ESTIMATING RISK AND RETURN OF A FINANCIAL LEVERAGE MODEL VIA TARGET MOTAD

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PREFACE

Optimal debt levels of farming/ranching operations are as varied as the operations themselves. The utility of the operators, which can not be measured cardinally, determines the amount of risk and thus the amount of debt one is willing and able to carry. Farmers/ranchers strive to become larger to capture the internalities and externalities of the larger operation. Borrowed capital helps greatly in this endeavor but too much debt can easily lead to insolvency due to high interest and principle obligations and reduced capital liquidity. This paper hopes to show the risk-return relationship of borrowed capital under various scenarios and that the type of debt incurred will affect the amount of leverage carried.

I would like to express my gratitude to all of those who assisted me during my stay at Oklahoma State. A special appreciation goes to my major advisor, Dr. James S. Plaxico, whose assistance and patience were instrumental during the writing of this thesis. His helpful and calm manner guided me through the hard times and allowed me to enjoy the good times.

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INTRODUCTION

The most recent boom for agriculture began in 1972. Rapid world wide economic growth, the devaluation of the dollar and the commitment of several importing countries to increase their demand for agricultural products led to an expansion of international trade. Fiscal and monetary policy from 1972-1979 kept real interest rates low and even negative (Jolly and Doye). National farm debt increased an average of 10 percent per year. Land values rose even faster, causing debt/asset (D/A) ratios of the agricultural sector to actually decline, supporting the increased borrowing and investment in new capital equipment, new production technologies and farmland (ERS Bulletin 490).

An anti-inflationary monetary policy initiated by the Federal Reserve Bank in 1979 was instrumental in changing the boom of 1972-1979 to bust for the agriculture sector. Real rates of interest rose from almost zero to historically high levels of 8 to 10 percent. Nominal interest rates reached a peak prime rate of 22 percent in 1981. This monetary policy, along with an expansionary fiscal policy, allowed the value of the dollar to increase steadily and the federal deficit to rise to historic levels.

In 1981, Oklahoma irrigated cropland reached a high of $2000 per acre. In 1986, the same land fell to an average of $800 per acre, a 60 percent decline (Gilliland). The preliminary results of the 1987 Oklahoma farm financial survey are shown in Table I (Plaxico, Tilley, and Bellinghausen). Farmers with debt to asset ratios greater than 40 percent own only 21.7 percent of the assets while

TABLE I

AVERAGE FARM FINANCIAL POSITION BY DEBT/ASSET RATIO, BASED ON 995 RESPONDENTS, OKLAHOMA, JANUARY 1987

	Debt/Asset Ratio				
Item	None	<.4	.4 - .7	>.7	All
Number of Farms	413	364	144	74	995
Age of Operator	63	56	50	49	58
Years Operated a Farm	35	31	25	23	31
Acres Operated	834	1,549	1,355	1,478	1,219
Total Assets	$322,188	$535,177	$438,528	$372,681	$420,698
Total Debts	$0	$92,618	$232,838	$337,116	$92,651
Equity	$322,188	$442,559	$205,690	$35,565	$328,046
Debt/Asset Ratio	0	.17	.53	.90	.22
Gross Sales	$43,062	$103,693	$130,126	$133,641	$84,579
Gov't Payments	$5,669	$14,480	$17,664	$22,630	$11,890
Gov't Loans	$1,195	$8,559	$10,982	$9,434	$5,922
Total Cash Farm Income	$49,926	$126,732	$158,772	$165,755	$102,391
Net Cash Farm Income	$19,276	$46,737	$50,951	$45,640	$35,867
Total Wages	$8,087	$13,037	$17,529	$15,847	$11,841
Mineral & Invest. Income	$5,299	$4,781	$6,500	$3,893	$5,179
Off-Farm Income	$23,143	$22,435	$27,905	$21,419	$23,445
Return on Assets	6.0	8.7	11.6	12.2	8.5
Return on Equity	6.0	10.6	24.8	128.3	10.9
Percent of Farms	41.5	36.6	14.5	7.4	100.0
Percent of Acres Operated	28.4	46.5	16.1	9.0	100.0
Percent of Assets	31.8	46.5	15.1	6.6	100.0
Percent of Debt	0.0	36.6	36.4	27.1	100.0
Percent of Gross Sales	21.1	44.9	22.3	11.8	100.0
Percent of Net Farm Income	22.3	47.7	20.6	9.5	100.0
Percent of Off-Farm Income	41.0	35.0	17.2	6.8	100.0

Source: James S. Plaxico, Marcia L. Tilley, and Bob Bellinghausen. "The Oklahoma Farm Financial Situation, 1987: Preliminary Survey Results." *Oklahoma Current Farm Economics*, 60(1987):3-14.

owing 63.5 percent of the debt. These farmers/ranchers receive 30.1 percent of the net farm income. Thus, 63.5 percent of the debt is required to be paid for by 30.1 percent of the net farm income. Also, these farms have only 24 percent of the off farm income to subsidize the operation.

The problems of agricultural banks and the Farm Credit System (FCS) are closely related to the problems of their borrowers. By mid-1985, producers with debt to asset ratios of 40 percent or more represented less than half of all farms but held nearly two-thirds of farm debt (Jolly and Doye). Total nominal farm debt increased from $53 billion in the first quarter of 1970 to $216 billion as of January 1, 1983. As a result, the availability and terms of credit have become more important determinants of the structure, profitability and financial stability of the agricultural economy. Commercial banks and the Farm Credit System are the most important sources of credit to farmers. On January 1, 1982, these lenders accounted for 49.6 percent of farm real estate debt and 56.2 percent of farm non-real estate debt (Duncan).

Approximately one-half of the outstanding U.S. farm debt cannot be fully serviced at current income and rates of interest. Seven to seventeen percent of commercial agricultural assets in the U.S. will need to be liquidated in order to service the remaining outstanding debt. This liquidation rate is three to four times the volume historically flowing through farm asset markets (Jolly and Doye).

On September 30, 1985, farm production loans made up only 2.9 percent of all loans in the banking system but contributed 5.7 percent of total delinquent loans and 7.8 percent of non-performing loans. Net charge-offs totaled $900 million or 2.2 percent of farm production loans outstanding in 1984. Farm loan charge-offs in the first half of 1985 were nearly twice those of a year earlier.

High interest rate risk premiums reflect the high rate of agricultural loan defaults (Board of Governors of the Federal Reserve).

A number of commercial banks and FCS associations are in severe difficulty. Agricultural banks accounted for more than one-half of the 118 U.S. commercial banks that failed in 1985. The number of potentially vulnerable agricultural banks rose from 96 to 302 in the period 1982-1985 (ERS).

Problem Statement

Farming and ranching are capital intensive commercial businesses. The capital intensive units are increasingly dependent on financial institutions for debt capital. Many changes including technology have led to specialization of farm production and greater capitalization. The combined effects of specialization and the business expansion needed for full resource utilization have stimulated high rates of financial growth to preserve the economic viability of farm units. Therefore, financial management plays an important role in accumulating capital and responding to risks (Barry, Hopkin, and Baker).

Leverage can be used to increase the size of farming operations with the objective of increasing profits. Increased leverage also increases the amount of risk a farmer assumes. In an adverse year a farmer can lose more than would be gained during a favorable year. Table II shows that, assuming a six percent interest rate and ignoring tax effects, a farm unit that has a leverage ratio of 1.0 will gain 18 percent at a 12 percent gross return on capital and lose 30 percent in an adverse year at a negative 12 percent gross rate of return.

Financial leverage or debt refers to the use of debt capital in financing a farm enterprise. A premium or cost in the form of interest is associated with the debt that is acquired . Interest is a fixed charge that must be paid regardless of

TABLE II

RATE OF RETURN ON EQUITY GIVEN A 12 PERCENT
GAIN (LOSS) ON INVESTMENT

Leverage	0	.50	1.0	2.0
Equity	$50,000	$50,000	$50,000	$50,000
Debt Non-equity	$0	$25,000	$50,000	$100,000
	-----------	-----------	------------	------------
Total Capital	$50,000	$75,000	$100,000	$150,000
Before tax income <u>earned</u> on investments of 12%				
Gross return on capital	$6,000	$9,000	$12,000	$18,000
Interest at 6%	0	($1,500)	($3,000)	($6,000)
	---------	-----------	-----------	------------
	$6,000	$7,500	$9,000	$12,000
Rate of return on equity	12%	15%	18%	24%
Before tax income <u>lost</u> on investments of 12%				
Gross loss on capital	($6,000)	($9,000)	($12,000)	($18,000)
Interest at 6%	0	($1,500)	($3,000)	($6,000)
	-----------	-----------	-----------	-------------
Before tax income	($6,000)	($10,500)	($15,000)	($24,000)
Rate of return on equity	-12%	-21%	-30%	-48%

whether the firm has a positive or negative rate of return. Variable interest rates, add to the volatility of net income. The greater the amount of debt, the greater the financial leverage, thus higher and higher debt service requirements are added to fixed costs. These higher fixed costs add to the negative returns during an adverse production year. The magnitude of negative net rates of return will increase at an increasing rate as the amount of debt increases. Thus, adding to financial leverage will add risk exponentially to the firm.

The purpose of leverage is the borrowing of other monies at a cost and adding to a given amount of owned equity to expand at an increasing rate, hopefully to reap the benefits of economies of size and/or scale. Therefore, a farmer/rancher, especially one in debt, may become more highly leveraged with the hopes of increased income. But what if the coming production year is adverse? Moderate financial stress can become critical. This dilemma can easily be seen, but the bottom line is to utilize debt capital so that there will be a farm/ranch operation in the near and distant future.

Agriculturalists have had considerable interest in means to reduce risk to farmers/ranchers, primarily by reducing business risk. Examples of means of reducing business risk are government programs, crop insurance, soil conservation, herbicides, insecticides, and marketing alternatives such as contracting and hedging.

The economic chain of events described earlier has caused much interest in financial risk. Gabriel and Baker state "that the financing decision is an important consideration in determining total risks, whether risk is defined in terms of income variability or as the probability of the occurrence of a dread event such as cash insolvency." Financial risk depends on the amount of fixed financial obligation which in the case of farmers/ranchers are mainly debt repayment in the form of interest and principal.

As a matter of convenience, henceforth, a farmer/rancher or farm/ranch operation will be referred to as "firm."

Objectives and Hypotheses

The primary objectives of this research are:

1. To establish guidelines for a debt level that will allow the firm to meet income objectives yet survive adverse years, within the context of the selected model and under alternative scenarios.
2. Determine the effects of different variables upon financial risk.
   A. Beginning equity
   B. Family living withdrawal
3. To evaluate the effects of capital gains or losses on the risk-return attributes of the firm.

