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Short-Run Indicators of Financial Success for Southwest Minnesota Farmers

by

Douglas D. Tvedt

Kent D. Olson

Douglas M. Hawkins

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry and Home Economics
St. Paul, Minnesota 55108

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Douglas D. Tvedt*

Kent D. Olson

Douglas M. Hawkins

* Tvedt is Research Associate, Department of Agricultural Economics, University of Kentucky, Lexington, KY, and formerly, Research Assistant, Department of Agricultural and Applied Economics, University of Minnesota--Twin Cities. Olson is Assistant Professor, Department of Agricultural and Applied Economics and Hawkins is Professor, Department of Applied Statistics, University of Minnesota--Twin Cities.

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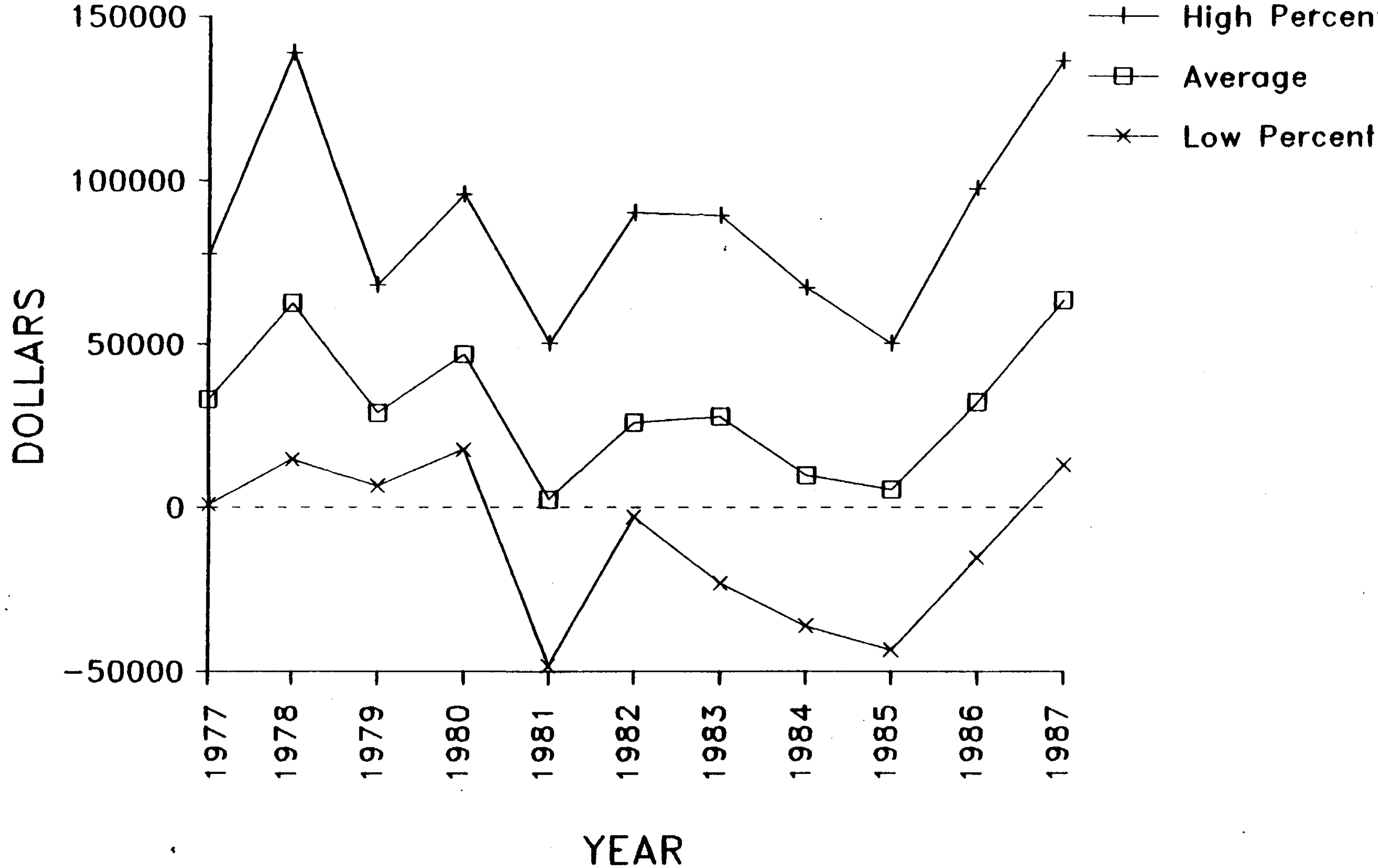
The drought of 1988, the financial crisis of the early 1980s, and the high incomes of the late 1970s have reminded us that farming is an uncertain enterprise. This uncertainty does not mean that farmers should quit; rather it means that farmers need to incorporate this uncertainty into their management process. Part of that incorporation process is deciding what variables are associated closely with financial success and, thus, included in an information system to be monitored closely. By choosing these variables correctly, farmers can increase their probability of financial success in both good and poor years.

The uncertainty can also be seen in the considerable range of profit/loss levels in farms. In the Southwestern Minnesota Farm Business Management Association (SWFBMA), the overall average profit in 1985 was $5,487 (Olson, et al.). The 20 percent of the farms that comprised the lowest profit had an average loss of -$43,474 and the average profit for the 20 percent of farms that comprised the highest profit was $50,151. This is a range of $93,625 between the high and low 20 percent averages. This dispersion is seen in other years also (Figure 1).

The macroeconomic environment may determine the average profit level, but the macroeconomic environment does not explain the dispersion of profits and losses. The dispersion may be explained by the different characteristics of the farmers. These characteristics include marketing,

Figure 1. SWFBMA Profit Dispersion

Profit -- Loss



production, and financial management ability; physical resources such as land and machinery; financial resources such as debt load, equity level, credit availability; education; personal preferences; and experience. Of these characteristics or factors, which are the most important? A farmer does not have time to monitor and control everything. Thus, the important characteristics or critical success factors need to be identified.

This paper analyzes the data from the **Southwestern Minnesota Farm Business Management Association** (SWFBMA) to find the critical success factors for those farms. Financial success is measured by the ending rate of return on assets (EROA), rather than profit, to account for differences in farm size. The analysis is short-run in nature because the analysis is done with variables from within the same year.[1] This short-run analysis is valuable for identifying critical success factors and building information systems for annual decision support and control systems. The initial analysis is done with 1985 data and verified with data from 1986 and 1987.

Identification of the critical success factors consists of determining potentially important variables, and analyzing them to find out which ones are indeed important. Variables with potential to explain financial success are determined and discussed using the framework of a conceptual model. The variables identified using the conceptual model are examined using a statistical regression analysis to discover the variables that are associated with financial success.

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[1] This analysis is not dynamic since it does not follow the performance of farms from one year to the next. This dynamic analysis is the subject of future research.

CONCEPTUAL MODEL

The conceptual model attempts to determine variables that explain the significant dispersion of profitability evident in the Southwestern Minnesota Farm Business Management Association (SWFBMA). Variables that may affect profitability include outputs from production and their prices, and inputs to production and their prices. The relationship between outputs and inputs may also provide useful information in determining profitability. Other characteristics, such as age and experience, may differentiate farmers without necessarily having a direct, measurable impact on outputs or inputs. The critical success factors for farmers are those that explain, affect, measure, or are associated with profitability. The development of the conceptual model and the variables included are specified in the following sections on how profit and the rate of return on assets are defined and the variables which come from considering revenue, costs, efficiencies, and other factors.

Profit Defined

In order to identify the critical success factors, a better understanding of profit needs to be established. Profit (π) is defined to be equal to total revenue (TR) minus total costs (TC).

$$\pi = TR - TC$$

In this definition, profit is used in its popular sense rather than in the narrower economic definition of returns above a "normal" range (i.e., economic rent). Empirically, profit is defined as net farm income

(NFI) which is gross cash farm income less cash farm expenses and adjusted for changes in inventories and depreciation and other capital adjustments. Differences in profitability are a function of differences in total revenue or total costs or both.

Rate of Return on Assets

Since farm size can have a major impact on profit and net farm income, the rate of return on assets is used as the response variable and financial success indicator since it adjusts for differences in size. The ending return on assets (EROA) is defined as the quantity, net farm income (NFI) minus the value of unpaid labor and management (VUPLM) plus interest paid (INTPAY), divided by the value of ending total assets (ETOTASST). The ending total asset value is used to account for asset changes during the year. The equation for the ending return on assets is as follows.

$$EROA = \frac{(NFI - VUPLM + INTPAY)}{ETOTASST}$$

The rate of return on assets is used instead of the rate of return on equity (ROE). The ROE is not used because of problems when equity is near zero (as is the case in the data used). When equity is near zero, the rate of return to equity becomes over-inflated and does not behave properly.

Total Revenue

The total revenue (TR) which a firm produces is equal to the firm's outputs multiplied by the prices received for the outputs:

$$TR = \sum_i P_i Y_i$$

where Y_i is the i^{th} product, and P_i is the price of the i^{th} product. With output expressed as a function of input levels, total revenue becomes,

$$TR = \sum_i P_i Y_i(X_1, \ldots, X_j)$$

where the X's are the inputs of production.

Factors affecting output or the price received for that output will have an affect on total revenue. Factors affecting output may be the size of the farm, the level of technology in use, and productive efficiency. Factors that could affect the price of output will be the marketing of the product, participation in government programs, and the type of product that is produced.

A factor affecting the output of the firm is the size of the operation. If average productivity can be maintained, bigger operations can produce more. We expect larger crop farms to produce more crops; larger dairy farms to produce more milk. Variables observable from the SWFBMA data that reflect the size of the farm are the number of acres farmed, total assets, and the value of farm production.

Total assets of the farm will reflect not only the number of acres owned, but also the value of buildings, plus other assets such as equipment and livestock. However, total assets underestimates the production of those farmers that rent some or all of their land. This occurs in the data used. Also the valuation of assets is not an exact science; thus, it is subject to potential variations and irregularities between farms.

The number of acres farmed (including both owned and rented land) is easier to quantify than asset value and is not subject to the variations in valuation methods and appraisals. But, the number of acres farmed may not be as uniform of a measure of size between crop and livestock farms.

The value of farm production reflects both asset and acreage levels and avoids their problems. However, the value of production may not be a uniform measure between different enterprises due to differences in output values and asset requirements. Hence, both the value of farm production and the number of acres farmed will be the variables used to represent size.

Technical efficiency is another factor that can affect farm output. Although land can be of comparable quality with similar amounts of rainfall, there always seem to be some farmers whose yields consistently exceed those of their neighbors. Farmers who return higher than average yields are technically efficient in terms of production. Higher yields lead to increased production which leads to higher profits. A variable that reflects productive efficiency for crops is the farm's crop yield divided by his/her county average yield. Dividing by the county average crop yield will help in correcting for differences in land quality and quantity of rain. Variables are developed for both corn yield and soybean yield.

One measure of technical efficiency for livestock enterprises is feed efficiency which is calculated by dividing pounds of feed by pounds of gain. For this analysis, an individual's feed efficiency is divided by the SWFBMA feed efficiency to develop technical efficiency ratios for beef finishing, hog finishing, and farrow-to-finish. Because a lower feed efficiency ratio represents more efficient management, inverting this factor yields a positive relationship with productive efficiency. For dairy farms, productive efficiency is measured by its production per cow divided by the SWFBMA average production per cow. For a measure of overall livestock efficiency, the inverted beef, hog finishing, and farrow-to-finish relative feed efficiency ratios are multiplied by the relative dairy production per cow ratio.

