/total assets ratios, cash grain, dairy, and hogs complete, benefit most from mortgage length extension. Interestingly enough, dairy operations with a smaller real estate share of assets than cash grain farms benefit about as much from mortgage term lengthening as do cash grain operations. This probably indicates that any alleviation of the large principal proportion of dairy farm debt service payments prominently augments debt capacity. This is perhaps more dramatically illustrated in the increase of the term of intermediate maturity debt from five to seven years, as shown in the comparison of dairy 20 years real estate, 5 year term debt from column 3 of Table 8B vs. 20 year real estate, 7 year term debt from column 6 of 8B. (Unfortunately, the sensitivity test on intermediate term debt length was not performed under the inflexible default condition). Here we see that the two-year intermediate term debt period extension shifts the debt ratio from 55.4 to 64.1 percent, a very respectiable 8.7 percentage point increase. The 2 year term debt extension has a much more powerful impact than a mortgage maturity extension of 20 years(debt ratio increases to .641 for 2-year intermediate debt term with 20 year mortgage term vs. .611

Maximum feasible debt ratios by deviation of real estate mortgage and term debt (10B) from historical average estimates.

Table 8A. No deferral of loan payments allowed.

Farm Type	Critical Year	----- Real Estate Mortgage Term ----- 20 years (Intermediate term debt = 5 years)	30 years	40 years
Cash grain	1967	.228	.26	.277
Dairy	1975	.414	.448	.463
Beef feeding	1974	.0	.0	.0
Hogs complete	1967	.471	.513	.533
Hog finishing	1974	.0	.0	.0
Cash grain-dairy	1975	.406	.451	.47
Cash grain-beef feeding	1967	.351	.392	.413
Cash grain-hogs complete	1967	.355	.395	.415
Cash grain-hog finishing	1971	.13	.14	.144
Dairy-beef feeding	1974	.307	.332	.342
Dairy-hogs complete	1967	.51	.551	.57
Dairy-hog finishing	1974	.121	.226	.232
Beef feeding-hogs complete	1974	.403	.439	.454
Beef feeding-hog finishing	1974	.0	.0	.0
Hogs complete-hog finishing	1971	.253	.27	.277

Table 8B. Two year deferral of non-real estate loan payments allowed.

Farm type	Critical Year	---- Real Estate Mortgage Term ----			Intermediate Debt Term
		20 years (Intermediate Debt Term =	30 years	40 years 5 years)	7 years (Real Estate Mortgage Term = 20 yrs.)
Cash grain	1967	.282	.325	.348	.308[2/]
Dairy	1974	.554	.594	.611	.641[2/]
Beef feeding	1974	.362	.394	.408	.391
Hogs complete	1974	.770[1/]	.818	.828	.821
Hog finishing	1974	.222	.240	.248	.247
Cash grain-dairy	1967	.452	.499	.523	.513
Cash grain-beef feeding	1967	.435	.488	.515	.479
Cash grain-hogs complete	1967	.542	.608	.642	.604
Cash grain-hogs finishing	1967	.358	.397	.416	.403
Dairy-beef feeding	1974	.484	.524	.54	.544
Dairy-hogs complete	1967	.652	.713	.739	.766
Dairy-hog finishing	1974	.415	.446	.459	.47
Beef feeding-hogs complete	1974	.665	.725	.744	.725
Beef feeding-hog finishing	1974	.287	.312	.323	.315
Hogs complete-hog finishing	1970	.548	.588	.606	.617

[1/] Critical year = 1967.

[2/] Critical year = 1975.

for a 5-year intermediate debt term with a 40-year mortgage term for dairy operations). Comparing the columns of 8B further, we find that increasing the intermediate term period raises debt ratios more than extending the mortgage term for two enterprise dairy combinations (i.e., 3 of the 4) and also for most non-cash grain combinations. The two-year intermediate term addition results in about the same magnitude of increase for the non-cash grain farms as a one percent increase in rate of return. While the 20-year mortgage extension most benefits cash grain and combinations involving a cash grain enterprise, and intermediate term maturity extension most benefits dairy and its combinations, both are, in general, quite helpful in terms of increasing debt carrying capacity.

Summary of Study Results

1. A flexible default condition that permits a recovery period following initial deferral on loan principal payments in low income years is basic to successful debt financing.
2. Large farms may always carry higher debt ratios than small farms under a flexible default condition everything else equal.
3. Diversification into a labor intensive enterprise such as complete program hogs or dairy generally raised debt carrying capacity. (Note: These enterprises may be capital intensive as well as labor intensive).
4. Diversification into equal asset shares per enterprise appears, in general, to be the best diversification plan for two enterprise farms.
5. Improving returns to assets by as little as one percentage point may significantly increase debt capacity.
6. Increasing the real estate mortgage term from 20 to 30 years for farms with a large proportion of assets in land may increase debt carrying ability significantly. Increasing the principal repayment period of intermediate term debt from five to seven years dramatically improves the ability of dairy farms to utilize debt.
7. Farm debt capacity is not particularly sensitive to $\pm$ 1 per- changes in interest rates.