These objectives will be accomplished by use of an empirical Target MOTAD model.

Procedure

The Target MOTAD model is structured to consider volatility associated with adverse states of nature. Favorable deviations from the average are not of concern to the firm since they do not threaten the debt repayment ability of the firm. This study deals with a modeled ranching operation in northeast Oklahoma.

The procedure to accomplish the identified objective will be to 1) gather historical costs of the firm (family living withdrawal will be a constant and debt repayment will depend on the amount of debt), 2) assemble historical income of the enterprises, 3) estimate rates of return of the firm given different levels of beginning equities, off-farm income, family living withdrawals and income variability.

A Target MOTAD model is used for computing risk efficient mixtures of risky alternatives. Target MOTAD solutions are computed using selected target income levels and various degrees of leverage. The model will estimate income and the sum of expected negative deviations from the target income.

CHAPTER II

CONCEPTUAL MODEL

The theoretical basis of this study is presented in this chapter. The first section examines the concept of leverage. What is it? Why is it important to the farmer? The second section considers capital gain/loss. Although capital gains and losses are not cash inflows and outflows, their impacts on the financial structure of the firm are important. The third section examines business and financial risk, both quantitatively and qualitatively. The effects of business risk are magnified as leverage increases. Higher leverage ratios can increase the rate of equity growth for a firm but also increases the risk of loss of equity. The optimal level of leverage within this risk-return trade off scenario will depend on the utility function of the farmer. Next, there is a brief discussion of risk programming models. The concept of states of nature will be discussed. This concept will be useful in later chapters. The final section covers the concept of safety first. Since the first objective of some farmers is to insure the survivability or solvency of the firm, this is a pertinent concept. The safety first criteria leads to the empirical analysis.

Leverage

The measure of leverage used in this study, is the debt-to-asset ratio. If debt is $100,000 and equity of the firm is $100,000, then the debt/asset (D/A) ratio is 50 percent. Debt is a cash entry on the asset side and a debt repayment entry on the liability side of the balance sheet. The cash (borrowed capital) is added to the equity to calculate total assets. Therefore, the D/A equation will be $100,000 divided by $200,000 or 50 percent.

Capital gains may cause a false illusion. Suppose you have land that originally cost $50,000 but now has a fair market value of $150,000. If you borrow $75,000 against the land, is the D/A ratio 150 percent ($75,000/$50,000) or 50 percent ($75,000/$150,000). The answer is that the D/A ratio is 50 percent. The current market value of the asset is used in calculating current D/A ratio.

When net farm income, inflation, and the economic indicators are positive, it is tempting and in the short run advantageous to the firm to borrow and invest in real assets. In the short run, the firm will reap the benefit of economies of size, increasing returns, and unrealized capital gains. But being able to cover the increased costs to the firm is a must. If there are external incomes, such as off-farm income or financial reserves(savings), then negative cash operating flows may be sustained for a short time. If debt servicing requirements continually exceed the debt repayment capacity of the firm, or especially if more debt is used to make debt payments then insolvency becomes a very real possibility.

Understanding leverage and its impacts on the returns of a firm is important to financial analysis. Leverage creates a fixed cost that must be paid regardless of the magnitude of returns.

Operating leverage and financial leverage can be referred to as first-stage and second-stage leverage, respectively. Operating leverage creates a fixed operating (short-term) cost while financial leverage creates a fixed financial (long-term) cost. Financial leverage is added to operating leverage to acquire total leverage. These two types of leverage are discussed in greater detail in the following two sections.

<u>Operating Leverage</u>

Operating leverage occurs when fixed operating costs are included in the firm's total operating costs. Operating leverage draws upon the returns of the firm. The greater the leverage the greater the decline in returns, thus an increase in the potential volatility of returns.

The degree of operating leverage (DOL) is defined as the percentage change in operating profits divided by the percentage change in sales or total revenue. To depict operating leverage algebraically

$$DOL = \frac{\Delta EBIT/EBIT}{\Delta Q/Q}$$

$$= \frac{Q(C-V)}{Q(C-V) - F} \qquad (2.1)$$

where:

- Δ = change in
- EBIT = earnings before interest and taxes
- Q = unit sales
- C = price per unit of output
- V = variable cost per unit of output
- F = fixed cost

In equation (2.1), the numerator and denominator are identical except for the fixed cost in the denominator. As fixed costs increase and are subtracted from the denominator, the degree of required operating leverage will increase. If the sales volume creates the returns to cover both variable and fixed cost, the firm will not suffer a loss. But as fixed cost increases, profitability will decrease, thus increased volatility or risk.

Financial Leverage

Financial leverage, similar in concept to operating leverage, occurs when debt is used in financing the firm. If the firm is financially leveraged, there is a fixed cost associated with the debt in terms of interest. This cost also draws on the earnings created by the firm. The greater the use of debt, the greater the financial leverage, the lower the profits, and the greater the variability of returns. The financial fixed costs are added to operating fixed costs to create total leverage of the firm.

The degree of financial leverage (DFL) is defined as the percentage change in after tax earnings divided by the percentage change in earnings before interest and taxes (EBIT).

$$\text{DFL} = \frac{\Delta(\text{EAIT})/\text{EAIT}}{\Delta(\text{EBIT})/\text{EBIT}}$$

$$= \frac{\text{EBIT}}{\text{EBIT} - \text{I} - \text{P}}$$

$$= \frac{\text{Q(C-V)} - \text{F}}{\text{Q(C-V)} - \text{F} - \text{I} - \text{P}} \qquad (2.2)$$

where:

Δ = change in

EAIT = earnings after interest and taxes

I = interest

P = principle

Q = unit sales

C = price per unit

V = variable cost per unit

F = fixed cost

The same concept applies to equation (2.2) as (2.1). As the interest and principle charges are subtracted from the denominator, the degree of financial leverage increases. Too much financial leverage is a major contributor to insolvency of farm firms today. Financial leverage can be reduced by repayment of debt or asset liquidation if cash flows are not sufficient. Baker and Hopkin give a more in-depth analysis of the concepts of leverage and liquidity.

> . . . the concept of leverage lacks an explicit cost associated with use, liquidity lacks an explicit return associated with its use. Indeed, the two concepts are most useful in an equilibrium frame of reference. Leverage operates as a multiplier with respect to the marginal value product of resources added to the firm. If the marginal value product is positive, no explicit limit terminates the addition of financial assets. But if liquidity is valuable to the firm, increasing debt relative to equity reduces credit left to finance capital assets or operating expenses in the future, or to meet unforeseen financial problems. It is reasonable to argue that as credit is reduced, remaining units of credit acquire successively higher values. That is, credit is used at a cost that increases as debt increases, even though the rate of interest may remain constant over wide ranges of credit use. Liquidity and leverage are concepts of central importance in the financial management of the farm and credit is an important component of a firm's liquidity.

Capital Gain/Loss

Capital gains or loss of assets are not actual cash inflows or outflows to the firm. However, when the debt repayment capacity of a firm is calculated, the capital gains/loss of the firms assets are included. When capital gains turns to capital loss, many firms are not able to collateralize their loans. For example, land is purchased with 50 percent equity and 50 percent borrowed capital (debt). If the land value fell 60 percent, which happened in some areas of

Oklahoma, the equity in the loan would be a negative 10 percent and hypothetically the debt the lending institution would be carrying would be 110 percent.

This is not to say capital gain/loss should be excluded from the financial analysis. But it is important to understand the difference between "unrealized" capital gain/loss and "realized" capital gain/loss. Unrealized capital gain (loss) is an increase (decrease) of the value of an asset on the financial books of a firm. Realized capital gain (loss) is an inflow (outflow) when the asset is sold. The keyword is realized.

Risk

There are many risks to a firm. Each firm has risk specific to its operation. Four major sources of risk are: (1) General economic risk may occur due to the change in supply and demand of inputs and outputs, government policies (monetary and fiscal), investor confidence, and regulatory attitudes. These influence the markets faced by the firm. (2) Inflation risk has an effect on the cost of financial and production inputs. (3) Firm specific risks are rather diverse. Cures for these risks may be more descriptive than the symptoms. Cures include diversification, forward contracting, hedging, options, production technologies, such as crossbreeds and disease resistant crops. (4) International risks may affect certain firms more than others but can affect all firms in a small way (Pinches). This is not a complete list but the risks listed are the more common risks faced by firms.

Risk is a concept that must be analyzed when making financial decisions. Therefore, understanding how risk is measured and its impact on expected returns is important. Just as leverage is divided into two areas, risk can be divided into two areas of business risk and financial risk.

Business Risk

Business risk is the variability of expected pretax returns (EBIT) on the firm's total assets (Weston and Copeland). Simply, business risk occurs due to the nature of the operations the firm is involved in. Business risk is primarily associated with operating leverage. As the firm increases its fixed operating costs, the variability of expected earnings before interest and taxes will increase, thus business risk will increase.

There are many determinants of business risk. Five primary determinants are: (1) Firms may experience volatility due to extreme magnitude of changes in sales as a result of changes in the general economy. (2) Smaller firms cannot reap the benefits of economies of scale, but trying to expand too rapidly may increase business and financial risk. (3) As stated before, high operating leverage leads to high business risk. (4) The volatility of input prices will increase risk. An example is the volatility of fertilizer prises resulting from volatile petroleum prices. (5) Farmers face a somewhat elastic demand curve and do not have the ability to control the price of their outputs (Pinches).

Business risk is the variability in net cash flows related to the fixed obligations of the operation, excluding debt repayment. Therefore, following Eidman's formulation, the equation for net cash flows before debt payments (NCFB) is as follows:

$$NCFB = \sum_{i=1}^{n} (P_i - C_i)Y_i - F_i - W \qquad (2.3)$$

where:

P_i = price received for the i^{th} product/unit

C_i = variable cash costs of producing that product/unit

Y_i = amount of the i^{th} product produced

F_i = fixed cash cost that must be paid annually regardless of the level of production

W = annual family withdrawals for consumption purposes

Given this equation, business risk (BR) can be determined.

$$BR = \frac{\sigma_n}{NCFB} \tag{2.4}$$

where:

σ_n = standard deviation in NCFB

Equation (2.4) shows that as NCFB decreases for a fixed standard deviation or as the standard deviation increases (more volatility) for a fixed NCFB, business risk increases.

Financial Risk

Financial risk is variability of earnings due to fixed debt repayment obligations (financial leverage). Financial risk is defined by Weston and Copeland as the additional risk induced by the use of financial leverage and is reflected in the variability of the net income stream. Therefore, financial risk and financial leverage are positively correlated.