An overall productive efficiency variable was derived by multiplying the livestock efficiency ratio by the crop efficiency ratio. Operators who have consistently high productive efficiencies will have higher values for this variable. A value greater than one for these variables will represent a productive efficiency that is above average. To insure that the above production efficiency variables estimate only efficiency, a '1' was inserted for all cases that failed to have an efficiency ratio in a particular enterprise. If a '1' is not inserted, these variables become merely an indicator representing the production of a certain item.

Labor is a major input into production. Efficient utilization of labor will have a positive affect on profitability. Since there is no information available in the SWFBMA records on the number of hours worked, labor efficiency is measured as the value of production divided by the number of operators. However, this ignores the use of hired labor; thus, it is not the best indicator of labor efficiency but is used as a proxy.

The efficient use of inventory may affect a farm's output and profitability. An inefficiently used inventory of an input can diminish potential output. Too much of an inventory item on hand can be costly in terms of interest expense and opportunity costs, and too little on hand can thwart efficient production. Inventory items that are allowed to sit and decay become useless. Inventory turnover is measured by dividing beginning current assets by the value of farm production (Pinches, Eubank, Mingo, and Caruthers, 1975).

Marketing of the farm product is a factor that affects the price received for the farm's output. Dahl and Usset demonstrate in a study that storage hedging can be a profitable corn marketing strategy. Forward contracting also lessens the price risk for farm enterprises. Locating the highest bid may require effort, but it may result in a higher price received for the farm product. The price received for corn, soybeans, beef, hog finishing, and farrow-to-finish for each farmer was divided by the SWFBMA county averages in each category. County averages are used to eliminate differences in closeness to markets. An overall marketing variable was derived by multiplying together the price ratios of each enterprise. A value greater than one for these variables will represent an average price received that is above average. Again, a '1' was substituted for all operators that didn't sell a commodity, otherwise these variables become an indicator that a certain item was sold.

Participation in government programs can also enhance farm profitability. Government programs are designed to stabilize and increase farm income. Farms that take advantage of these programs are likely to benefit. In 1985, SWFBMA farmers that received government payments obtained an average of $12,811 (Olson, et al.). A dummy variable is used to represent this information; the variable equals a '1' if the farmer received government payments, and '0' if otherwise.

The quality of the farm product may also influence the price received. Unfortunately, in farming there is little an individual farmer can do to distinguish his/her product from other farm production in major commodities. While there are monetary incentives to produce within a specified livestock weight range or grain moisture level, other quality improvements are not rewarded in the major markets. However, the operator that produces a product that meets buyer's specifications and markets it well, should receive a higher price for his/her product. The previously outlined price ratio variables should also reflect quality differences rewarded in the marketplace.

The choice of crop and livestock enterprises operated by the farm may influence the overall level of income. Some enterprises may be more profitable in certain years than other enterprises. Low prices in one agricultural market can mean low input prices for another enterprise. This relationship is illustrated in the corn market and swine industry where low corn prices hamper profits for corn farmers but provide a cheap input for hog farmers. Dummy variables equaling a '1' if the operator produced the commodity, and a '0' if otherwise, are developed for beef, farrow-to-finish hogs, hog finishing, dairy, corn and soybean enterprises. These dummy variables are not mutually exclusive, that is producing one product does not prevent the farmer from producing another or several other farm products.

Total revenue can be enhanced by the level and quality of investments. A quality investment is one where the cost of the investment compares favorably to its ability to generate production. Capital turnover gauges how well assets or investments are able to produce a valuable product. The capital turnover variable used in this study is the asset turnover rate: value of production divided by the average asset value. The value of land rented is used to adjust beginning total assets because the asset turnover rate would be inflated for farmers that rented most or all of their land.

The ability to take advantage of unanticipated investment opportunities can enhance profitability. Liquidity measures the ability to meet financial obligations and unexpected demands in the short-run. Liquidity can also be described as a measure of the cushion between assets that are cash or near cash and fixed financial obligations; the size of the cushion indicates the ability to meet unexpected demands on assets. Higher liquidity levels are hypothesized to be related to higher profit levels by allowing a farmer to meet unexpected demands without altering profitable plans, to take advantage of unexpected profitable options, to lessen interest costs by borrowing less operating capital, and to not be limited in planning by a lack of operating funds. The beginning current ratio is used as an indicator of liquidity in this study; it is calculated by dividing beginning current assets by beginning current liabilities.

Lee, Boehlje, Nelson, and Murray (1980) state that maintaining the proper balance of short-term, intermediate, and long-term debt can positively influence the debt-servicing capacity of the farm firm. Beginning current liabilities divided by beginning total liabilities is the debt structure of the farm. It estimates the short-term demands on assets. An imbalance in the debt structure of a farm can cause liquidity problems. Likewise, liquidity problems can occur if an improper balance of beginning, intermediate, and long-term assets is maintained. Beginning current assets divided by beginning total assets measures the asset structure of the farm.

A farm's cash position relative to its size of operation also indicates its ability to adapt to changing conditions. Cash on hand divided by the value of farm production is used as a relative cash position variable in this study.

Total Costs

The other part of the profit equation is total costs. Because annual data is used, the emphasis is on costs associated with those inputs that can be changed within a one year period (i.e., production or variable costs). Total variable costs (TVC) are equal to input prices times the quantity of inputs:

$$TVC = \Sigma_i X_i * P_i$$

where X_i is the i^{th} input, and P_i is the price of the i^{th} input.

Differences in costs will be a function of differences in input prices, and/or the quantity of inputs used. There may be little that an individual farmer can do to affect his input prices. However, purchases of large quantities of an input may have an effect on its price. The size of the farm operation will influence the quantity of inputs purchased. The bigger the operation, the more it can produce. The more it produces, the greater the quantity of inputs that are required. Large farms will have an advantage if they can increase production while lowering the are the number of acres farmed, total assets, the value of farm production, and total expenses of production. Total assets of the farm will reflect not only the number of acres owned, but also the value of buildings, plus other assets such as equipment and livestock. The number of acres farmed is easier to quantify and is not subject to the variations in valuation methods and appraisals. Total expenses of production give a more direct indication of the quantity of inputs needed. But the value of farm production also gives an indication of the quantity of inputs used due to its high correlation (.82) with total expenses.

The debt load of the operation will have an effect on total costs. Solvency measures debt load by comparing total asset value versus the debt held against those assets. An insolvent business has a total asset value which is insufficient to discharge all debt if the assets were to be sold. Solvency is a measure of an operator's ability to meet long-term financial obligations. The current solvency condition may give an indication of profit from previous years. Consecutive years of stable profitability provides an atmosphere conducive to paying down debt. Conversely, a firm that is currently highly leveraged may have suffered from poor profitability in past years. Variables reflecting financial leverage are total liabilities divided by total assets, total assets divided by net worth, total liabilities divided by net worth, and total debt divided by total capital. Beginning total liabilities divided by beginning total assets is used as a measure of solvency. Other ratios that are related to debt are the debt burden ratio (Penson), the times interest earned ratio (Penson), and interest expense as a percentage of gross income. The debt burden ratio measures the relative impact of debt. It is calculated by burden ratio measures the relative impact of debt. It is calculated by dividing income by debt. The times-interest-earned ratio measures debt servicing ability, which is calculated as earnings before interest and taxes divided by total interest payments.

Interest expense as a percentage of gross income measures the burden of debt by relating the size of the farm to total interest payments. It may have been a very important factor in the early 1980's when interest rates were at historically high levels. Wood and Johnson conclude that high financial risk farms have a lower cost of debt because they qualify for subsidized low-interest rate credit, whereas, low financial risk farms fail to qualify because they are able to receive higher cost credit from commercial lending institutions.

Financial Efficiency

Financial efficiency has a positive affect on farm profitability. The gross ratio is a measure of financial efficiency. The gross ratio is an indicator of cost control and an overall measure of efficiency in the use of resources (Lee, Boehlje, Nelson, and Murray 1980). The gross ratio is calculated as the total expenses of production divided by the value of farm production. A value of less than one indicates that the value of production exceeds total expenses. The financial leverage index (Penson) indicates whether farmers benefit from the use of financial leverage. It indicates an overall ability to efficiently manage the farm in areas that affect profitability. The financial leverage index is the rate of return on equity divided by the rate of return on assets. If this index exceeds one, it suggests that a farmer is employing debt capital beneficially. However, the financial leverage index gives a false indication when both return on equity and return on assets are negative. Both the gross ratio and the financial leverage index are used as variables in the statistical models.

Other Factors

Other variables which may explain differences in profitability include characteristics of the operator. The age and the number of years farming of the operator give an indication of the experience of the farm operator. Older operators may be more experienced and more knowledgeable in farming, thus being more likely to earn a profit. Younger farmers may be more aggressive, and may be more willing to accept new technology, thus being more profitable. The tenure of the operator, whether the farm is a corporation, a partnership, or a proprietorship, is another characteristic which may affect profitability.

In 1986, Benson and Boehlje noted that people contemplating starting or re-entering farming should consider the possibility of a share rental agreement rather than purchasing land. They noted that the crop share rental arrangement generates higher levels of cash income after debt servicing than cash rent or ownership acquisition strategies. To determine the effects of renting land on profitability, two dummy variables were established: one for whether a farmer share rented land, and one for whether a farmer cash rented land.

Whether a farmer had debt forgiven may have an impact on profitability. A break from creditors may provide the cushion necessary to increase earnings. Another dummy variable is used to indicate the incidence of debt forgiveness.

The focus of the conceptual model is on variables that affect, measure, or are associated with profitability. The variables identified by the conceptual model (Table 1) are tested by the statistical methods described in the next section in order to find the critical success factors.

Table 1. Conceptual Model Variable Summary.

Specific Variable:		Measure of:	Expected relation:
Response Variable			
EROA	: rate of return on assets	Profitability	
Predictor Variables			
ACRE	: number of acres farmed	Farm size	+
AGE	: age of operator	Experience	
BASTRC	: asset structure	Liquidity	+
BCASHPO	: cash position	Cash flow	+
BCURRAT	: current ratio	Liquidity	+
BDSTRC	: debt structure	Liquidity	-
BDTA	: debt to asset ratio	Solvency	-
BFDUMM	: beef feeding indicator	Enterprise selection	
BFFEEDRT	: beef feed ratio	Production eff.	+
BFINLEV	: financial leverage	Overall mgt. ability	+
BFPRRAT	: beef price ratio	Marketing efficiency	+
CNDUMM	: corn prod. indicator	Enterprise selection	
CORP	: corporation indicator	Business org.	
CNPRRAT	: corn price ratio	Marketing efficiency	+
CSRENTDM	: cash rent indicator	Rent vs. own	
CYLDRAT	: corn yield ratio	Production eff.	+
DARYDUMM	: dairy prod. indicator	Enterprise selection	
DEBTMPCT	: net cash income / debt	Debt impact	+
DEBTSERV	: debt servicing ability	Cash flow	+
DFORDUMM	: debt forgiven indicator	Creditors	+
DYYLDRT	: dairy production ratio	Production eff.	+
FFDUMM	: farrow to finish indicator	Enterprise selection	
FFFEEDRT	: farrow to finish feed ratio	Production eff.	+
FFPRRAT	: farrow to fin. price ratio	Marketing efficiency	+
GOVT	: government pay. indicator	Govt. program part.	+
GROSRAT	: gross ratio	Financial efficiency	-
HFDUMM	: hog finishing indicator	Enterprise selection	
HFFEEDRT	: hog finishing feed ratio	Production eff.	+
HFPRRAT	: hog finishing price ratio	Marketing efficiency	+
INTG	: interest exp. / gross inc.	Cost of debt	-
INVTURNO	: inventory turnover	Inventory efficiency	+
LABREFF	: value of prod. / operators	Labor efficiency	+
MARKEFF	: overall price ratio	Marketing efficiency	+
PARTNER	: partnership indicator	Business organization	
PRODEFF	: overall yield ratio	Technical efficiency	+
SBDUMM	: soybean prod. indicator	Enterprise selection	
SBPRRAT	: soybean price ratio	Marketing efficiency	+
SHRENTDM	: share rent indicator	Rent vs. own	
SYLDRAT	: soybean yield ratio	Production eff.	+
VALPROD	: value of production	Farm size	+
VALPTA	: asset turnover	Asset use efficiency	+
YEARS	: years op. has been farming	Experience	+

STATISTICAL METHODS AND TESTS

Multiple linear regression is used to analyze the data available in the Southwestern Minnesota Farm Business Management Association (SWFBMA). In this section, the procedures for model selection, problem diagnosis and correction, and model validation are reviewed.