8. Small farms with above average rates of return may maintain very competitive proportional debt loads compared to those of large farms with average rates of return. To become a good manager will, in general, enhance debt servicing ability better than simply becoming a large operator.

APPENDIX

(1) $(CASHROR_{kt} + OPEXPR_{kt}) * ASSETS_t + SVDPINC_{kt} \geq HHEX_t$

i.e., cash income; operating expenses; interest income; minimum household expenditures

$+ OPEXPR_{kt} * ASSETS_t + TTLINT_{kt} + MPC * (ACRLROR_{kt} * ASSETS_t$

i.e. operating expenses; interest expense; marginal consumption

$+ SVDPINC_{kt} - TTLINT_{kt}) + TTLPPL_{kt} + TTLTAX_{kt} + SDR_{kt}$

i.e. debt principal payments; taxes; seasonal debt repayment

farmtype $k = 1, \ldots. K$
year $t = 1, \ldots. T$

The above terms are described as follows:

$CASHROR_{kt}$ = adjusted cash rate of return to assets of farmtype k in year t (see footnote 5).

$ASSETS_t$ = representative average asset levels based upon estimated asset value of sample farms in year t

$OPEXPR_{kt}$ = ratio of total operating expense to total farm assets of farmtype k in year t.

$SVDPINC_{kt}$ = interest income from cash balances held for consumption purposes by farmtype k in year t.[1/]

$HHEX_t$ = minimum preferred level of household expenditures (estimated from record analysis) in year t.

$TTLINT_{kt}$ = total interest paid by farmtype k in year t. This is obtained by multiplying current, term, and mortgage debt categories by current, term, and mortgage interest rates. Also seasonal debt is multiplied by the current interest rate times one-half year (less five days free trade credit).

1/ Varies by farm type between $0 and $123 in 1966 and $0 and $204 in 1975. This variable has proven to be essentially of no consequence to the model.

(2) $$TTLINT_{it} = RATEST_t * SOEXPR_{kt} * OPERXPR_{kt} * (165/365) * ASSETS_t + RATEST_t * CRASTR_{kt} * D/A_{kt}\ ASSETS_t + RATEIT_t * MCRASTR_{kt} * D/A_{kt} * ASSETS + REDINTF * AFPV * RER_{kt} * D/A_{kt} * ASSETS_t$$

where

$RATEST_t$ = short-term interest rate. An annual average PCA rate for Minnesota, adjusted for stock purchase requirement (5).

$RATEIT_t$ = intermediate term interest rate for Minnesota, adjusted for stock purchase requirements. Estimated as a simple average of current and preceding four years of annual PCA production loan effective rates (5) .

AFPV = annuity factor for commercial farm real estate mortgage. Estimated from FLB rates for Minnesota and adjusted for stock purchase requirements. The fixed payment mortgage is assumed to be in the third year of a 20 year loan. (Rate information obtained from the St. Paul Federal Land Bank).

REDINTF = the ratio of annual mortgage interest to annual total mortgage payment, i.e., real estate debt interest fraction.

MPC = marginal propensity to consume, estimated to be .097[2/]

$ACRLROR_{kt}$ = accrual rate of return on assets of farmtype k in year t.

$TTLPPL_{kt}$ = total loan principal payment. Consists of one-fifth of all term debt and the noninterest portion of the real estate mortgage payment. That is,

(3) $$TTLPPL_{kt} = .2 * NCASTR_{kt} * D/A_{kt} + (1 - REDINTF) * AFPV * RER_{kt} * D/A_{kt} * ASSETS_t$$

2/ Estimate was made on income before taxes and interest, basis a sample of farms with very low debt. Since we are exploring much heavier debt usage, the estimated MPC is applied in this study on "accrual" income after interest payments but before tax payments. We are presently attempting to obtain an MPC estimate that is based upon records in the Minnesota Farm Management Association and that would apply to income after interest and taxes.

NOTE: Operating expenses and annual debt are assumed paid each year as livestock and crops are sold (both were deducted in computing the adjusted cash ROR). Observe also that the presence of the term "OPEXPR...$ASSET_t$" in equation (2) implicitly assumes principal repayment of all current and seasonal operating credit employed.

$TTLTAX_{kt}$ = total of estimated annual Social Security taxes, Minnesota income taxes, and U.S. personal income taxes paid. Effective tax rate functions were estimated for alternative years in the study period from Social Security tax tables and from aggregate Minnesota and U.S. income taxes paid data for married persons filing jointly. The effective tax rate (EFFTAXR) was then applied to accrual income after interest payments to compute total taxes.

(4) $TTLTAX_{kt} = EFFTXR_t*(ACRLROR_{kt}*ASSETS_t + SVDPINC_{kt} - TTLINT_{kt})$

SDR = seasonal debt repayment. The amount of current plus seasonal debt is constrained to not exceed operating expenses. This is since the usage of short-term credit is limited to planting, harvesting, feeding and purchasing of livestock, etc. expenses of a short-term character.

(5) $SDR = SOEXPR_{kt}OPEXPR_{kt}*ASSETS_t + CRASTR_{kt}*D/A_{kt}*ASSETS - OPEXPR*ASSETS$

or SDR = 0, if the right hand side of the above equation < 0.

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