Financial risk is the variability in net cash flows due to debt repayment. Financial risk can be explained by Eidman's formulation. Net cash flows after debt payments (NCFA) but before taxes can be expressed as:

$$NCFA = NCFB - P - I \tag{2.5}$$

where:

NCFB = net cash flow before debt payments

P = annual principal payment

I = annual interest payment

Financial risk (FR) can now be expressed as:

$$FR = \frac{\sigma_n}{NCFA} - \frac{\sigma_n}{NCFB} \tag{2.6}$$

where

σ_n (first term) = standard deviation in NCFA

σ_n (second term) = standard deviation in NCFB

Total risk (TR) can be calculated as:

$$TR = \frac{\sigma_n}{NCFA} \tag{2.7}$$

Equation (2.6) is obtained by subtracting business risk from total risk. This equation assumes that business risk does not change as financial risk changes.

Gabriel and Baker express this equation to show that financial risk is a multiplicative function of business risk. The algebraic process is as follows:

$$FR = TR - BR$$

$$= \frac{\sigma_n}{NCFB - P - I} - \frac{\sigma_n}{NCFB}$$

$$= \frac{\sigma_n NCFB - \sigma_n NCFB + \sigma_n P + \sigma_n I}{NCFB(NCFB - P - I)}$$

$$= \frac{\sigma_n}{NCFB} \bullet \frac{P + I}{NCFA} \qquad (2.8)$$

Empirical Risk Models

Several mathematical programming models have been developed to incorporate the risk-adverse behavior of the firm. These risk models do not compute a single farm plan but rather many possible farm plans of different degrees of risk and varying income.

A particular set of outcomes of all the c_j, a_{ij}, and b_i coefficients in the models can be referred to as states of nature. A state of nature is analogous to a particular type of year, such as a high price or low price year. Each state of nature will most likely have a different level of income for each farm plan (Hazell and Norton).

There are several risk models with objectives of maximizing the firm's returns for a given level of variability of farm income. Some examples are (1) mean-variance (E, V) models that minimize the associated income variances [V(Y)] for given expected income levels, (2) quadratic programming models that compute the efficient (E, V) set of alternative farm plans, and (3) the MOTAD (Minimization of Total Absolute Deviations) model developed by Hazell (1971) that uses variance estimates based on the sample Mean Absolute Deviation

(MAD). The Target MOTAD model developed by Tauer (1983) extends the MOTAD model by maximizing E(Y) for each level of negative deviations from the target income. If the target income can not be met, Target MOTAD compensates the negative deviations which allows feasible solutions.

Safety-First Criteria

Safety-first models calculate the minimum income necessary to meet fixed costs, such as debt repayment, overhead, asset replacement costs, management, labor, and family living withdrawals. Safety-first models are valuable modeling tools when the risk of insolvency is great or when there are minimal financial reserves to subsidize the firm in an adverse year.

Roy's (1952) safety-first model minimized the probability that income could fall below a sustainable income that would cover fixed costs and family living withdrawal. As simple as this concept seems, it is not easily incorporated in a mathematical programming model.

Low (1974), on the other hand, proposed a safety-first model to maximize expected income while having an income equal to or greater than a sustainable income in every state of nature. The shortfall to this model is that if a state of nature cannot meet the established criterion, then the model becomes infeasible. To correct this problem, the sustainable income can be set as a target and have the model select the farm plan that deviates the least from the target. This now leads us into Chapter 3 and Target MOTAD.

CHAPTER III

EMPIRICAL MODEL

This chapter will discuss the Target MOTAD model and how the model is structured for this analysis. The basic structure of Target MOTAD will be examined first. Then, the assumptions of the model and the structure used for this study will be explained. Lastly, the initial model and its data will be explained.

Underlying Basis of Target MOTAD

The major contribution of Target MOTAD to risk programming techniques is that only negative deviations form the target income are considered and the solutions meet the second-degree stochastic dominance (SSD) test. Target MOTAD does not require that returns be normally distributed to have solutions that are SSD. First-degree stochastic dominance (FSD) plans would be preferred by individuals with increasing utility, e.g., preferring more income to less income. SSD plans would be preferred by individuals with (1) increasing utility for income and (2) who is risk adverse. It has been shown that all solutions calculated by Target MOTAD are SSD but not necessarily all SSD solutions will be determined (McCamley and Kliebenstein).

In a comparison of Target MOTAD to MOTAD, Watts, Held, and Helmers concluded:

The principle purpose of risk-return analysis lies in ranking alternative farm plans on the basis of risk, and examining trade-offs between risk and mean income. However, analyzing trade-offs between "risk" (defined as deviation from mean income) and "mean income" is subject to question since risk is not expressed in a "pure" sense: i.e., such a risk expression is not independent of, but rather dependent on mean income. Furthermore, in most cases the only possible way to reduce (or eliminate) risk in MOTAD (and quadratic programming) is to reduce (or eliminate) income. Yet, from a practical standpoint, it is not "higher income" per se that poses a threat. To the contrary, it is "low income," yielding negative deviations from a final level of acceptable target income.

While it seems perfectly logical to penalize negative deviations as a source of risk, it is very difficult to view positive deviations as a genuine source of risk. That is, do rational producers really attach as much dis-utility to high income years as they do to low income years? If not, the proposed Target MOTAD model appears to be a more plausible approach for examining risk-return trade-offs and in addition is more consistent with recent risk literature.

Target MOTAD Modelling Components

Tauer's equational interpretation of Target MOTAD is as follows:

$$\text{Max } E(z) = \sum_{j=1}^{n} c_j x_j \qquad (3.1)$$

subject to:

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i \qquad (3.2)$$

$i = 1, ..., m$ constraints

$$T - \sum_{j=1}^{n} c_{rj} x_j - y_r \leq 0 \tag{3.3}$$

$r = 1, ..., s$ state of nature

$$\sum_{r=1}^{s} p_r y_r = \lambda \tag{3.4}$$

$\lambda = M \rightarrow 0$

$$\text{all } x_j \geq 0 \tag{3.5}$$

$$\text{all } y_r \geq 0 \tag{3.6}$$

where:

$E(z)$ = expected return of the solution

c_j = expected return per unit of activity j

x_j = level of activity j

a_{ij} = technical requirement of activity j for resource or constraint i

b_i = level of resource or constraint i

T = target level of return

c_{rj} = return of activity j for state of nature or observation r

y_r = deviation below T for state of nature or observation r

p_r = probability that state of nature or observation r will occur

λ = constant parameterized from M to O

m = number of constraint and resource equations

s = number of states of nature or observations

M = a large number.

Equation (3.1) maximizes expected return of the farm plan solution set. Equation (3.2) ensures the fixed resource (technical) constraints are not violated. Equation (3.3) measures the revenue of a solution under state r. If the revenue is less than the target T, the difference is transferred to equation (3.4) via variable y_r. Equation (3.4) sums the negative deviations after weighting them by their probability of occurring, p_r. Equations (3.5) and (3.6) ensure there are not any negative activity levels.

It is widely accepted that farm plans obtained from Target MOTAD are in the second-degree stochastic dominant set. The proof, by *modus tollens*, consists of a multitude of mathematical equations and can be found in Tauer's article, thus the proof will be excluded.

Assumptions of Target MOTAD

Target MOTAD is a linear programming model. Therefore, the assumptions that hold for linear programming also hold for Target MOTAD. These assumptions are:

1. *Optimization*. It is assumed that an appropriate function is either maximized or minimized. Objectives may consist of maximizing profits or minimizing costs.
2. *Fixedness*. At least one constraint has a nonzero right hand side (RHS) coefficient.
3. *Finiteness*. It is assumed that there are only a finite number of activities and constraints to be considered so that a solution may be sought.
4. *Determinism*. All c_j, a_{ij}, and b_i coefficients in the model are assumed to be known constants.

5. *Continuity*. It is assumed that resources can be used and activities produced in quantities that are fractional units, i.e., 146.5 cow/calf units may be produced.
6. *Homogeneity*. It is assumed that all units of the same resource or activity are identical.
7. *Additivity*. The activities are assumed to be additive in the sense that when two or more are used, their total product is the sum of their individual products. No interaction effects between activities are permitted.
8. *Proportionality*. The gross margin and resource requirements per unit of activity are assumed to be constant regardless of the level of the activity used. A constant gross margin per unit of activity assumes a perfectly elastic demand curve for the product, and perfectly elastic supplies of any variable inputs that may be used. Constant resource requirements per unit of activity are equivalent to a Leontief production function, that is, a linear ray through the origin (Hazell and Norton).

Additivity and proportionality define the linearity in the activities. This linearity allows linear programming to be used. The simplicity of linear programming is advantageous especially for large models. Other algorithms, such as quadratic programming, are often troublesome due to their complexity and computer rounding errors.

All assumptions listed must hold for all rows and columns in the model. These assumptions do not have to hold for the aggregate farm production processes. However, due to Euler's theorem, the aggregate farm production processes also have constant returns to scale. Euler's theorem states that if each resource is valued at its marginal product (the value the i^{th} resource adds to output), then the sum of the resources multiplied by their associated marginal products is equal to total output. In the Target MOTAD model, Euler's theorem is the sum of the resources (x_i) multiplied by its marginal value product (c_j). This equals the objective function (E_z). This is consistent with equation (3.1).

Model Components

Table III explains the model using the variables from equations (3.2) through (3.6). The objective function is to maximize returns. The resource constraints are rows and the activities are columns. The fixed resources and requirements are the right hand side (RHS). These b_i coefficients may be stipulated as less than or equal to (≤) constraints, equality constraints (=), or greater than or equal to (≥) constraints.

Appendix A shows the initial tableau which includes the data collected for this study. The initial tableau will be referred to for explaining the model and data for this study. Appendix B explains the abbreviated row and column names used in the model.

The Target MOTAD model as used here is a mono (one) period model. Within the model there can be a varying number of states of nature. Within the model in the study there are basically four components. (1) The objective function is to maximize income (wealth) subject to defined restraints, including a target income. The target in this case is the amount equal to the annual withdrawal required for family living and other fixed costs. (2) The row constraints themselves can be broken down into four parts. (a) The technical constraints associated with the farming enterprises, such as land and labor. (b) The technical constraints associated with the financial aspects of the firm, e.g., equity and borrowing constraints. (c) The constraints associated with the target

TABLE III

A LINEAR PROGRAMMING TABLEAU

Row Name	Columns				RHS
	x_1	x_2	.....	c_n	
Objective Function	c_1	c_2	.....	c_n	maximize
Resource constraints:					
1	a_{11}	a_{12}	.....	a_{1n}	$\leq b_1$
2	a_{21}	a_{22}	.....	a_{2n}	$\leq b_2$
.	.	.	.....		.
.	.	.	.....		.
.	.	.	.....		.
.	.	.	.....		.
m	a_{m1}	a_{m2}	.....	a_{mn}	$\leq b_m$

Source: Peter B. R. Hazell and Roger D. Norton. *Mathematical Programming For Economic Analysis in Agriculture*. New York, NY: MacMillan Publishing Company, 1986.

that sum the weighted negative deviations from the target returns. (d) The accounting rows to calculate needed output for this analysis. (3) The alternative activities or enterprises (columns) that are available to this model. (4) The right-hand side (RHS) shows the magnitude of the constraints.