Model Selection

Several criteria are used to select the final set of models. A step-wise regression technique called **backward elimination** is used to make the first determination of insignificant variables. A significance of level of five percent is generally followed unless the conceptual model says that a variable should be included even though its t-test does not meet the five percent test. Likewise, partial F-tests, Mallow's Cp statistic, and the adjusted R-squared are used to assist model selection. In all decisions, the overriding determinate in model selection is the economic logic of including certain variables in the model and the illogic of excluding them.

Problem Diagnosis

Methods are available to diagnose the basic multiple regression assumptions of linearity, normality, and constant variance. The most common problems associated with linear regression are those violating the assumptions of linearity and constant variance. Case diagnostics are useful in testing the assumptions of linear regression, the appropriateness of the regression model, and searching for outliers. Case diagnostics include residuals, residual plots, leverage, distance, and externally studentized residuals.

Residuals are the amount by which the actual response variable for the i^{th} case exceeds the predicted value for the i^{th} case. Residuals provide information about the assumptions of linear regression, and about the appropriateness of the model. A few large residuals may indicate outliers, and residuals that increase along with the values of the predicted values may indicate nonconstant variance.

A residual plot is a useful graphical technique to verify all three assumptions of multiple regression. A residual plot graphs residuals or studentized residuals on the y-axis versus the predicted values on the x-axis. Many possible problems can be uncovered with a residual plot. The pattern of the residual plot can reveal potential violations in the assumptions such as nonconstant variance and nonlinearity, or problems with the data such as outliers. A curvature in the residual plot may be indicative of nonlinearity. A pattern of residuals that indicates nonconstant variance may be similar to a megaphone shape. It could be either a right or left opening megaphone or there could be a bulge in the middle of the residual graph, all would nonconstant variance.

Leverage (h_{ii}) provides a measure of the affect of the i^{th} case on the regression. Leverage depends only on the predictor variables, and does not rely on the response variable (Weisberg). Cases with the largest leverage may be the most influential on the regression. Again from Weisberg, hii is the i^{th} diagonal element of the n x n hat matrix.

$$h_{ii} = x_i^T(X^TX)^{-1}x_i$$

where x_i represents the predictor variables for the i^{th} case, and X represents the matrix of predictors.

Distance measures the influence of the i^{th} case on the regression by estimating the distance between the coefficients in the regression model when the i^{th} case is deleted. Distance is a function of studentized residuals (r_i) and leverage (h_{ii}). Weisberg explains that a large value for Distance is due to a large studentized residual, or large leverage, or both. Cases with large values of Distance are ones whose deletion will result in considerable changes in the analysis.

$$D_i = \frac{1}{p'} * r_i^2 * \left(\frac{h_{ii}}{1 - h_{ii}}\right)$$

where p' is the number of predictors including the intercept term, r_i^2 is the i^{th} studentized residual squared, and h_{ii} is the leverage of the i^{th} observation.

Externally studentized residuals (t_i) measure the influence of the i^{th} case by estimating the mean shift in the predicted values when it is deleted from the model. Weisberg describes the procedure as eliminating the case in question, fit a new regression line, and check to see if the removed point can be acceptably explained by the new regression line. It is called an externally studentized residual because case i is not included in the analysis. Large externally studentized residuals indicate that the i^{th} case exerts a lot of influence over the regression. Externally studentized residuals are used in an outlier test which will be discussed in the following section.

$$t_i = \frac{\hat{e}_i}{\hat{\sigma}_{(i)}\sqrt{(1-h_{ii})}}$$

where $\hat{e}_i$ is the estimated residual for the i^{th} observation, $\hat{\sigma}_{(i)}$ is the estimated standard error of regression when the i^{th} case is removed from the model, and h_{ii} is the leverage associated with the i^{th} observation.

The <u>outlier test</u> utilizes the externally studentized residuals to detect observations that may be outliers. The outlier test, taken from Weisberg, proceeds as follows.

1. Delete the i^{th} case from the data. The remaining n-1 cases will be used to fit a linear model.
2. Using the reduced data set, estimate the coefficients and standard error of the regression.
3. Using the estimated coefficients from reduced data, compute a predicted value $\tilde{y}_i$ for the deleted case. Because the i_{th} case was not used in the estimation, y_i and $\tilde{y}_i$ are independent.
4. The outlier test tests whether an observation is compatible with the rest of the data. If y_i is not an outlier, the expected value of y_i minus $\tilde{y}_i$ will be equal to zero. If errors are normally distributed, then this t-test will be distributed as Student's t with n-p'-1 degrees of freedom. Critical values for the outlier test can be found (Table E, pages 302-303, Weisberg).

<u>Response Variable Transformation</u>. The residual analysis may uncover problems such as nonconstant variance and nonlinearity. Problems exposed with the model may be corrected by transforming the response variable. Transforming the response can correct violations of linearity and constant variance. The Atkinson Score Test is a procedure for choosing an appropriate transformation.

The Atkinson score test provides a means in which to test the fit of the multiple linear regression model to the data. It also provides an estimate of transformation for the response variable which can correct nonconstant variance or nonlinearity. The score variable (LSCORE) is linear and the estimate of its coefficient (γ) provides a test for transformation. If γ is insignificant then the linear model is appropriate and no transformation is necessary. If γ is significant then the appropriate transformation is $1 - \gamma$. The Atkinson score test variable is calculated as,

LSCORE (Y) = -Y*(1 - ln(Y/G)) - 1 + G

where Y is the variable that is being transformed into the lscore variable, and G is the geometric mean of Y.

Verification of Regression Model

The regression model found using the 1985 SWFBMA data is verified by using 1986 and 1987 SWFBMA data. The verification of the 1985 regression model is computed in two ways. Both techniques are described and performed for completeness.

The first technique utilizes approximately 40 of the original predictor variables used in the 1985 SWFBMA regression analysis. The first technique is described as follows.

1. 'Stack' all the 1985, 1986, and 1987 observations on top of each other to form cross sectional data. There are 539 total observations in the total 'stacked' regression. The first 179 observations are from 1985 data, the next 182 observations are from 1986 data, and the last 178 observations are from the 1987 data.

2. Set up two dummy variables. A dummy variable testing the strength of linear effects in the response variable is setup with a '-1' for 1985 data, a '0' for 1986 data, and a '1' for 1987 data. A dummy variable testing the strength of quadratic effects in the response variable, which is the ending return on assets (EROA) is setup with a '1' for 1985 data, a '-2' for 1986 data, and a '1' for 1987 data.

3. To test the linear drift in the coefficients, the 'stacked' matrix of variables is multiplied by the linear effects dummy variable. Therefore, all 1985 data have the opposite sign that they have originally, all 1986 data are zeros, and all 1987 are the same as they were originally.

4. To test the quadratic drift in the coefficients, the 'stacked' matrix of variables is multiplied by the quadratic effects dummy variable. All 1986 data is now a negative two times the original data. And all 1985 and 1987 data are as they were originally.

5. Regress the response variable on the 'stacked' set of observations plus the linear and quadratic effects dummy variables. The coefficients obtained here are the pooled coefficients throughout the three year period. Retain the residuals from this regression.

6. Regress the residuals obtained in step (5) on the linear drift components for each year, and find the general F-test for these variables. If the F-test is not significant, then there is not a linear drift associated with the coefficients.

7. Regress the residuals obtained in step (5) on the quadratic drift variables for each year, and find the general F-test for this group of variables. If the F-test is not significant, then there is not a quadratic drift associated the regression coefficients over the three year period.

The <u>second technique</u> for verifying the 1985 regression model is described by combining the previous seven steps into one regression model by limiting the number of variables in the model to eleven. The verification technique can be represented by the following system of equations.

RESPONSE	PRED	LINEAR EFFECT	QUAD. EFFECT	LINEAR DRIFT IN β	QUAD. DRIFT IN β
y_{85}	x_{85}	-1	1	$-1*(x_{85})$	$1*(x_{85})$
y_{86}	x_{86}	0	-2	$0*(x_{86})$	$-2*(x_{86})$
y_{87}	x_{87}	1	1	$1*(x_{87})$	$1*(x_{87})$

The previous system of equations can be described in one equation. An observation in the verification regression model is thus described as,

$$Y = X\beta + A_L\delta_L + A_Q\delta_Q + (A_LX)\gamma_L + (A_QX)\gamma_Q$$

where Y is the response variable, X are the predictor variables, A_L and A_Q represent the dummy variables testing linear and quadratic effects, respectively, and γ_L and γ_Q represent the coefficients for testing linear and quadratic drift in the β's.

A t-test of A_L and A_Q is used to determine the significance of the linear and quadratic effect, respectively, in the response variable. A partial F-test is computed to determine the usefulness of γ_L and γ_Q, the linear and quadratic drift components of the variables. Again, if the partial F-tests are not significant, then the null hypothesis associated with that component or group of variables is accepted.

RESULTS AND DISCUSSION

The original 1985 data set had 180 observations. After observing the data, a case was found to have a negative value of farm production. This appears to be an error because the farm shows an $80,000 decrease in inventory of feed and grain which is not reflected in its income. Value of farm production is an important variable in the regression analysis because it is used in several variables such as the gross ratio, capital turnover variable, and labor efficiency to name a few. Because the value of farm production is an important variable, this case was removed from all regression models.

1985 Linear Regression Model

The full linear regression model using 179 cases from the 1985 Southwestern Minnesota Farm Business Management Association (SWFBMA) is listed in Appendix B. Using the model selection procedures in the previous section, the full model is condensed to one with 7 variables (Table 2).

Table 2. Linear Ordinary Least Squares Estimates for the Original 1985 SWFBMA Data.

Dependent Variable..........	EROA
Number of Observations......	179.
Mean of Dependent Variable..	.11442
Std. Dev. of Dep. Variable..	.15899
Std. Error of Regression....	.13408
Sum of Squared Residuals....	3.0740
R - Squared................	.31682
Adjusted R - Squared........	.28885
Mallow's Cp Statistic.......	-12.81137
F-Statistic (7, 171).....	11.32856
Significance of F-Test......	.00000

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	.572904	.1682	3.405	(.00097)
ACRE	.909208E-04	.3272E-04	2.779	(.00605)
BFPRRAT	-.682745	.1614	-4.231	(.00007)
VALPTA	.375112	.8742E-01	4.291	(.00006)
BASTRC	.201873	.7120E-01	2.835	(.00517)
BDTA	.104696	.2783E-01	3.762	(.00032)
GROSRAT	-.124298	.2708E-01	-4.590	(.00002)
YEARS	.218016E-02	.9294E-03	2.346	(.01916)
Sigma	.134077	.7086E-02	18.921	(.00000)

Problems are evident in the model because two of the variables have signs that are opposite of their expected signs in the conceptual model. All price ratio variables were expected to have positive signs in the conceptual model, however, the beef price ratio (BFPRRAT) variable was observed to be negative. In the conceptual model, BDTA was expected to have a negative sign, but is observed to be positive in the regression analysis.

Due to the apparent problems of the selected model, a test of the assumptions of multiple linear regression is necessary. Using a residual plot and residual analysis, two outliers are identified and examined. Transforming the response variable as indicated by the Atkinson score tests did not improve the signs or the outliers. Case diagnostics also show these two cases to be different from the rest. Thus, both cases are deleted from the analysis leaving 177 observations. Further details of this process can be found in Tvedt (1988).

1985 Data Regression Model with Deleted Observations

Using the 1985 SWFBMA data with 177 cases, six variables are significant (Table 3). The beginning debt to asset ratio (BDTA) is among these six, and was again observed to have a sign that was different than expected in the conceptual model. It is clear that BDTA is correlated with profitability. However, correlation is not causation. It may be that there are other factors relating these two variables that may explain this unexpected association. It may be that creditors and bankers are more willing to lend money to farmers who have a high return on assets, thus, positively associating debt to assets and return on investment. Also, in 1985, some farmers were not paying interest costs so net farm income was artificially raised for these farms and debt levels were not changed.

Table 3. Selected Linear Regression Model for 1985 SWFBMA Data.

Dependent Variable..........	EROA
Number of Observations......	177.
Mean of Dependent Variable..	.11412
Std. Dev. of Dep. Variable..	.09800
Std. Error of Regression....	.07301
Sum of Squared Residuals....	.90627
R - Squared.................	.46388
Adjusted R - Squared........	.44496
Mallow's Cp Statistic.......	-7.23155
F-Statistic (6, 170).......	24.51554
Significance of F-Test......	.00000

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	-.316735	.8857E-01	-3.576	(.00057)
ACRE	.446653E-04	.1778E-04	2.512	(.01246)
CYLDRAT	.192676	.4934E-01	3.905	(.00020)
VALPTA	.371598	.4607E-01	8.066	(.00000)
BDTA	.459227E-01	.1343E-01	3.420	(.00093)
GROSRAT	-.791548E-01	.1402E-01	-5.646	(.00000)
CNPRRAT	.148335	.7931E-01	1.870	(.05991)
Sigma	.730135E-01	.3881E-02	18.815	(.00000)

The corn price ratio (CNPRRAT) is included, even with a t-ratio greater than five percent, because Mallow's Cp statistic is -6.03 without it, and the adjusted R-squared was also lower at .43685 (Table 4). Also, a Type I error, which is accepting a variable when it should have been rejected, is not as serious for this variable as it is for others.

Table 4. Linear Regression Model for 1985 SWFBMA Data without CNPRRAT Variable.

Dependent Variable..........	EROA
Number of Observations......	177.
Mean of Dependent Variable..	.11412
Std. Dev. of Dep. Variable..	.09800
Std. Error of Regression....	.07354
Sum of Squared Residuals....	.92491
R - Squared.................	.45285
Adjusted R - Squared........	.43685
Mallow's Cp Statistic.......	-6.03
F-Statistic (5, 171).......	28.30560
Significance of F-Test......	.00000

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	-.181562	.5157E-01	-3.521	(.00068)
ACRE	.450522E-04	.1791E-04	2.516	(.01234)
CYLDRAT	.204503	.4929E-01	4.149	(.00009)
VALPTA	.373536	.4639E-01	8.051	(.00000)
BDTA	.448314E-01	.1351E-01	3.318	(.00127)
GROSRAT	-.777366E-01	.1410E-01	-5.513	(.00000)
Sigma	.735449E-01	.3909E-02	18.815	(.00000)

In reviewing the model selected (Table 3), there are variables representing size (ACRE), technical production efficiency (CYLDRAT), asset turnover (VALPTA), solvency (BDTA), financial efficiency (GROSRAT), and marketing efficiency (CNPRRAT). A variable that is missing is liquidity even though there are liquidity measures in the initial list of predictor variables (Table 1). To check that the absence of liquidity is correct, the beginning current ratio (BCURRAT) is added to the model in Table 3. The results show that the beginning current ratio has an insignificant coefficient, but the adjusted R-squared values are very similar (Table 5). The model in Table 3 is selected as the most appropriate linear regression model for the 1985 SWFBMA data due to the insignificance of the current ratio in Table 5.

Table 5. Linear Regression Model for 1985 SWFBMA Data with the CNPRRAT and BCURRAT Variables.

Dependent Variable..........	EROA
Number of Observations......	177.
Mean of Dependent Variable..	.11412
Std. Dev. of Dep. Variable..	.09800
Std. Error of Regression....	.07304
Sum of Squared Residuals....	.90163
R - Squared.................	.46663
Adjusted R - Squared........	.44453
F-Statistic (7, 169).......	21.12148
Significance of F-Test......	.00000

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	-.317822	.8861E-01	-3.587	(.00055)
ACRE	.426907E-04	.1791E-04	2.383	(.01742)
CYLDRAT	.189611	.4946E-01	3.833	(.00025)
VALPTA	.374167	.4617E-01	8.104	(.00000)
BDTA	.480894E-01	.1363E-01	3.528	(.00067)
GROSRAT	-.797513E-01	.1404E-01	-5.681	(.00000)
CNPRRAT	.150221	.7937E-01	1.893	(.05697)
BCURRAT	.313702E-07	.3364E-07	.933	(.35518)
Sigma	.730415E-01	.3882E-02	18.815	(.00000)

To assure that the assumptions of multiple linear regression are not violated, a residual plot, residual analysis, and the Atkinson score test are analyzed for the selected model (Table 3). These analyses show two possible outliers and since the Atkinson score test variable is not significant, no transformation of the response variable is necessary. The basic assumptions of multiple linear regression appear to be satisfied, except for the influence of these two cases. Statistically speaking, both cases should be removed from the data. However, case diagnostics does not provide economic justification for deleting these observations; thus, they are not deleted. Therefore, after testing, the model presented in Table 3 is still the selected linear regression model for the 1985 SWFBMA data.

1985 Quadratic Regression Model with Deleted Observations

The selected linear regression model (Table 3) can cause some interpretation problems because it is a linear model. For example, in a pure mathematical sense, the linear model says that one can continue to increase acreage and always increase the rate of return on assets since the estimated coefficient is positive. This leads to an obviously incorrect conclusion that by farming more acres, profitability will increase.

To avoid these misinterpretations, the model is respecified to include the quadratic terms for those variables in the selected linear model plus the liquidity measure (BCURRAT). However, regressions containing polynomials usually have problems with collinearity. Thus, adding a quadratic term often makes the associated linear term insignificant. A partial F-test of the squared terms is the only reliable check of their importance.

When this model is estimated (Table 6), the F-statistic for the quadratic terms is significant (Table 7). However, several coefficients are insignificant at the five percent level: the corn price ratio (CNPRRAT) and its quadratic term, and the beginning debt-to-asset ratio (BDTA) and its quadratic term, the beginning current ratio (BCURRAT) and its quadratic term, and the quadratic term of the capital turnover rate (VALPTA). The importance of the above variables are tested with a partial F-test, which was found to be insignificant (Table 8). Thus, the above variables failed to add explanatory power to the regression and are deleted in the selected quadratic model.

Table 6. Quadratic Regression Model with Insignificant Variables for 1985 SWFBMA Data.

Dependent Variable..........	EROA
Number of Observations......	177.
Mean of Dependent Variable..	.11412
Std. Dev. of Dep. Variable..	.09800
Std. Error of Regression....	.06491
Sum of Squared Residuals....	.68260
R - Squared.................	.59619
Adjusted R - Squared........	.56130
F-Statistic (14, 162).......	17.08454

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	-.970794	.3761	-2.581	(.01040)
ACRE	.282335E-03	.5503E-04	5.130	(.00000)
CYLDRAT	1.55372	.4915	3.161	(.00204)
VALPTA	.289396	.1043	2.776	(.00614)
BDTA	.431888E-01	.4701E-01	.919	(.36279)
GROSRAT	-.228030	.4615E-01	-4.941	(.00001)
CNPRRAT	.295633	.5979	.494	(.62736)
BCURRAT	.103457E-06	.7769E-07	1.332	(.18139)
ACRES2	-.137900E-06	.3105E-07	-4.441	(.00003)
CYLDRAT2	-.734300	.2538	-2.893	(.00442)
VALPTA2	.142543	.9967E-01	1.430	(.15056)
BDTA2	.513570E-02	.2883E-01	.178	(.83618)
GROSRAT2	.542121E-01	.1500E-01	3.615	(.00051)
CNPRRAT2	-.974623E-01	.3109	-.313	(.74919)
BCURRAT2	-.722495E-13	.8790E-13	-.822	(.41744)
Sigma	.649121E-01	.3450E-02	18.815	(.00000)

Table 7. ANOVA table testing the quadratic terms in Table 6.

Source	df	SS	MS	F-Test	Sig.Lvl
linear terms	7	.7888	.1127	26.74	(.000)
quadratic terms	7	.2190	.0313	7.43	(.000)
all variables	14	1.0078	.0720	17.08	(.000)
RESIDUAL	162	.6826	.0042		
TOTAL	176	1.6904			

Table 8. ANOVA table testing overall importance of the insignificant variables in Table 6.

Source	df	SS	MS	F-Test	Sig.Lvl
selected variables	8	.9752	.1219	28.93	(.000)
insig. variables	6	.0326	.0054	1.29	(.264)
all variables	14	1.0078	.0720	17.08	(.000)
RESIDUAL	162	.6826	.0042		
TOTAL	176	1.6904			

For the selected quadratic regression model (Table 9), the seven insignificant variables listed are deleted except for the beginning debt-to-asset ratio (BDTA) which is kept since it is important in the linear model. The F-statistic for the quadratic terms in the selected model is also significant (Table 10). Even though the selected quadratic model has an adjusted R-squared (.557) lower than the initial quadratic model (.561), the initial quadratic model is rejected because of the number of insignificant coefficients and the partial F-tests showing the lack of importance of those variables.

The analysis of the residual plots of the selected quadratic regression show that the regression assumptions are not violated. Case diagnostics point to one potential outlier which was also observed in the linear model as an outlier. This case was discussed, but retained for the linear model (Tvedt, 1988) and so is retained for the quadratic model for the same reasons.

Table 9. Selected Quadratic Regression Model for 1985 SWFBMA Data.