By referring again to Appendix A, the components above can be explained. The objective function is to maximize returns or wealth. The mathematical means of reaching the objective can be shown by assuming the solution consists of one unit of each activity.

$$\begin{aligned} \text{Max } Z = \; & (268.55 * \text{CCOWN}) + (268.55 * \text{CCRENT}) + \\ & (92.82 * \text{STKOWN}) + (92.82 * \text{STKRENT}) + \\ & (.1387 * \text{CD}) + (-.1790 * \text{BUYOPCAP}) + \\ & (-.1691 * \text{BUYLTCAP}) + (-3.88 * \text{LABHIRE}) + \\ & (3.88 * \text{OFLAB}) + (-15.59 * \text{RENTIN}) + \\ & (15.59 * \text{RENTOUT}) + (-1.52 * \text{LANDINV}) + \\ & (-10.69 * \text{COWINV}) \; = \; 710.32 \end{aligned} \tag{3.7}$$

From equation (3.7), a question may arise concerning principal payback. Since Target MOTAD is a single period model, the principal is assumed to be conveyed to the firm and then conveyed back to the lending institution within the workings of the model. Land rented by the firm is treated in the same manner.

Land is a technical constraint associated with the farming enterprises. In the initial tableau, it can be seen that CCOWN and CCRENT (cow/calf operation on owned and rented land, respectively) requires 5.92 hours of labor. STKOWN and STKRENT (stocker operation on owned and rented land, respectively) requires 1.50 hours of labor. LABHIRE (labor hired) adds to the

RHS (right hand side) of 2000 and OFLAB (off farm labor) subtracts from the RHS. This can be shown in the following equations:

$$(5.92 * CCOWN) + (5.92 * CCRENT) + (1.5 * STKOWN) + (1.50 * STKRENT) + (1 * OFLAB) + (-1 * LABHIRE) \leq 2000 \tag{3.8}$$

$$(5.92 * CCOWN) + (5.92 * CCRENT) + (1.5 * STKOWN) + (1.50 * STKRENT) + (1 * OFLAB) \leq 2000 + (1 * LABHIRE) \tag{3.9}$$

Equation (3.8) states that the hours required for the cow/calf operation plus the hours required for the stocker production plus the hours worked off the farm minus the amount of labor hired has to be less than or equal to 2000 hours. If the -1 * LABHIRE were carried over to the RHS as shown in equation (3.9) the -1 * LABHIRE would become +1 * LABHIRE, thus the labor hired adds to the RHS.

The technical constraints associated with the leverage of the model are EQUITY and MAXBORR (maximum amount that can be borrowed). The same mathematics apply to these constraints as the ones above. The equation for MAXBORR:

$$(1 * BUYOPCAP) + (1 * BUYLTCAP) \leq \$100,000 \tag{3.10}$$

Equation (3.10) states that the amount of BUYOPCAP (buy operating capital) plus the amount of BUYLTCAP (buy long-term capital) has to be less than or equal to $100,000.

The target portion of the model includes the rows from GM1970 (Gross margins of 1970) to LAMBDA (expected shortfall from the target). Z70 to Z85 are variables to measure the value of any deviations in income below the target. These negative deviations are multiplied by the probabilities of the states of nature (year) in which they occur. These are summed to give the total expected negative deviations from the target. This sum is shown in the solutions by LAMBDA. A mathematical interpretation of GM1970 can be shown:

(304.06 * CCOWN) + (304.06 * CCRENT) + (60.06 * STKOWN) +
(60.06 * STKRENT) + (.2011 * CD) + (-.2654 * BUYOPCAP) +
(-.2565 * BUYLTCAP) + (-4.26 * LABHIRE) + (4.26 * OFLAB) +
(-15.68 * RENTIN) + (15.68 * RENTOUT) + (-2 * LANDINV) +
(-6.43 * COWINV) + (1 * Z70) $\leq$ 25000 (3.11)

The set of gross margin rows are the returns of the activities minus the variable costs. These returns are used to reach a target income. The target incomes in this model are the amount assumed for family living. The magnitude of the target incomes are shown in the RHS.

LAMBDA (total expected negative deviations from the target) has a RHS set at an arbitrary high level of $100,000. This high value allows the model to draw from this row when deviations from the mean are negative and the solutions infeasible. The value taken from LAMBDA to allow feasible solutions are totaled as negative deviations from the target income. This total is a measure of risk. This risk value will be important to the interpretation of the results.

There are four accounting rows used to calculate values internally in the model. The RETOPER (returns to the operations) keeps up with the ordinary earnings of the activities. THE RETGAIN (returns to capital gain/loss) calculates the capital gain/loss associated with land or cows. The ACCTDEBT (accounting for debt) row accounts for the debt accumulated. The ASSET row figures the total assets. The last two rows can easily be used to calculate the debt/asset ratios.

The row of variables are the alternative activities that are available to the model. This model depicts a rancher with an opportunity to invest into a cow/calf and/or stocker operation on owned or rented land. A risk free certificate of deposit (CD) may be invested in. He may invest in operating or long-term capital, hire labor, or rent land. On the other hand, his labor or land may be used to generate earnings by the means of off farm labor or renting land to someone else.

Using the CCOWN column as an example, the structure of the activities can be explained. A unit of CCOWN will yield an expected return (c_j) of $169.33. This value is an average of the gross margins from 1975 to 1980 listed lower in the column. The CCOWN activity requires eight acres of owned land, one cow, $109.07 of operating capital, and 5.92 hours of labor. Next, are the gross margins mentioned above. The average gross margin is again listed in the returns to the operation row to account for the regular earnings (returns).

The right hand side (RHS) simply shows the magnitude of the constraints. Equity is stated as $100,000. Therefore, the amount of equity used in this model can not exceed $100,000. The initial model consists of RHS constraints that will allow the model to calculate a broad range of debt/asset ratios yet be as realistic as possible. Equity is constrained at $100,000. The maximum amount that can be borrowed is $400,000. Labor is constrained at 2000 hours (40 hours/week at 50 weeks/year). The amount of land that can be rented is constrained at 6400 acres (10 sections).

Further Explanation of the Model Components

The row labeled FORCELD (force land) requires that a minimum amount 640 acres of land be invested in for ranching purposes. The purpose of this row is to ensure the opportunity for a ranching operation to exist. The only a_{ij} associated with the FORCELD row falls under the LANDINV (land investment) column. The equational interpretation of this row is:

$$(1 * LANDINV) \geq 640 \tag{3.12}$$

This equation states that the amount of land invested in must be equal to or greater than 640 acres.

The second row that needs further explanation is the COW row. To be consistent with the comparable constraints, a less then (L) sign should be appropriate. The equation below shows that a less than would be incorrect:

$$(1 * C/COWN) + (1 * C/CRENT) + (-1 * COWINV) \leq 0$$

$$(1 * C/COWN) + (1 * C/CRENT) \leq (1 * COWINV) \tag{3.13}$$

Equation (3.13) states that the number of cow/calf on owned land plus the number of cow/calf units on rented land can be equal to or less than the number of cow/calf units invested in. This is incorrect since the number of cows used for production would have to be at least the number of cows invested in.

If less than is incorrect then maybe greater than or equal to (G) is the correct sign. The equation is as follows:

$$(1 * C/COWN) + (1 * C/CRENT) + (-1 * COWINV) \geq 0$$

$$= (1 * C/COWN) + (1 * C/CRENT) \geq (1 * COWINV) \quad (3.14)$$

Equation (3.14) is a mirror image of equation (3.13), and is also incorrect. The number of cow/calf units on owned land plus the number of cow/calf units on rented land can be equal to or greater than the number of cows invested in. A rancher cannot have greater number of cows for production than the number that was invested in.

The following equation shows that an equal sign is the correct answer.

$$(1 * C/COWN) + (1 * C/CRENT) + (-1 * COWINV) = 0$$

$$= (1 * C/COWN) + (1 * C/CRENT) = (1 * COWINV) \quad (3.15)$$

Equation (3.15) states that the number of cow/calf units on owned land plus the number of cow/calf units on rented land equals the number of cows invested in.

Two columns, LANDINV and COWINV, are not commonly seen separated from the associated production enterprises. The LTCAP (long-term capital) a_{ij}'s could easily be put in the CCOWN, CCRENT, columns. But the LTCAP a_{ij}'s were placed in the LANDINV and COWINV columns to show that when long term capital is invested in land or cows, a capital gain/loss will be captured.

CHAPTER IV

EMPIRICAL RESULTS

In this chapter the data and the empirical results of the Target MOTAD model described in Chapter III are discussed. The model estimated risks and returns subject to technical constraints and a target income. The results of the two models are presented together to allow an analysis of the farm plans calculated by the model.

Data

A series of Oklahoma cattle and stocker prices from 1970 to 1985 were collected (See Appendix C). The production yields are assumed to be constant. Thus, zero level of production risk is assumed. The prices and yields are used to calculate gross incomes for each year. The production costs taken from the *Oklahoma Crop and Livestock Budgets* are subtracted from the gross incomes to give the gross margins for the cow/calf and stocker activities.

The yearly differences in the values of brood cows and pasture land are the capital gains or losses. The pasture values were assumed to have a high value of $250/acre in 1982. The Oklahoma land index was used to calculate the remaining values. Data on Kansas Bluestem pasture rental values are used. These values are assumed to represent values common to Osage County.

The short term and long term interest rates are historical rates charged by the Production Credit Association (PCA) and Federal Land Bank (FLB), respectively. The interest rates were divided by .9 to reflect the required stocks. The Certificate of Deposit (CD) rates used are the historical returns for a three-month CD. Also, the wage rates are the historical minimum wage rates. All data used were indexed by an implicit price deflator for Gross National Product (GNP) to 1985 dollars.

Assumptions of the Model

To illustrate the affects of debt upon the structure of the firm, many variables that regularly influence the firm's structure and operation are held as constants. The effects of taxes, depreciation, and other economic variables are assumed to be constant for every state of nature. Thus, these variables do not affect the solutions of the model. Elements of nature, such as weather, insects, and disease are also constant for every state of nature.

The gross margins from 1970 to 1985 incorporate price variations (business risk) into the model. These variations will remain the same for each state of nature, thus for each farm plan. The Target MOTAD model calculated the debt/asset ratios and the associated risk. Therefore, much of the change in risk can be attributed to the change in the financial structure of the firm.