Dependent Variable..........	EROA
Number of Observations......	177.
Mean of Dependent Variable..	.11412
Std. Dev. of Dep. Variable..	.09800
Std. Error of Regression....	.06525
Sum of Squared Residuals....	.71523
R - Squared.................	.57689
Adjusted R - Squared........	.55674
F-Statistic (8, 168).......	28.63265
Significance of F-test......	.00000

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	-.750930	.2324	-3.231	(.00165)
ACRE	.288329E-03	.5358E-04	5.381	(.00000)
CYLDRAT	1.46893	.4786	3.069	(.00266)
VALPTA	.407916	.4209E-01	9.693	(.00000)
BDTA	.448798E-01	.1261E-01	3.559	(.00061)
GROSRAT	-.233702	.4346E-01	-5.378	(.00000)
ACRES2	-.141062E-06	.3057E-07	-4.614	(.00002)
CYLDRAT2	-.685210	.2470	-2.774	(.00614)
GROSRAT2	.558151E-01	.1452E-01	3.843	(.00025)
Sigma	.652481E-01	.3468E-02	18.815	(.00000)

All of the quadratic terms have the appropriate signs to counteract the signs of the linear coefficients. For example, farms with larger acreages or higher corn yield ratios will have higher rates of return on assets but the negative quadratic terms will show that increasing acreage and yields will not increase rates of returns proportaionately. Similarly, lower gross ratio levels (i.e., better levels) are correlated with higher rates of return on assets but the quadratic term shows that overemphasis on a low gross ratio may be detrimental to the rate of return.

Table 10. ANOVA table testing quadratic terms in the selected quadratic model (Table 9).

Source	df	SS	MS	F-Test	Sig.Lvl
linear terms	5	.7655	.1531	35.96	(.000)
quadratic terms	3	.2096	.0693	16.41	(.000)
all variables	8	.9751	.1218	28.63	(.000)
RESIDUAL	168	.7152	.0042		
TOTAL	176	1.6904		25.96	

Verification of Regression Models

The two verification techniques described in the statistical methods and tests section are used to verify the selected models for the 1985 data (Tables 3 and 9) by using data from 1986 and 1987. The first technique is called the large model verification since it includes all variables; it utilizes residuals for linear and quadratic drift effects. The second technique is called the small model verification since it includes a subset of all variables; it incorporates the linear and quadratic drift effects into the model directly. Both techniques initially include all cases (179 cases in 1985), even those which were excluded in the final 1985 model. With both techniques, residual plots, residual analysis, and case diagnostics are used to determine whether the model and the data satisfy the needed assumptions. The response variable was transformed and cases deleted as needed to correct for any problems detected. The details of this process for the linear model can be found in Tvedt (1988).

In the large model verification of the linear model, three outliers are deleted with economic justification leaving 536 observations. The Atkinson score test shows the LSCORE variable to be significant with a coefficient of 2.41692. Thus, the response variable (EROA) is transformed by raising it to the power of -1.41692 (1 - 2.41692). The verification of the 1985 linear regression model is reestimated with three observations removed and with a transformed response variable (Table 11).

A residual plot and case diagnostics show that the transformation of the response variable and deletion of three cases have corrected possible violations of the necessary assumptions. Potential outliers were retained due to lack of economic justification for deletion.

Because the transformation raises the response variable to a negative power, the effects of the variables are inverted. Therefore, a negative coefficient represents a positive impact on profitability and vice versa. The dummy variable representing linear effects in the response variable (LINEFF) is significant and the quadratic effect is not. Also, impacts on EROA have to be interpreted through the transformation.

The next step in the large model verification technique is to use the residuals from the previous regression (Table 11) to test the hypothesis of a linear drift in the coefficients (Table 12). Since the crucial result is whether the F-test is significant, the variables and coefficients are omitted. Because the F-statistic is not significant, we can accept the hypothesis that there is no linear drift in the coefficients from 1985 to 1987.

Table 11. Transformed verification of the linear regression Model with 536 observations.

Dependent Variable..........	TRANEROA
Number of Observations......	536.
Std. Error of Regression....	.08123
Sum of Squared Residuals....	3.2863
R - Squared.................	.58474
Adjusted R - Squared........	.55389
F-Statistic (37, 498).....	18.95304

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	1.15589	.1372	8.428	(.00000)
LINEFF	-.288737E-01	.5390E-02	-5.357	(.00000)
QUADEFF	.317544E-02	.2543E-02	1.249	(.20965)
VALPROD	-.469054E-07	.8743E-07	-.536	(.59865)
ACRE	-.300448E-04	.1892E-04	-1.588	(.10867)
PRODEFF	-.579454E-02	.2259E-01	-.257	(.78633)
BFFEEDRT	-.243456E-01	.3001E-01	-.811	(.42291)
FFFEEDRT	-.101416	.5688E-01	-1.783	(.07149)
HFFEEDRT	-.877633E-01	.7070E-01	-1.241	(.21237)
DYYLDRT	.960308E-01	.7489E-01	1.282	(.19724)
CYLDRAT	-.156182	.4073E-01	-3.834	(.00021)
SYLDRAT	-.217406E-02	.3587E-01	-.061	(.90704)
LABREFF	.530665E-07	.9469E-07	.560	(.58258)
INVTURNO	.205499E-01	.1155E-01	1.779	(.07211)
MARKEFF	.152739E-01	.2681E-01	.570	(.57639)
CNPRRAT	.138767E-01	.3196E-01	.434	(.66786)
GOVT	-.100108E-01	.1996E-01	-.502	(.62218)
BFDUMM	-.276551E-01	.1090E-01	-2.537	(.01113)
FFDUMM	.568575E-02	.9513E-02	.598	(.55779)
HFDUMM	-.143802E-01	.1083E-01	-1.327	(.18147)
DARYDUMM	-.482722E-02	.1279E-01	-.377	(.70626)
CNDUMM	.132260E-01	.3455E-01	.383	(.70258)
SBDUMM	-.163292E-01	.2826E-01	-.578	(.57104)
VALPTA	-.275651	.3543E-01	-7.779	(.00000)
BCURRAT	-.794863E-07	.4033E-07	-1.971	(.04655)
BASTRC	-.407001E-01	.2803E-01	-1.452	(.14298)
BCASHPO	.230989E-01	.1922E-01	1.202	(.22783)
BDTA	-.309613E-01	.9192E-02	-3.368	(.00097)
DEBTMPCT	-.193400E-05	.4825E-05	-.401	(.69040)
INTG	-.187724E-01	.6074E-01	-.309	(.75192)
GROSRAT	.108442	.1248E-01	8.691	(.00000)
BFINLEV	-.101775E-03	.6096E-04	-1.670	(.09151)
YEARS	.100261E-03	.3930E-03	.255	(.78724)
PARTNER	-.282987E-02	.2044E-01	-.138	(.86046)
CORP	.225904E-01	.3108E-01	.727	(.47448)
CSRENTDM	-.313683E-01	.9771E-02	-3.210	(.00159)
SHRENTDM	-.130334E-01	.8102E-02	-1.609	(.10406)
DFORDUMM	-.228800E-01	.1190E-01	-1.923	(.05206)

Table 12. Test of the hypothesis of a linear drift in the coefficients with 536 observations and a transformed response variable.

Dependent Variable..........	RESID
Number of Observations......	536.
Mean of Dependent Variable..	.00000
Std. Dev. of Dep. Variable..	.09065
Std. Error of Regression....	.09164
Sum of Squared Residuals....	4.1992
R - Squared.................	.04485
Adjusted R - Squared........	-.02201
F-Statistic (35, 500).....	.67084
Significance of F-Test......	.92654

The third step in large model verification is to use the residuals from the regression in Table 11 to test the hypothesis of a quadratic drift in the coefficients. Again the variables and coefficients are omitted since the F-test is the significant test (Table 13). The results show that the F-statistic testing a quadratic drift in the coefficients is not significant so we can accept the hypothesis that there is no quadratic drift in the coefficients spanning the three year period from 1985 to 1987.

Table 13. Test of the hypothesis of a quad. drift in the coefficients with 536 observations and a transformed response variable.

Dependent Variable..........	RESID
Number of Observations......	536.
Mean of Dependent Variable..	.00000
Std. Dev. of Dep. Variable..	.09065
Std. Error of Regression....	.09103
Sum of Squared Residuals....	4.1436
R - Squared.................	.05750
Adjusted R - Squared........	-.00848
F-Statistic (35, 500).....	.87154
Significance of F-Test......	.68189

The results of the large model verification analysis support the conclusion that there is a linear effect in response variable, but no quadratic effect. That is, that the intercept variable has increased in a linear fashion each year. This may be a result of a general improvement in the overall macroeconomic environment for farming. The verification results also support the hypothesis that there is neither a linear nor quadratic drift in the coefficients. That is, that the overall value for the coefficients neither rose nor fell in a linear or quadratic fashion over the three year period. These conclusions indicate that the 1986 and 1987 SWFBMA regression results are likely to be parallel to the 1985 SWFBMA regression result, with 1986 having a higher intercept than 1985, and 1987 having a higher intercept than 1986.

Four of the six variables found significant in the selected 1985 SWFBMA linear regression model are significant in the verification results. Those four variables are the corn yield ratio (CYLDRAT), asset turnover (VALPTA), the beginning debt to asset ratio (BDTA), and the gross ratio (GROSRAT).

Verification results do not support the predictive usefulness of the number of acres farmed (ACRE) and especially, the corn price ratio (CNPRRAT). The verification results also suggest that the dummy variables for cash rent (CSRENTDM) and beef finishing (BFDUMM); the beginning current ratio (BCURRAT); and possibly the dummy variable for debt forgiven (DFORDUM) should be included in a predictive model.

A smaller set of predictor variables is used to develop the <u>small model verification of the linear regression model</u>. An analysis of variance table is used to determine the significance of various groups of variables, such as the linear drift in the coefficients. As in the large verification model, the assumptions of multiple linear regression will be verified along with tests and possible implementation of a transformation of the response variable.

Due to algorithm constraints, a maximum of eleven variables are used in the small verification model. This maximum of eleven variables includes the six variables that were found significant in the 1985 regression analysis: the number of acres farmed (ACRE), the corn yield ratio (CYLDRAT), asset turnover (VALPTA), beginning debt to asset (BDTA), the gross ratio (GROSRAT), and the corn price ratio (CNPRRAT). Also included are the three variables that are significant in the large verification model, but are not found to be significant in the 1985 linear analysis: the dummy variable for beef finishing (BFDUMM), the dummy variable for cash rent (CSRENTDM), and the beginning current ratio (BCURRAT). The dummy variables for share rent (SHRENTDM) and for debt forgiven (DFORDUMM) are included also.

The same three cases which are deleted as outliers in the large model verification are also deleted as outliers in the small model verification of the linear model. The response variable is also transformed, after a significant Atkinson score test, by raising it to a power of -1.50592 and reestimating the model (Table 14). Analysis of the residuals and case diagnostics show this model to be acceptable.

Table 14. Results for small model verification of the linear model with a transformed response variable.