The affects of real capital gains or losses are shown separately. It is assumed the real capital gains (losses) increase (decrease) regular earnings thus increase (decrease) the wealth of the firm.

Initial Model Specifications

A ranching operation was modelled using prices, yields, costs of production, and ranching requirements typical for Osage County in northeast Oklahoma. A representative 640 acre ranch is modelled for this analysis. The enterprises consist of cow/calf production on owned and rented land, summer stocker production (buy May - sell October) on owned and rented land, certificates of deposit (CD) investment, renting land in or out, hiring labor, and off farm employment. Capital gain/loss on land and cows are shown separately. A lower bound of 640 acres was placed on owned land. Equity and borrowing capacity will vary as these aspects are the central points of this analysis. Labor has an upper bound of 2000 hours (40 hours/week times 50 weeks/year).

The aij's in the model are the specific production requirements of the enterprises. For example, the cow/calf production enterprise requires eight acres of pasture per cow. It takes $165.30 operating capital and 5.92 hours of labor per cow per year. The gross margin aij's are the gross income less the production cost. The average of the gross margins are an average expected return for the cow/calf operation, thus the cj is an average return.

The average expected returns of the activities in the basis make up the objective function. Therefore, the objective function may be called "expected returns." Likewise, the lambda row is the average expected negative deviation from the expected return. Thus, lambda may be called 'expected risk.'

The expected returns calculated by the models are the returns to the unpaid resources of the firm. Thus, the expected returns are returns to equity, labor, overhead, management, and risk.

The first model presented has equity and available debt constraints of $100,000 and $400,000, respectively. The target income that includes family withdrawal and required fixed costs is initially $25,000. Other constraints are labor at 2000 hours and renting in land at 6400 acres. The second model assumes the same constraints but equity and available debt capital is increased to $200,000 and $800,000 respectively.

Expected Risk and Return

The expected risk and return are the lambda and the objective value, respectively. The results obtained by solving the model by parametrically varying lambda are listed in Tables IV and V. Notice that both the expected risks and the returns increase as we move to increasingly higher farm plan levels.

The relative change in expected risk and return can be visualized more easily by plotting the values on a graph such as Figure 1. If the farm plans with the least risk for each level of expected returns are defined, the relationship may be referred to as a risk-return frontier. The frontier shows the maximum expected income for any given level of risk. Or stated another way, the frontier shows the minimum risk level for any level of expected returns. Therefore, it is possible to have other farm plans below the frontier, but not above it.

The frontier is a good analytical tool in defining efficient alternatives for using the decision making process. The frontier identifies the farm plans that have the greatest expected returns for any level of risk. Firms that prefer more to less and are risk averse will prefer a farm plan on the frontier to any below the frontier.

The asterisk on the risk-return frontier represents the basis changes. This is not saying these points are the only alternative plans. The model will slide along a constraint until a basis change is made. The farm plan chosen should lie on the frontier but the exact farm plan chosen depends on the unknown utility of the farmer.

TABLE IV

TARGET MOTAD RESULTS REPRESENTING DIFFERENT
FARM PLANS WITH $100,000 EQUITY-$400,000 AVAILABLE DEBT (A)

	MIN LAMBDA			MED LAMBDA			MAX LAMBDA		
EQUITY	100000	100000	100000	100000	100000	100000	100000	100000	100000
DEBT	72334	73151	89204	115325	140190	150720	185976	293149	400000
ASSETS	172334	173151	189204	215325	240190	250720	285976	393149	500000
D/A RATIO	42%	42%	47%	54%	58%	60%	65%	75%	80%
EX RETURN	11438	11560	13974	16184	18287	19178	21811	29816	37797
EX RISK	14939	14942	15690	17227	18943	19773	22663	31707	40723
COW	0	0	0	0	0	0	0	0	0
STOCKER	143	149	256	393	525	580	767	1333	1897
CD	0	0	0	0	0	0	0	0	0
RENT IN	0	0	0	344	673	812	1277	2693	4104
RENT OUT	280	266	0	0	0	0	0	0	0
LAB HIRE	0	0	0	0	0	0	0	0	846
OF LABOR	1784	1776	1616	1409	1211	1128	849	0	0
# YRS NEG DEV	11	10	10	9	8	8	8	9	9
MAX NEG DEV	2900	2888	2675	3100	4020	4410	5780	9943	14093

A TARGET = $25000
EQUITY = $100000
DEBT = $400000

TABLE V

TARGET MOTAD RESULTS REPRESENTING DIFFERENT
FARM PLANS WITH $200,000 EQUITY-$800,000 AVAILABLE DEBT (A)

	MIN LAMBDA			MED LAMBDA				MAX LAMBDA		
EQUITY	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000
DEBT	0	0	0	0	0	150720	193149	200235	213639	473825
ASSETS	200000	200000	200000	200000	200000	350720	393149	400235	413639	673825
D/A RATIOS	0%	0%	0%	0%	0%	43%	49%	50%	52%	70%
EX RETURN	25408	26760	27367	30556	31797	44547	47716	48245	49247	68680
EX RISK	5748	5830	6019	7126	7793	19411	22839	23412	24604	48051
COW	0	0	0	0	0	0	0	0	0	0
STOCKER	66	116	138	256	313	1109	1333	1370	1441	2816
CD	39276	31796	28435	10795	0	0	0	0	0	0
RENT IN	0	0	0	0	142	2133	2693	2786	2963	6400
RENT OUT	473	1825	293	0	0	0	0	0	0	0
LAB HIRE	0	0	0	0	0	0	0	56	162	2224
OF LABOR	1900	1825	1792	1616	1530	336	0	0	0	0
# YRS NEG DEV	4	5	6	7	7	7	7	6	6	7
MAX NEG DEV	2280	2167	2117	1851	1761	6940	8588	8864	9384	19492

A TARGET = $25000
EQUITY = $200000
DEBT = $800000

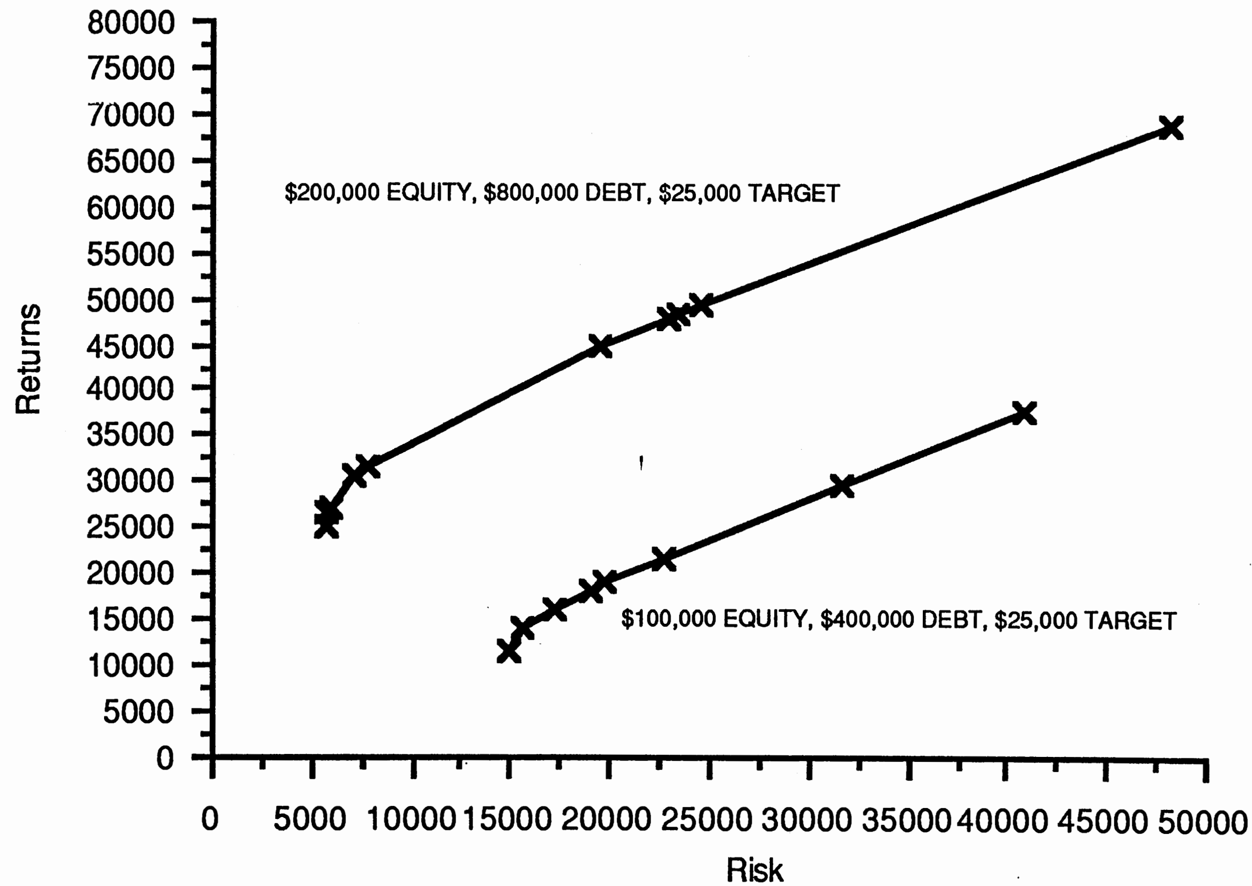

Figure 1. Risk-Return Frontiers Representing Different Levels of Equity and Debt

Results of the Target MOTAD Models

The availability of owner's equity is an important factor to the survivability of the firm. Table IV shows that with 100,000 equity-$400,000 available debt, the firm must borrow capital to have feasible Target MOTAD solutions due to the investment in land. Table V shows that with 200,000 equity-$800,000 available debt, there are several model solutions that do not require debt to finance the firm's operations.

The results from the first model show that the average expected risk is greater than the average expected returns. Therefore, from 1970 to 1985, on the average, the expected negative deviations would be greater than the expected returns. Having an equity constraint of $100,000, any farm plan the model calculates will be highly risky. A note of reminder is that the results of both models reflect a constraint that an investment in 640 acres must be made.

Other aspects of the model is that out of the enterprise alternatives (cow, stocker, and CD), stocker is the only enterprise in the basis. This is due to stocker having a higher average return than either cow or CD.

The farm plans with the lowest expected risk consist of renting land out and working off farm. The farm plans with the highest risk require debt financing plus rented land and hired labor. Also the earnings from renting land out and working off farm that were available in the lower risk farm plans, are not available for the higher risk farm plans.

The results from the second model, which assumes $200,000 equity and $800,000 debt, suggest that equity is important to the firm and that higher equity reduces risk. It is shown that risk can be held very low due to the absence of any debt repayment obligation, having low risk CD's, renting land out, and working off the farm. The two models are shown graphically in Figure 1.