Dependent Variable..........	TRANEROA
Number of Observations......	536.
Std. Error of Regression....	.08489
Sum of Squared Residuals....	3.6034
R - Squared.................	.58635
Adjusted R - Squared........	.55740
F-Statistic (35, 500).....	20.25017

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	1.11662	.4853E-01	23.011	(.00000)
ACRE	-.408636E-04	.1388E-04	-2.943	(.00354)
CYLDRAT	-.163088	.3386E-01	-4.817	(.00001)
CNPRRAT	-.276731E-01	.3649E-01	-.758	(.45484)
BFDUMM	-.283752E-01	.1067E-01	-2.659	(.00796)
VALPTA	-.360020	.2653E-01	-13.571	(.00000)
BCURRAT	.317148E-04	.4176E-04	.759	(.45419)
BDTA	-.437462E-01	.8732E-02	-5.010	(.00000)
GROSRAT	.118641	.1189E-01	9.981	(.00000)
CSRENTDM	-.409439E-01	.9147E-02	-4.476	(.00002)
SHRENTDM	-.188396E-01	.7931E-02	-2.375	(.01707)
DFORDUMM	-.191800E-01	.1237E-01	-1.551	(.11728)
LINEFF	-.220499	.6345E-01	-3.475	(.00069)
QUADEFF	.736444E-01	.3182E-01	2.314	(.02001)
LACRE	-.165927E-04	.1760E-04	-.943	(.34890)
LCYLDRAT	.833182E-01	.4438E-01	1.877	(.05782)
LCNPRRAT	.128977	.4972E-01	2.594	(.00951)
LBFDUMM	.154601E-01	.1291E-01	1.198	(.22939)
LVALPTA	.247781E-01	.3374E-01	.734	(.46971)
LBCURRAT	-.499828E-06	.1469E-05	-.340	(.73120)
LBDTA	.136210E-01	.1095E-01	1.244	(.21157)
LGROSRAT	-.914500E-02	.1440E-01	-.635	(.53310)
LCRENTDM	-.249579E-01	.1114E-01	-2.241	(.02412)
LSRENTDM	-.975567E-02	.9801E-02	-.995	(.32153)
LDFORDUM	-.670840E-02	.1540E-01	-.436	(.66679)
QACRE	-.122936E-04	.9461E-05	-1.299	(.19113)
QCYLDRAT	-.143148E-01	.2213E-01	-.647	(.52548)
QCNPRRAT	-.428347E-01	.2253E-01	-1.902	(.05470)
QBFDUMM	.927931E-02	.7641E-02	1.214	(.22286)
QVALPTA	-.795028E-02	.1801E-01	-.441	(.66293)
QBCURRAT	-.322490E-04	.4175E-04	-.772	(.44628)
QBDTA	-.423953E-02	.6022E-02	-.704	(.48878)
QGROSRAT	-.126848E-01	.8497E-02	-1.493	(.13183)
QCRENTDM	.379122E-02	.6505E-02	.583	(.56766)
QSRENTDM	.644286E-02	.5557E-02	1.159	(.24529)
QDFORDUM	.141141E-01	.8601E-02	1.641	(.09723)

To test the significance of the F-statistics for linear and quadratic drifts in the coefficients, an ANOVA table is constructed (Table 15).

Table 15. ANOVA table for the small model verification of the linear model with a transformed response.

Source	df	SS	MS	F-Test	Sig.Lvl
original variables	11	4.6756	.4251	58.98	(.000)
linear effect	1	.2027	.2027	28.13	(.000)
quadratic effect	1	.0096	.0096	1.33	(.248)
linear drift	11	.1342	.0122	1.69	(.072)
quadratic drift	11	.0857	.0078	1.08	(.375)
all variables	35	5.1078	.1459	20.25	(.000)
RESIDUAL	500	3.6034	.0072		
TOTAL	535	8.7112			

The results of the small model verification analysis confirm some of the findings of the large model verification analysis. There is evidence to support a linear effect in the response variable, meaning that the coefficient for the intercept variable rose each year in a linear fashion. Unlike the large verification model, the test for a quadratic effect in the response variable is significant suggesting that the coefficient for the intercept variable changed in a quadratic fashion over the three-year period. Although the F-statistic for a linear drift in the coefficients was significant at the 10 percent level (Table 15), the results do not support either a linear or a quadratic drift in the coefficients at the five percent level. However, the results of the small verification model suggest that the coefficients for the corn price ratio and the cash rent dummy variable change in a linear fashion over the three-year period. Overall, the small verification results suggest that the 1986 and 1987 regressions would have parallel regression lines. It also suggests that the 1985 regression analysis is fairly representative of the three year period.

The results of the small model verification regression further support the conclusion that a Type I error was made in the 1985 regression analysis when the corn price ratio (CNPRRAT) variable was included. The cash rent dummy variable (CSRENTDM) and the share rent dummy variable (SHRENTDM) were significant in the small model verification regression which suggest the possibility of a Type II error in the 1985 regression analysis. There also is the possibility of Type II error in the 1985 analysis for the dummy variable for beef finishing (BFDUMM) and possibly for the dummy variable for debt forgiven (DFORDUMM).

The small model verification of the linear model results disagree with some of the large model verification results. The small model results show that the size of farm, measured by ACRE, is significant while it is not in the large model results. The beginning current ratio (BCURRAT) is not significant in the small model while it is in the large model. Also, the dummy variable for share rent (SHRENTDM) is significant in the small model and is not in the large model.

The small model verification of the quadratic model follows the same procedures as for the linear model. Again due to the algorithm constraint, a maximum of eleven variables are used. These eleven are: the number of acres farmed (ACRE); the corn yield ratio (CYLDRAT); the asset turnover rate (VALPTA); the beginning debt-to-asset ratio (BDTA); the gross ratio (GROSRAT); the dummy variables for beef finishing (BFDUMM), cash renting land (CSRENTDM), and share renting land (SHRENTDM);

and the quadratic terms for ACRE, CYLDRAT, and GROSRAT. These eleven variables are selected because they were significant in the selected quadratic model for 1985 data or were important in the verification of the linear model. The Atkinson score test was significant so the response variable was transformed by raising it by -1.63867 and reestimating the model. The resulting coefficients have to be interpreted in the light of this transformation.

The results of the small model verification of the selected quadratic model show that there are potential model selection errors. As with previous results, the results show that the response variable has changed in a positive, linear movement, but not a quadratic fashion (Table 16). Unlike the previous verification results, there is evidence to support a linear drift in the coefficients (Table 17). The variables that have coefficients that change in a linear fashion are the linear and quadratic terms for the corn yield ratio and the cash rent variable. The results support the predictive usefulness of all the variables in the small model verification of the quadratic model. However, the results do suggest that the dummy variables for cash renting land (CSRENTDM) and beef finishing (BFDUMM) have predictive power not captured in the original model specification.

Table 16. Results for small model verification of the quadratic model with a transformed response variable.

Dependent Variable..........	TRANEROA
Number of Observations......	536.
Mean of Dependent Variable..	.78308
Std. Dev. of Dep. Variable..	.13627
Std. Error of Regression....	.08397
Sum of Squared Residuals....	3.5256
R - Squared.................	.64512
Adjusted R - Squared........	.62028
F-Statistic (35, 500)......	25.96940
Significance of F-test.......	.00000

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	1.55450	.1909	8.145	(.00000)
ACRE	-.278751E-03	.4517E-04	-6.171	(.00000)
CYLDRAT	-1.24782	.3879	-3.217	(.00156)
VALPTA	-.417355	.2680E-01	-15.571	(.00000)
BDTA	-.496220E-01	.8384E-02	-5.919	(.00000)
GROSRAT	.319881	.3960E-01	8.077	(.00000)
BFDUMM	-.272981E-01	.1069E-01	-2.553	(.01064)
CSRENTDM	-.361010E-01	.9266E-02	-3.896	(.00017)
SHRENTDM	-.143895E-01	.7912E-02	-1.819	(.06604)
ACRE2	.140677E-06	.2857E-07	4.923	(.00000)
CYLDRAT2	.580222	.1961	2.959	(.00337)
GROSRAT2	-.762623E-01	.1418E-01	-5.379	(.00000)
LINEFF	-.830012	.2703	-3.071	(.00242)
QUADEFF	.198997	.1099	1.811	(.06724)
LACRE	.523313E-04	.6021E-04	.869	(.38936)
LCYLDRAT	1.62973	.5485	2.971	(.00326)
LVALPTA	.417137E-01	.3402E-01	1.226	(.21823)
LBDTA	.112531E-01	.1027E-01	1.096	(.27314)
LGROSRAT	-.412308E-01	.4713E-01	-.875	(.38615)
LBFDUMM	.153962E-01	.1289E-01	1.194	(.23100)
LCRENTDM	-.317038E-01	.1126E-01	-2.817	(.00510)
LSRENTDM	-.713011E-02	.9788E-02	-.728	(.47342)
LACRE2	-.224238E-07	.3941E-07	-.569	(.57683)
LCYLDRAT2	-.804434	.2761	-2.913	(.00386)
LGRSRAT2	.113955E-01	.1622E-01	.702	(.48976)
QACRE	-.393571E-04	.2885E-04	-1.364	(.16931)
QCYLDRAT	-.334163	.2240	-1.492	(.13214)
QVALPTA	-.468933E-02	.1824E-01	-.257	(.78595)
QBDTA	.128319E-03	.5929E-02	.022	(.93126)
QGROSRAT	-.348472E-01	.2877E-01	-1.211	(.22415)
QBFDUMM	.515914E-02	.7674E-02	.672	(.50906)
QCRENTDM	.504195E-02	.6604E-02	.763	(.45179)
QSRENTDM	.616385E-02	.5538E-02	1.113	(.26545)
QACRE2	.225397E-07	.1729E-07	1.304	(.18961)
QCYLDRT2	.162381	.1142	1.422	(.15145)
QGRSRAT2	.116973E-01	.1064E-01	1.099	(.27170)
Sigma	.839710E-01	.2565E-02	32.741	(.00000)

Table 17. ANOVA table for the small model verification of the quadratic model with a transformed response variable.

Source	df	SS	MS	F-Test	Sig.Lvl
original variables	11	5.9829	.5439	77.14	(.000)
linear effect	1	.1134	.1134	16.08	(.000)
quadratic effect	1	.0314	.0314	4.45	(.036)
linear drift	11	.2260	.0205	2.91	(.001)
quadratic drift	11	.0552	.0050	.71	(.739)
all variables	35	6.4089	.1831	25.97	(.000)
RESIDUAL	500	3.5256	.0071		
TOTAL	535	9.9345			

SUMMARY AND CONCLUSIONS

This paper has attempted to identify factors that are critical for success. While success can be defined as many things, this study used the rate of return on assets. Potentially important variables, which were related to return on assets, are determined and discussed using a conceptual model.

This group of potential variables are statistically analyzed to determine which ones are correlated with a high return on assets and thus critical to farmers. Data from the Southwestern Minnesota Farm Business Management Association for 1985 were used for the initial analysis. Data for 1986 and 1987 were used to verify the results with the 1985 data.

There were seven variables found to be significantly related to the rate of return on assets (Table 18). The number of acres farmed, corn yield ratio, asset turnover rate, beginning debt to asset ratio, and dummy variables for cash rent and for beef finishing have a positive correlation. The gross ratio has a negative correlation. Also, the number of acres farmed and the corn yield ratio have a significant, negative quadratic effect on the rate of return on assets and the gross ratio has a significant, positive quadratic effect.

The signs on these relationships are as expected except for the beginning debt-to-asset ratio. The debt-to-asset ratio is expected to have a negative effect but had a significant, positive effect in all model specifications. This deviation from expected results may be due to two reasons. First, rather than only avoiding farmers with high debt loads, creditors may allow farmers with high rates of return to borrow more and thus raise their debt ratios. Second, a few farmers with high debt loads were not paying interest costs and thus raising their net incomes.

Table 18. Summary of Variables Significantly Correlated with the Rate of Return on Assets.

Variable	Measure of:	Estimated EROA* Relationship
ACRE : number of acres farmed	farm size	+
ACRE squared		-
CYLDRAT: corn yield ratio	production eff.	+
CYLDRAT squared		-
VALPTA : asset turnover	asset use eff.	+
BDTA: beg. debt-to-asset ratio	solvency	+
GROSRAT: gross ratio (TE/VP)**	financial eff.	-
GROSRAT squared		+
BFDUMM: beef feeding indicator	enterprise select.	+
CSRENTDM: cash rent indicator	rent vs. own	+

* EROA = ending rate of return on assets
**TE/VP = total cash expenses divided by value of production

One measure which is missing from the above list is liquidity. In this study, the beginning current ratio was used as the liquidity measure. This was significant in only the large model verification of the linear model. Liquidity's overall lack of significance may be due to its true lack of significance, the reliance on borrowed operating capital instead of equity capital, or the possibility that all SWFBMA farmers have sufficient liquidity levels so that it is not significant in explaining differences in this group's rates of return.

What do these results mean for farmers in the Southwestern Minnesota Farm Business Management Association and other farmers? Conclusions that are drawn from the results are important not only to farmers, but also to creditors and policy makers. Before we discuss these conclusions, let us first look at the potential for extrapolating these results to other groups of farmers.

Extrapolation of Results

The results of the statistical analysis are directly applicable to SWFBMA members. The results cannot be directly extrapolated to the general southwestern Minnesota farm population because membership in the SWFBMA is voluntary and not a random sample. Olson and Tvedt show that in 1982, SWFBMA farmers were larger than the average census farmers and more likely to have livestock; thus, these critical success factors also may be useful to other larger, crop/livestock farms which are not members of the SWFBMA.

Interpretations for Farmers

The regression results indicate that farmers with low percentages of total expenses to the value of production (GROSRAT) are observed to have higher profitability. This stresses the need for good cost control management; however, the significant quadratic term also shows that too much cost control can be detrimental to profitability.

Farmers with high ratios of asset turnover (VALPTA) are observed to have higher profitability. This result stresses the need for farmers to utilize their resources efficiently and productively. It is important for farmers to recognize how much an asset will contribute to the value of production in relation to its cost or value.

Technical efficiency in terms of production is found to be important. Farmers who have corn yields that are higher than their county's average corn yield are observed to have higher levels of profitability. Corn is a major cash crop, and it is also an important feed for many livestock operations. Corn is an important crop for almost all farmers. Out of 539 farmers during the three year period of 1985 through 1987, 526 grew corn. Since it's virtually a universal crop in the SWFBMA, the corn yield ratio may be a reasonable indicator of profitability and, thus, correlated with return on assets. However, the significance of the quadratic term of the corn yield ratio with a negative impact on profitability, shows that corn yield can be overemphasized to the point of decreasing the return on assets.

Farmers that are interested in expanding their enterprises will be interested to know that farmers with larger acreages farmed are observed to have higher levels of profitability. This result along with the observation that farmers who cash rent land are observed to have higher levels of profitability suggests that a farmer wanting to expand the number of acres farmed should attempt to rent land, rather than buy land. However, larger acreages can reduce the rate of return on assets as the quadratic term on acreage shows.

Farmers with higher profitability are observed to have high beginning debt-to-asset levels. These results may lead to an incorrect conclusion that increasing the debt load and, thus, the debt-to-asset ratio, will cause an increase in profitability. However, correlation is not causation. That is to say that higher profitability farms are only observed to have higher debt-to-asset ratios. It may be that creditors allow higher profitability farms to increase their debt-to-asset ratios more than lower profitability farms. Thus, high profitability may be causing higher debt-to-asset ratios and not the other way around.

Except for beef feeding, specific enterprises did not have significance explaining differences in the rates of return on assets. Beef feeding may reflect favorable years or good management for those farmers. The farmer's age and years of farming were also not significant. The financial leverage ratio (ROE/ROA) and the labor efficiency ratios were not significant either.

Interpretations for Creditors

The results support a conclusion that farmers with a high beginning debt-to-asset ratio are observed to have higher levels of profitability. Again, correlation is not causation. It may be that this variable is positively associated with profitability because creditors may feel more comfortable allowing highly profitable farms to increase their debt to asset ratio above normal levels. This leads to the question of how does the debt-to-asset ratio impact a credit rating system.

It is interesting to note that liquidity variables were not found to be significant in any of the regression models. Debt forgiveness was not found to be significant in explaining differences in rate of return on assets.

Interpretations for Policy Makers

The dummy variable for the receipt of income from government programs was not significant in any of the regressions. This is not to say that government programs do not provide income that is crucial to farmers.

Most of the farmers examined received some income from government programs, in fact 515 farmers out of 539. For those farmers that did receive government income, it comprised an important portion of their income. This variable may have been insignificant because such a large proportion of farmers in the regression received income from government sources, which makes it hard to differentiate these farmers from those who didn't receive government income.

Other results which may affect policy are the positive impacts of improving the farmer's corn yield ratio and gross ratio (i.e., decreasing). Thus, organizations which help farmers improve in these areas (such as Extension, Vocational Agriculture, etc.) may be able to ask for public funding of their programs.

Suggestions for Future Research

Suggestions of further research includes the resolution of whether the SWFBMA is truly a random sample of the general farm population. Knowledge of this information would allow these results and future studies to be used by a greater number of people.

A time series analysis of SWFBMA data over a number of years would provide useful information. There were 137 farmers in the SWFBMA who were represented with data in each of the three years spanning 1985 to 1987. A time series analysis could provide information about the long term affects of the debt to asset ratio on profitability. It may also provide information about the long term affects of debt forgiveness on profits.

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APPENDIX A:

COMPLETE CORRELATION MATRIX
1985 DATA WITH 177 CASES

	EROA	VALPROD	ACRE	PRODEFF	BFFEEDRT	FFFEEDRT	HFFEEDRT
EROA	1.0000						
VALPROD	.2225	1.0000					
ACRE	.0599	.5517	1.0000				
PRODEFF	.1099	.2268	.0345	1.0000			
BFFEEDRT	.0563	-.0523	-.0048	-.4619	1.0000		
FFFEEDRT	.0218	-.0708	-.0461	-.3250	.0040	1.0000	
HFFEEDRT	-.0135	.0477	.1034	-.2857	-.0131	.0171	1.0000
DYYLDRT	.0254	.0828	.0472	.1009	.0965	-.0407	-.0097
CYLDRAT	.2804	.2477	.1442	.5641	.0642	-.0512	-.0160
SYLDRAT	.1023	.1283	-.0495	.6372	-.0711	-.0633	.0116
LABREFF	.1542	.8918	.5603	.2258	-.0811	-.0450	.0341
INVTURNO	-.2916	-.1007	.0919	.1126	-.0655	-.0058	.0473
MARKEFF	.0067	.0366	.0372	.2194	-.1097	-.0672	-.0621
BFPRRAT	-.0226	.0671	.1876	-.0260	-.0407	.0206	.0396
FFPRRAT	-.0610	-.0548	-.0212	.1029	-.0712	-.0866	-.0044
HFPRRAT	-.0581	.0520	-.0216	.1430	.0598	.0021	-.3535
CNPRRAT	.1287	.0736	.0254	.2395	-.0185	.0231	-.0391
SBPRRAT	-.0156	-.0138	-.0638	.0850	-.0835	-.0770	-.0443
GOVT	.0479	.1422	.0985	.0334	.0000	.1433	.0000
BFDUMM	-.1495	.1910	.2286	.2202	.0000	-.0477	-.0280
FFDUMM	.0554	.1766	-.0472	.0362	.0047	.0000	-.0631
HFDUMM	.0500	.1042	.0073	.1713	-.0401	-.0199	.0000
DARYDUMM	.1087	-.0597	-.1461	-.1682	.0882	.0252	.0097
CNDUMM	.0063	.1506	.0147	.0135	-.0250	.1324	.0337
SBDUMM	.0410	.1246	.1094	-.0934	.0628	.1229	.0000
VALPTA	.5093	.2805	-.2435	.0237	.0520	.0070	-.0129
BCURRAT	-.0057	.1253	.1274	.1142	.0432	-.2899	.0000
BASTRC	.0364	-.0363	-.0230	.0506	-.0574	-.0356	.0365
BDSTRC	.0620	-.0872	-.0833	-.0123	-.1445	.0508	.0580
BCASHPO	-.0968	-.2465	-.1858	.0131	-.1137	-.0840	.0234
BDTA	.1972	.0978	.1437	-.1207	.0390	.1751	-.0730
DEBTMPCT	.0171	-.0580	-.0643	.0631	-.0049	-.0210	.0022
DEBTSERV	-.0323	-.0736	-.1052	-.0278	-.0023	-.0627	.0010
INTG	-.0067	.0310	.0969	-.1667	.0390	.2384	.0001
GROSRAT	-.2816	.2326	.1184	.0657	-.1185	.0970	.0026
BFINLEV	.1506	.0334	.0793	.0949	.0082	-.1325	.0275
AGE	-.1801	.1244	-.0010	.0740	-.0214	-.0362	.0480
YEARS	-.1413	.1494	.0262	.0638	.0221	-.0057	.0432
PARTNER	.2215	.1653	-.0078	.1006	.1076	-.2166	.0308
CORP	-.0823	.3853	.1251	.0994	-.0016	-.0588	.0000
CSRENTDM	.1580	.2110	.2700	.0938	-.0736	.0123	-.0422
SHRENTDM	.0524	-.0648	.0919	-.0670	-.0828	.0972	-.0886
DFORDUMM	.0593	-.0510	-.0836	.0538	-.0669	.0883	-.1831

APPENDIX A:
(continued)

	DYYLDRT	CYLDRAT	SYLDRAT	LABREFF	INVTURNO	MARKEFF	BFPRRAT
DYYLDRT	1.0000						
CYLDRAT	-.0261	1.0000					
SYLDRAT	-.0629	.3425	1.0000				
LABREFF	.0277	.2193	.1314	1.0000			
INVTURNO	-.0409	.1156	.0738	-.0922	1.0000		
MARKEFF	.0103	.0949	.2377	.0496	.1571	1.0000	
BFPRRAT	-.0184	-.0369	.0161	.0646	.0829	.3813	1.0000
FFPRRAT	.1239	.0168	.0037	-.0566	.2042	.4962	.0108
HFPRRAT	.0032	.0675	.0516	.0470	.0231	.1533	.0162
CNPRRAT	-.0644	.1389	.4122	.0924	.0314	.4505	.0260
SBPRRAT	-.0043	.0480	.0442	-.0015	.0321	.6450	-.0308
GOVT	.1046	.0344	.0792	.1576	.0353	.0679	.0089
BFDUMM	.0385	.1464	.0746	.2331	.4140	.1421	.0384
FFDUMM	-.0766	-.0105	.0437	.1687	-.0647	.0938	.0581
HFDUMM	-.0583	.0777	.1677	.1433	-.0537	-.0176	-.0832
DARYDUMM	.0437	-.1122	-.1036	-.0879	-.2503	-.1449	-.0289
CNDUMM	.0192	.0026	.0805	.1470	.0471	.0080	.0213
SBDUMM	-.1191	-.0107	.0012	.1447	-.0273	-.1576	-.0289
VALPTA	.0474	.0769	.0929	.1853	-.4655	-.0060	-.0408
BCURRAT	.0021	.0912	-.0163	.1478	.3072	.0804	.0539
BASTRC	-.0534	.0914	.0400	-.0740	.3709	.1474	.0530
BDSTRC	.0903	-.0588	-.0500	-.1307	-.0596	-.0237	.0677
BCASHPO	-.0280	-.0746	-.0375	-.2379	.3494	.0659	.0333
BDTA	-.0342	-.0801	-.0803	.1383	-.4471	-.2166	-.0840
DEBTMPCT	-.0012	.0704	.0863	-.0698	.0763	.0476	.0061
DEBTSERV	-.0032	-.0840	.0007	-.0748	.0595	.0412	-.0026
INTG	-.0347	-.1649	-.0795	.0698	-.2482	-.1370	-.0270
GROSRAT	-.0125	.0113	-.0006	.2229	.2077	-.0597	-.0743
BFINLEV	.0016	.1254	.0956	.0197	.0285	-.0866	-.1561
AGE	.1169	.0113	.0113	.1034	.3235	.0326	.1022
YEARS	.1556	.0516	-.0019	.1154	.3595	.0048	.0867
PARTNER	.2599	.0987	-.0051	-.1197	-.1085	-.0840	-.0705
CORP	-.0023	.1160	.0988	.1742	.0703	.1356	.1941
CSRENTDM	.0045	.0853	.0813	.2174	-.2010	.0774	.0276
SHRENTDM	-.1228	-.1730	.0248	-.0580	-.1046	.0354	.0304
DFORDUMM	-.0162	-.0806	.0746	-.0204	-.1837	-.0203	.0100