The results of the second model illustrate the additional risk assumed by the addition of debt financing. This can be seen by comparing columns 5 and 6. The two farm plans have the same activities in the solutions. Column 5 shows 313 stockers while column 6 shows 1109. Since the price variations in the gross margins reflect the business risk, this risk should increase as the number of stockers increase. But the majority of the increase in the expected risk, from $7793 to $19,411 is associated with the debt of $150,720.

A comparison of the two models can be made by comparing column 3 of the first model and column 4 of the second model. The results of both models show 256 stockers and 1616 hours working off the farm. The first model consist of $89,204 of borrowed capital and does not have any CD's while the second model has zero debt and $10,795 of CD's. Thus, the decrease in risk can be attributed to the low risk CD's and the absence of debt.

Constraining the Models

The model calculated the historical data entered and provided a frontier resulting from combining risk and return The optimal debt of an individual firm depends on the unknown utility function of the individual operator.

The last two rows of results listed in Table IV and V illustrate the number of times out of 16 states of nature (1970-1985) that the farm plan had negative deviations relative to the target income. Also shown is the maximum negative deviation associated with their farm plans.

The results propose that for both models, negative deviations occur 38 percent to 69 percent of the time. Even the farm plan with the lowest risk from the second model has negative deviations 25 percent of the time. With the first model, the number of times that the negative deviations occurred is greater for the lower risk farm plans than for the higher risk farm plans. This is mainly due to the constraint that the model investment in 640 acres of pasture land. The quantity of state of nature that negative deviations occurred may be great but the magnitude of the negative deviations are not as great for the low risk plans as for the high risk plans.

A maximum allowable negative deviation constraint was placed upon the models. This constraint provided an upper limit for debt. The constraint for the model consisting of $100,000 equity is that negative deviations over $3000 for any state of nature will not be allowed and with $200,000 equity, negative deviations over $7000 for any state of nature will not be allowed.

Given this constraint, the maximum allowable debt/asset (D/A) ratio would be less than 54 percent D/A for the first model and a D/A ratio of 43 percent or less for the second model. Again, the D/A ratio assumed will depend on the individual's utility curve but the constraints establish debt limits to the firm.

USDA proposes that a farm firm with a D/A ratio below 40 percent and a positive cash flow will demonstrate zero or low financial stress, whereas, a firm with a D/A ratio above 40 percent and a negative cash flow will exhibit financial stress. The results concluded by this model, especially the first model with $100,000 equity, support this hypothesis.

CHAPTER V

SENSITIVITY OF ANALYSIS

This chapter considers the question of "what if" the model and/or its constraints were changed. There will be three changes introduced in this chapter. The first and most important is the deletion of the constraint requiring the model to invest in 640 acres of pasture land. The second results illustrate the affects on the firm if the farm family lives indigently. The last topic addressed is whether nominal data values or real data values should be used.

Optimal Investment of Available Capital

The models described in Chapter IV had a constraint that the model invest in 640 acres of pasture land. The model simulation described in this section does not require a land investment constraint. Table VI depicts the empirical results of the simulation and Figure 2 illustrates the results graphically.

The model is given the freedom to determine the best alternative investments. As shown by Table VI, the farm plans with minimal risk consist of mainly certificate of deposit (CD) investment. Working off farm also adds to the expected returns . Land is rented to support a small number of cows and stockers.

The farm plans with a high level of risk do not invest in cows or CDs. The risk associated with these plans is attributed to 1) the risk associated with the price variation of stockers and 2) the risk associated with the acquired debt.

TABLE VI

TARGET MOTAD RESULTS REPRESENTING THE MODEL WITHOUT A LAND PURCHASE CONSTRAINT (A)

	MIN LAMBDA			MED LAMBDA			MAX LAMBDA	
EQUITY	100000	100000	100000	100000	100000	100000	100000	100000
DEBT	0	0	0	0	0	0	152406	384620
ASSETS	100000	100000	100000	100000	100000	100000	252406	484620
D/A RATIO	0%	0%	0%	0%	0%	0%	60%	79%
EX RETURN	22189	22471	23563	24978	26636	30736	44512	61856
EX RISK	3198	3227	3475	4136	5022	7462	23448	45156
COW	16	15	0	0	0	0	0	0
STOCKER	21	34	88	153	229	409	1333	2560
CD	83678	81901	80184	70881	56461	0	0	0
RENT IN	184	209	222	384	574	1263	3333	6400
RENT OUT	0	0	0	0	0	0	0	0
LAB HIRE	0	0	0	0	0	0	0	1840
OF LABOR	1871	1856	1866	1769	1655	1208	0	0

A
TARGET = $25000
EQUITY = $100000
DEBT = $400000

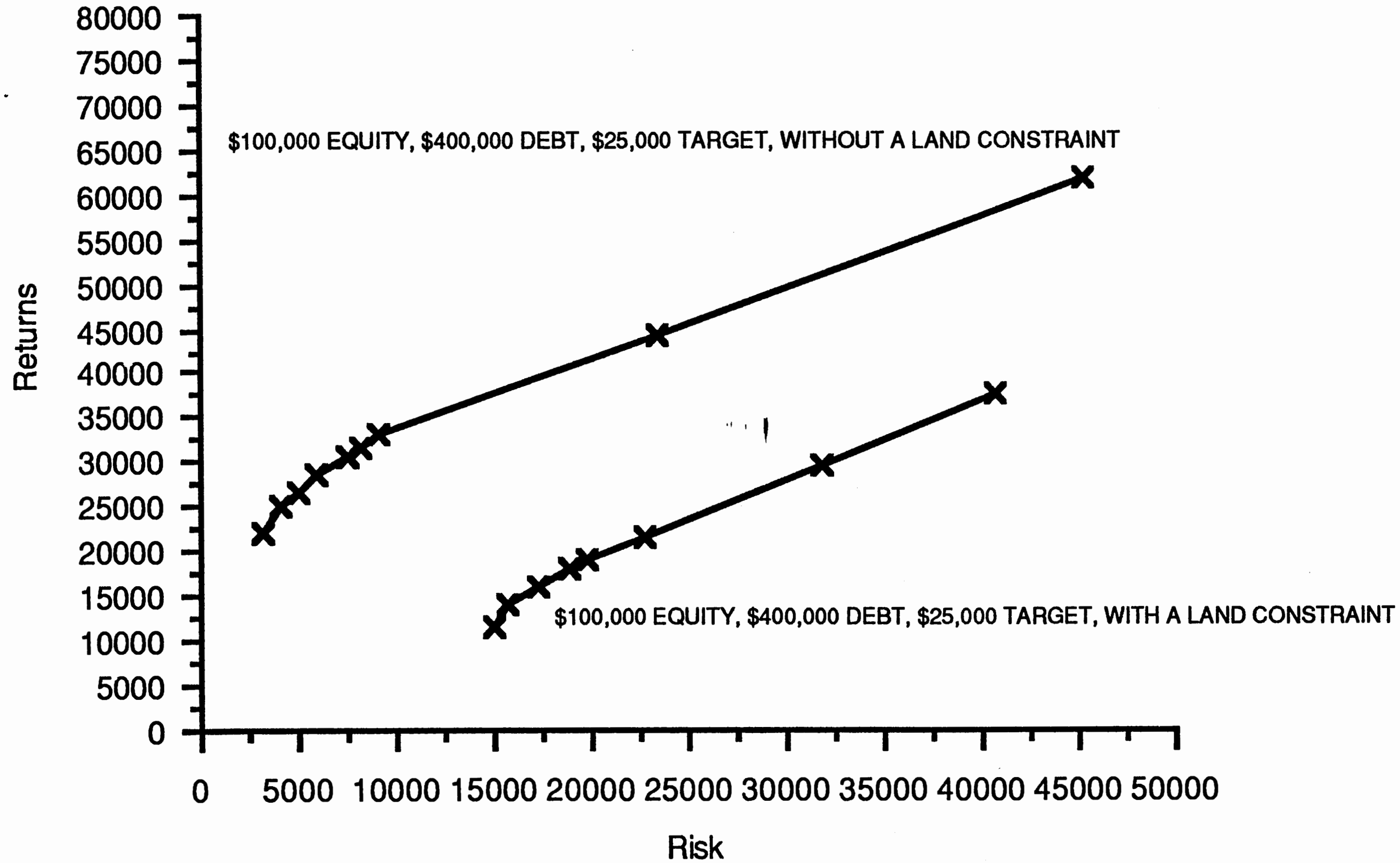

Figure 2. Risk-Return Frontiers Representing Models With and Without a Land Constraint

Requiring the model to invest in 640 acres of pasture land reduced the probability of achieving the target level of income, thus increasing risk to the firm. Figure 2 illustrates that at a return of $29,816, the farm plan with a land constraint has an associated risk of $31707 and the farm plan without the land constraint has risk of approximately $7,000. Or to state it another way, with a risk of $31,700, the farm plan with the land constraint will return $29,816 while a farm plan without the land constraint has a return of approximately $51,000.

Both scenarios suggest that, given the models assumptions, land is a poor investment for farm firms. Thomason used the Capital Asset Pricing Model (CAPM) in a portfolio framework to determine if farmland is a feasible investment, in a diversified portfolio, for investors who are not farm operators. The results determine that adding land to a diversified portfolio is suitable for non-farmers but unsuitable for farmers. The results of the Target MOTAD model also suggest that to increase returns and lower risk, it is more advantageous to rent land than to purchase land, especially for highly leveraged firms.

Comments About Target Income

The value that depicts family living expenses and other fixed costs may vary widely from region to region and within different types of farming operations. The $25,000 target income used in this study was an arbitrary assumption of the model. A model with a $15,000 target was computed to show that as a farm family's withdrawals becomes more frugal, the amount of risk (as defined by lambda) imposed on the firm would decrease.

Today, farms are capital intensive and highly mechanized. Expenses cannot easily be reduced without changing the operations of the firm. For example, machinery can not be easily adjusted to save on expenses. A tractor will use the same amount of fuel per hour this year as it did the year before barring changes in the operation.

Assuming a positive propensity to consume, as the firm-size increases so may the amount of family living withdrawal. If the firm's total assets are $100,000, a family living withdrawal of $15,000 may be suitable. If the firm's total assets are higher, such as $500,000, a higher family living withdrawal such as $25,000 may be more accurate.

Reduced Target Income

A model was simulated in which the target income was lowered from $25,000 to $15,000. The target income is the amount of income withdrawn for family living and other fixed costs. This implies that the life style of the family will be more mediocre in this model than those proposed in Chapters III and IV. The constraints are the same as the ones established for the first model in Chapter III. There may be $100,000 equity-$400,000 available debt, 2000 hours of available family labor, and 6400 acres that may be rented. Also, the constraint that 640 acres of pasture land must be invested in is the same for both models.