APPENDIX A:
(continued)

	FFPRRAT	HFPRRAT	CNPRRAT	SBPRRAT	GOVT	BFDUMM	FFDUMM
FFPRRAT	1.0000						
HFPRRAT	-.0005	1.0000					
CNPRRAT	.0166	.0529	1.0000				
SBPRRAT	.0897	.0647	-.0548	1.0000			
GOVT	-.0585	-.0118	.1052	.0601	1.0000		
BFDUMM	.1646	.0575	.0959	-.0023	.1365	1.0000	
FFDUMM	.0858	.0205	-.0079	.0575	-.0819	-.1122	1.0000
HFDUMM	.0052	-.0969	.1430	-.0713	.0992	.1551	-.1623
DARYDUMM	-.1647	.0143	-.0896	-.0472	-.0732	-.1505	-.1606
CNDUMM	.1356	-.0616	-.0111	-.0823	.3598	.0311	.0377
SBDUMM	-.0547	-.0098	.0208	-.1872	.2015	-.0231	.0519
VALPTA	-.0518	.0338	.0214	.0300	.0897	-.2296	.0569
BCURRAT	.1424	.0165	-.0049	-.0137	-.0289	.1129	.2145
BASTRC	.1459	-.0887	.0522	.0748	-.0215	.1606	-.0311
BDSTRC	-.0009	-.1026	-.0111	-.0506	-.0951	-.0059	-.1457
BCASHPO	.1678	-.0597	.0079	-.0253	-.2575	-.0781	-.0418
BDTA	-.2088	-.0496	-.0387	-.1212	.0922	-.0777	-.0468
DEBTMPCT	.0377	.0041	-.0099	.0505	-.1063	-.0628	.0614
DEBTSERV	.0925	.0052	-.0459	.0424	-.2797	-.0708	.1148
INTG	-.2194	.0046	-.0287	-.0273	.0589	-.0120	-.0094
GROSRAT	-.0418	.0407	.0467	-.0694	.1270	.4904	-.0921
BFINLEV	-.0601	-.0415	-.0194	.0256	-.0376	.0242	-.0604
AGE	.2251	.0153	-.0988	-.0943	-.0175	.2722	.0958
YEARS	.1896	-.0226	-.0905	-.1009	-.0071	.2686	.0775
PARTNER	-.0332	.0230	-.0073	-.0719	-.1096	-.1143	.0693
CORP	.0641	.0073	.0392	.0059	.0372	.0939	.0858
CSRENTDM	.0498	-.0609	.0237	.0602	.0857	.0443	.0656
SHRENTDM	-.0712	-.0136	.1213	-.0036	.0666	-.0608	.0111
DFORDUMM	-.0816	.0451	.0624	-.0356	.0922	-.1296	-.0233

APPENDIX A:
(continued)

	HFDUMM	DARYDUMM	CNDUMM	SBDUMM	VALPTA	BCURRAT	BASTRC
HFDUMM	1.0000						
DARYDUMM	-.0882	1.0000					
CNDUMM	-.0137	-.0359	1.0000				
SBDUMM	.0823	-.1169	.6027	1.0000			
VALPTA	.0962	.1811	.1367	.0684	1.0000		
BCURRAT	-.1383	-.0925	.0368	.0440	-.1144	1.0000	
BASTRC	.0514	-.2057	.0445	-.0207	.1690	.1822	1.0000
BDSTRC	.0284	.0693	-.0214	-.1267	.1366	-.3448	.3362
BCASHPO	-.0188	-.1092	-.2900	-.2474	-.1081	.1925	.2765
BDTA	.1485	.0774	-.0651	.0920	.1399	-.1633	-.2990
DEBTMPCT	-.0606	-.0473	.0271	.0046	-.0692	.0058	.0071
DEBTSERV	-.0545	-.0451	.0077	.0034	-.0469	-.0147	.0190
INTG	.0642	.1357	-.0694	.0014	-.0397	-.1223	-.4247
GROSRAT	.1957	-.1110	-.0065	.0443	-.0519	.0231	.1749
BFINLEV	.0032	.0522	-.0249	-.0283	-.0007	-.1301	.0316
AGE	-.1108	-.0906	.1493	.0378	-.2217	.1768	-.1171
YEARS	-.1137	-.1162	.1288	.0513	-.2275	.2116	-.1215
PARTNER	-.0587	.1012	-.0608	-.1553	.2366	.1095	.0106
CORP	-.0617	-.0527	.0285	.0309	.0091	.2105	.1107
CSRENTDM	-.0670	-.0117	.1090	.0174	.0707	-.0048	.2177
SHRENTDM	.0695	-.0834	.1644	.1781	.0149	-.1311	.0950
DFORDUMM	-.0544	-.0200	-.0241	-.0114	-.0239	-.0327	-.2106

	BDSTRC	BCASHPO	BDTA	DEBTMPCT	DEBTSERV	INTG	GROSRAT
BDSTRC	1.0000						
BCASHPO	-.0084	1.0000					
BDTA	-.0629	-.1550	1.0000				
DEBTMPCT	.2024	.0398	-.2249	1.0000			
DEBTSERV	.1960	.0923	-.1900	.7519	1.0000		
INTG	-.2536	-.1058	.5472	-.1916	-.1711	1.0000	
GROSRAT	.0004	-.1251	.2247	-.1613	-.1249	.2223	1.0000
BFINLEV	.0968	.0484	-.0838	.0272	.0203	-.0805	-.1120
AGE	-.0076	.0615	-.2845	.1530	.1498	.0333	.0773
YEARS	-.0391	.0743	-.2774	.1465	.1196	.0137	.0546
PARTNER	.1081	-.0867	-.1123	.0551	.0085	-.1136	-.1132
CORP	-.0400	-.0264	.0156	-.0252	-.0224	-.0007	.2696
CSRENTDM	.1444	-.0971	.2161	-.0723	-.0171	-.0204	.0339
SHRENTDM	-.0183	-.0843	.1914	-.0448	.0388	.0302	.0447
DFORDUMM	-.1239	-.0367	.4469	-.0601	-.0494	.0791	.0061

APPENDIX A:
(continued)

	BFINLEV	AGE	YEARS	PARTNER	CORP	CSRENTDM	SHRENTDM
BFINLEV	1.0000						
AGE	-.0285	1.0000					
YEARS	-.0268	.9318	1.0000				
PARTNER	.0426	-.0004	.0309	1.0000			
CORP	-.1452	.1843	.1839	-.0446	1.0000		
CSRENTDM	.1379	-.1039	-.1439	-.0252	.0875	1.0000	
SHRENTDM	.0840	-.2594	-.2865	-.0883	-.0568	-.0490	1.0000
DFORDUMM	-.1366	-.1543	-.1581	-.0470	-.0573	.0582	.1530

	DFORDUMM
DFORDUMM	1.0000

APPENDIX B:

COMPLETE FULL MODEL RESULTS
1985 DATA WITH 177 CASES

Ordinary least squares estimates for complete, full 1985 data model with 177 cases.

Dependent Variable..........	EROA
Number of Observations......	177.
Mean of Dependent Variable..	.11412
Std. Dev. of Dep. Variable..	.09800
Std. Error of Regression....	.07628
Sum of Squared Residuals....	.78544
R - Squared.................	.53536
Adjusted R - Squared........	.39424
F-Statistic (41, 135).....	3.79382
Significance of F-Test......	.00000

Variable	Coefficient	Std. Error	T-ratio	(Sig.Lvl)
ONE	-.489692	1.828	-.268	(.77914)
VALPROD	.259415E-06	.1970E-06	1.317	(.18679)
ACRE	.221684E-04	.3200E-04	.693	(.49667)
PRODEFF	-.364319E-01	.9714E-01	-.375	(.70813)
BFFEEDRT	-.829178E-01	.1144	-.725	(.47644)
FFFEEDRT	.446122E-01	.1242	.359	(.71881)
HFFEEDRT	-.750574E-01	.2005	-.374	(.70860)
DYYLDRT	.634004E-01	.1683	.377	(.70704)
CYLDRAT	.230423	.1156	1.994	(.04556)
SYLDRAT	-.536955E-02	.1116	-.048	(.91461)
LABREFF	-.277335E-06	.2052E-06	-1.352	(.17517)
INVTURNO	.135337E-01	.1849E-01	.732	(.47210)
MARKEFF	-.191683	.4323	-.443	(.66199)
BFPRRAT	.179041	.4531	.395	(.69463)
FFPRRAT	.212591	.4739	.449	(.65851)
HFPRRAT	-.329669	.6005	-.549	(.59078)
CNPRRAT	.369720	.4550	.813	(.42317)
SBPRRAT	.158520	.4378	.362	(.71687)
GOVT	.367027E-02	.3125E-01	.117	(.87323)
BFDUMM	.227149E-01	.2073E-01	1.096	(.27463)
FFDUMM	.425227E-02	.1569E-01	.271	(.77712)
HFDUMM	.625538E-02	.1956E-01	.320	(.74506)
DARYDUMM	.120188E-01	.2165E-01	.555	(.58668)
CNDUMM	-.823720E-01	.5013E-01	-1.643	(.09858)

continued on following page

APPENDIX B:
(continued)

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SBDUMM	.186276E-01	.4311E-01	.432	(.66962)
VALPTA	.389432	.8038E-01	4.845	(.00001)
BCURRAT	.789992E-07	.4962E-07	1.592	(.10951)
BASTRC	.270614E-01	.6459E-01	.419	(.67853)
BDSTRC	.696661E-02	.2520E-01	.276	(.77355)
BCASHPO	-.163305	.1184	-1.379	(.16635)
BDTA	.515282E-01	.2421E-01	2.128	(.03322)
DEBTMPCT	.840371E-03	.1773E-02	.474	(.64132)
DEBTSERV	-.645510E-07	.5626E-04	-.001	(.94810)
INTG	.560024E-01	.9839E-01	.569	(.57731)
GROSRAT	-.976895E-01	.2095E-01	-4.662	(.00002)
BFINLEV	.790435E-04	.6329E-04	1.249	(.21124)
YEARS	.358904E-03	.6698E-03	.536	(.59962)
PARTNER	-.101683E-01	.3871E-01	-.263	(.78255)
CORP	-.839631E-01	.6593E-01	-1.274	(.20209)
CSRENTDM	.116035E-01	.1819E-01	.638	(.53193)
SHRENTDM	.123512E-01	.1459E-01	.846	(.40348)
DFORDUMM	.901066E-02	.2297E-01	.392	(.69653)
Sigma	.762762E-01	.4054E-02	18.815	(.00000)