The results of the model with a $15,000 target and the model with a $25,000 target are shown respectively, to allow a comparison of the models (Table VII). Figure 3 has the results of the model with a $25,000 target imposed on the graph depicting the model with a $15,000 target. Since the only difference in the two models is the target income, there are several identical farm plans. Column 7 of the first model and column 6 of the second model are identical except the degree of risk. The risk is decreased due to the decrease in the target income. Assuming a state of nature of $20,000, the model with a

TABLE VII

TARGET MOTAD RESULTS REPRESENTING THE MODEL
WITH A TARGET INCOME OF $15,000 (A)

	MIN LAMBDA			MED LAMBDA				MAX LAMBDA		
EQUITY	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000
DEBT	54551	58271	67287	80712	89204	96131	150720	293149	335138	400000
ASSETS	154551	158271	167287	180712	189204	196131	250720	393149	435138	500000
D/A RATIO	35%	37%	40%	45%	47%	49%	60%	75%	77%	80%
EX RETURN	8764	9323	10679	12697	13974	14560	19178	29816	32952	37797
EX RISK	7984	8002	8424	9274	9936	10470	14773	26446	29887	35732
COW	0	0	0	0	0	0	0	0	0	0
STOCKER	25	50	110	199	256	292	580	1333	1555	1897
CD	0	0	0	0	0	0	0	0	0	0
RENT IN	0	0	0	0	0	91	812	2693	3247	4104
RENT OUT	576	514	364	141	0	0	0	0	0	0
LAB HIRE	0	0	0	0	0	0	0	0	332	846
OF LABOR	1961	1924	1834	1700	1616	1561	1128	0	0	0

A TARGET = $15000
EQUITY = $100000
DEBT = $400000

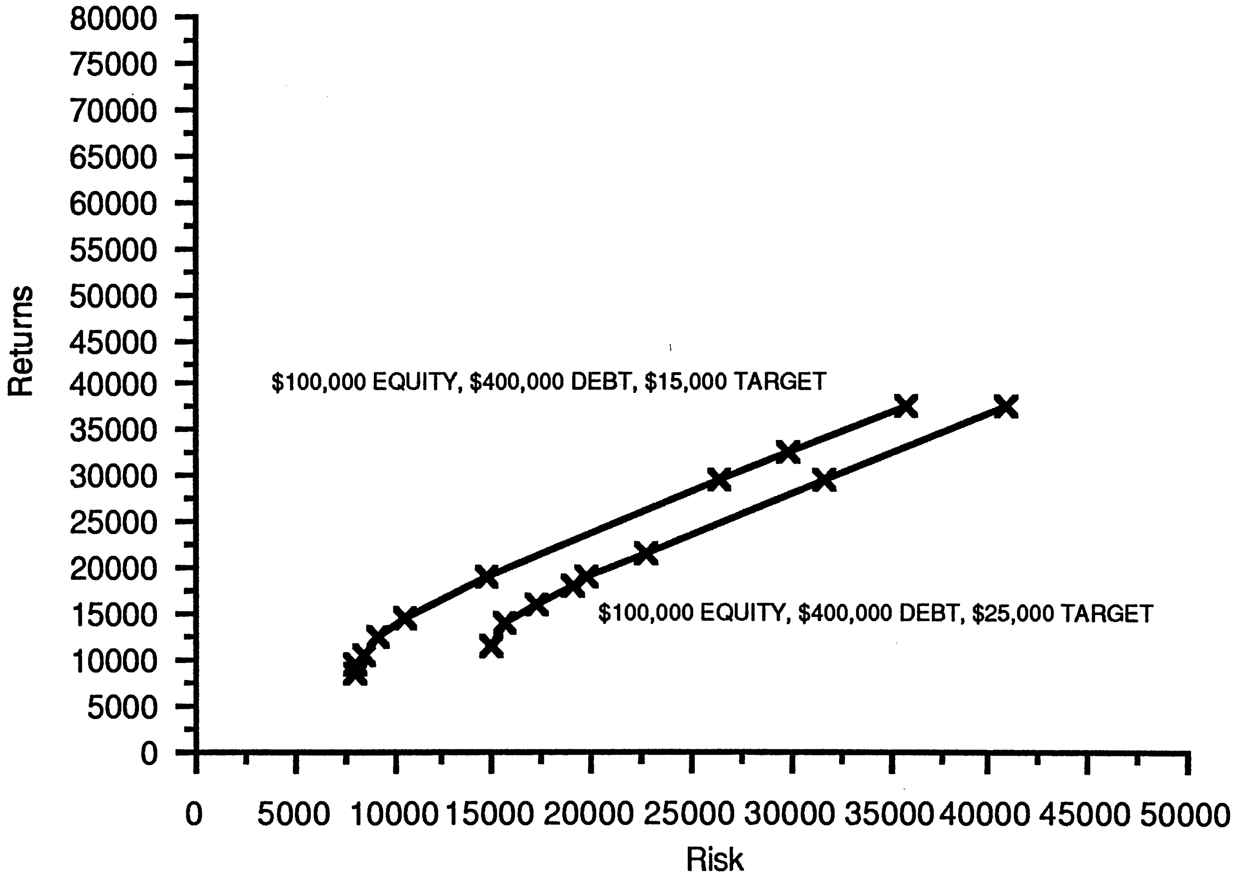

Figure 3. Risk-Return Frontiers Representing Models With Target Incomes of $15,000 and $25,000

target income of $15,000 will have a negative deviation of $5,000 while the model with a target income of $25,000 will not have any negative deviation.

Nominal Model

All models described in Chapters IV and V use data that are indexed to 1985 dollars by an implicit Gross National Product (GNP) inflator. By using "real" values, the effects of inflation are taken out of the model. Real values are used in the models because the Target MOTAD model used is a one-period model. To put the data in a one year framework, values are inflated to 1985 values. Also, the affects of debt upon the firm, not inflation, is the focus of the study.

Which values should be used in a financial model, real or nominal? There are many concepts that arise concerning a financial model. Some that may arise are 1) firms are influenced by the affects of inflation, therefore, inflation should be used in the model and 2) firms borrow in nominal dollars and pay back in nominal dollars.

A Target MOTAD model was constructed using data in nominal dollars. Table VIII and Figure 4 illustrates the results numerically and graphically. The results of the nominal model, just as in the real models, show that as returns to the firm are increased (decreased) the risk increases (decreases). The two types of models are structurally different and should not be compared.

Considering the years in the model as states of nature, an empirical model may be constructed using nominal data values. Many cj's, aij's, and right hand side constraints change since nominal values are used. The gross margins are the nominal gross incomes less operating costs. The target income of $25,000

TABLE VIII

TARGET MOTAD RESULTS REPRESENTING THE MODEL USING NOMINAL DATA VALUES (A)

	MIN LAMBDA				MED LAMBDA				MAX LAMBDA		
EQUITY	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000
DEBT	31615	36994	135288	160210	218857	237495	400000	400000	400000	400000	400000
ASSETS	131615	136994	235288	260210	318857	337495	500000	500000	500000	500000	500000
D/A RATIOS	24%	27%	57%	62%	69%	70%	80%	80%	80%	80%	80%
EX RETURN	19264	19598	25659	27570	32067	33426	45267	49509	52439	54570	58028
EX RISK	8039	8068	8829	9139	9870	10129	12389	14014	15731	18676	24477
COW	27	39	262	303	399	430	694	494	324	200	0
STOCKER	168	164	93	133	226	256	517	1233	1794	2202	2865
CD	0	0	0	0	0	0	0	0	0	0	0
RENT IN	0	88	1701	2125	3124	3441	6209	6400	6400	6400	6400
RENT OUT	0	0	0	0	0	0	0	0	0	0	0
LAB HIRE	0	0	0	0	706	930	2887	2777	2613	2493	2298
OF LABOR	1585	1518	300	0	0	0	0	0	0	0	0

A TARGET = $25000
EQUITY = $100000
DEBT = $400000

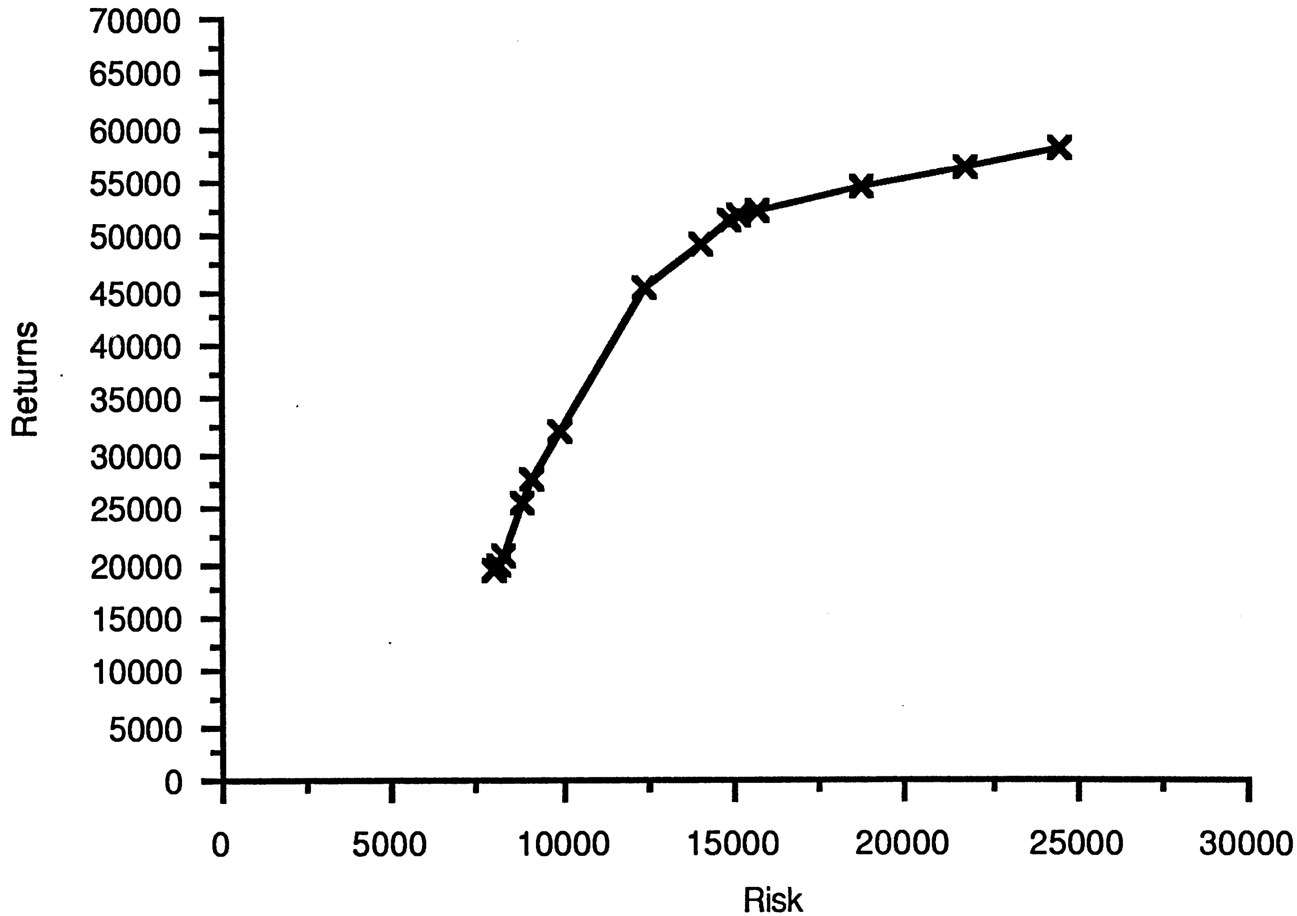

Figure 4. Risk-Return Frontier Representing a Model Using Nominal Data Values

and the probabilities relating to the negative deviations (LAMBDA) are indexed to reflect the nominal weight of a given state of nature.

The results of the nominal model show a completely different set of farm plans than the real model. Cows are included in the results of the model using nominal values. Cows and land show positive capital gains using nominal values and negative capital gains using real values. Cows and land now show greater returns since the model calculates capital gains as regular earnings. The purpose for including this section is simply to illustrate the concept that financial models may provide a more realistic picture for the farmer if nominal values are used.

Correlation Coefficients

A statistical program is used to calculate the Pearson Correlation Coefficients of the "real" gross margin values and the "nominal" gross margin values. A correlation program is used to determine if a relationship exists between the variables, used in the model, which occur together in a way not expected from chance alone. That is, the variables may have a positive or negative association. The variables used are COWO (cows on owned land), COWR (cows on rented land), STKO (stockers on owned land), STKR (stockers on rented land), and CD (certificate of deposit).

The correlation coefficients are numbers that indicate the degree of correlation between two variables. The correlation coefficients calculated from the gross margins values from 1970 to 1985 are shown in Table IX. The results calculated from "real" values show that as the returns from cows increase (decrease), the returns from stockers increase (decrease). The results continue to show that as the returns from cows increase (decrease), the returns from

TABLE IX

PEARSON CORRELATION COEFFICIENTS DETERMINED BY REAL AND NOMINAL VALUES

	COWO	COWR	STKO	STKR	CD
COWO	1.00000 0.0000	1.00000 0.0001	0.56033 0.0240	0.56033 0.0240	0.38719 0.1384
COWR	1.00000 0.0001	1.00000 0.0000	0.56033 0.0240	0.56033 0.0240	0.38719 0.1384
STKO	0.56033 0.0240	0.56033 0.0240	1.00000 0.0000	1.00000 0.0000	-0.01485 0.9565
STKR	0.56033 0.0240	0.56033 0.0240	1.00000 0.0000	1.00000 0.0000	-0.01485 0.9565
CD	0.38719 0.1384	0.38719 0.1384	-0.01485 0.9565	-0.01485 0.9565	1.00000 0.0000

A CALCULATED FROM "REAL" VALUES

	COWO	COWR	STKO	STKR	CD
COWO	1.00000 0.0000	1.00000 0.0001	0.53651 0.0321	0.53651 0.0321	0.50637 0.0453
COWR	1.00000 0.0001	1.00000 0.0000	0.53651 0.0321	0.53651 0.0321	0.50637 0.1453
STKO	0.53651 0.0321	0.53651 0.0321	1.00000 0.0000	1.00000 0.0000	0.32026 0.2265
STKR	0.53651 0.0321	0.53651 0.0321	1.00000 0.0000	1.00000 0.0000	0.32026 0.2265
CD	0.50637 0.0453	0.50637 0.0453	0.32026 0.2265	0.32026 0.2265	1.00000 0.0000

A CALCULATED FROM "NOMINAL" VALUES

certificates of deposit increase (decrease). But as the returns from stockers increase (decrease), the returns from certificates of deposit decrease (increase).

The correlation coefficients determined by "nominal" values show that the variables in the model all have a positive correlation. Therefore, as the returns of the variables increase (decrease), an associated variable also increases (decreases).

There is a positive correlation between cows or stockers and certificates of deposit. This may be explained by the upward trend in returns for all variables during the time period used in this study.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

Summary

The results of this analysis are specific for a particular study area, period of time, and limited enterprises. The specific results could differ if other areas, time periods, or enterprises were tested. The underlying concept of leverage is to increase income. But this increased income also has an increased risk associated with it. This study supports this concept by pointing out that to the extent that the time period from 1970 to 1985 is typical of agricultural returns. too much leverage is extremely detrimental to the firm's survival.

A risk programming model was used to compute an empirical financial leverage analysis of a model farm. The financial conditions of the 1970's and early 1980's were presented to introduce the importance of financial analysis and risk management. The concepts of leverage, capital gain/loss, risk, risk modelling theory, and safety-first criteria were presented. Although these are not the only important concepts of financial analysis and risk management, they are the most important concepts to this study.

The Target MOTAD used for this analysis was presented in Chapter III. This risk programming model is a form of linear programming (LP) and is mathematically conceived. The theory was presented as much as possible in layman's terms to avoid the confusion of a highly mathematical model. Even though, some technical theory was needed to present the Target MOTAD model.

The initial results for two models were presented to show the effects of equity and debt upon the structure of the firm. A Risk-Return frontier was constructed from the efficient farm plans calculated by the model. An upper limit on debt was established by constraining the negative deviations.

Next was the "what if" chapter. Changes where made to the model and the results of those changes were analyzed.

Conclusions

The initial results of the empirical Target MOTAD model were presented in Chapter IV. Two models consisting of $100,000 equity-$400,000 debt and $200,000 equity-$800,000 debt, respectively, were simulated. The initial results showed the importance of equity to the financial structure of the firm. The higher equity level reduced expected risk given an expected return. Or stated another way, the higher equity level increased expected return given an expected risk.

A constraint was placed on the maximum allowable negative deviation. This enabled an upper limit to be established for debt/asset (D/A) ratios. For the model consisting of $100,000 equity-$400,000 debt, the maximum allowable negative deviation for any state of nature was established at $3,000 while the model consisting of $200,000 equity-$800,000 debt had a maximum allowable negative deviation for any state of nature of $7,000. The results showed a maximum D/A ratio of 54 percent and 43 percent, respectively.

Changes in the model's constraints and/or structure were presented in Chapter V. The first model presented deleted the constraint requiring an investment in 640 acres of pasture land. The results showed that the investment in land decreases the returns to the firm, thus, acquisition of land may prove unfavorable to farmers.

A model was constructed using a $15,000 target income and was compared to a model consisting of a $25,000 target income. The remaining constraints were the same for both models. The results show that risk can be reduced if the farm family lives more indigently.

The last model was constructed using nominal data values. The results were different from all preceding results. The change may be due to the positive affects of capital gains for cows and land. It was discussed that the concept of using nominal data values rather than real data values may be appealing to financial models.

Suggestions for Further Research

The traditional means of financial analysis has been in real terms. But just as farmers must develop and/or even change their traditional ways of farming, researchers may need to develop and/or change their traditional means of analysis. Therefore, some suggestions for further research are to analyze the concept that financial problems (models) should be dealt with in nominal terms rather than real. Although real terms reduce the effects of inflation and bring all years studied in constant terms, firms borrow money and pay back loans in nominal dollars. Firms must also deal with the influences of inflation. Within this framework, a multi-period linear programming model may be compared to a single-period model to establish the usefulness of each. A multi-period model may handle concepts of depreciation, amortization, and even nominal dollars, but the time and cost required may exceed the gain.

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APPENDIXES

APPENDIX A

INITIAL TABLEAU

TARGET MOTAD MODEL 1970 TO 1985

ACTIVITY	CCOWN	CCRENT	STKOWN	STKRENT	CD	EQOP	EQLT	BUYOPCAP	1....1 ACTIVITY
	.	.	.	.	.	.	.	.	
CJ	268.55000	268.55000	92.82000	92.82000	.13870	.	.	.17900-	CJ
LANDOWN	8.00000	.	2.50000	.	.	.	.	.	LANDOWN
LANDRENT	.	8.00000	.	2.50000	.	.	.	.	LANDRENT
COW	1.00000	1.00000	.	.	.	.	.	.	COW
OPERCAP	165.30000	165.30000	150.33000	150.33000	.	1.00000-	.	1.00000-	OPERCAP
LTCAP	.	.	.	.	.	.	1.00000-	.	LTCAP
EQUITY	.	.	.	.	1.00000	1.00000	1.00000	.	EQUITY
MAXBORR	.	.	.	.	.	.	.	1.00000	MAXBORR
LABOR	5.92000	5.92000	1.50000	1.50000	.	.	.	.	LABOR
GM1970	304.06000	304.06000	60.06000	60.06000	.20110	.	.	.26540-	GM1970
GM1971	316.06000	316.06000	114.65000	114.65000	.12630	.	.	.20350-	GM1971
GM1972	373.45000	373.45000	196.81000	196.81000	.11150	.	.	.18740-	GM1972
GM1973	456.86000	456.86000	148.01000	148.01000	.18930	.	.	.20280-	GM1973
GM1974	181.53000	181.53000	26.68000-	26.68000-	.21240	.	.	.21670-	GM1974
GM1975	157.04000	157.04000	139.85000	139.85000	.12110	.	.	.18650-	GM1975
GM1976	187.50000	187.50000	13.48000	13.48000	.09360	.	.	.16210-	GM1976
GM1977	194.58000	194.58000	74.14000	74.14000	.09260	.	.	.14530-	GM1977
GM1978	348.66000	348.66000	172.01000	172.01000	.12760	.	.	.15140-	GM1978
GM1979	441.40000	441.40000	76.29000	76.29000	.15940	.	.	.16910-	GM1979
GM1980	328.72000	328.72000	171.74000	171.74000	.17040	.	.	.18620-	GM1980
GM1981	239.63000	239.63000	100.65000	100.65000	.18910	.	.	.19660-	GM1981
GM1982	203.31000	203.31000	77.87000	77.87000	.13710	.	.	.17800-	GM1982
GM1983	196.26000	196.26000	26.76000	26.76000	.09760	.	.	.13740-	GM1983
GM1984	179.50000	179.50000	90.56000	90.56000	.10720	.	.	.14560-	GM1984
GM1985	188.27000	188.27000	48.84000	48.84000	.08250	.	.	.13030-	GM1985
RETOPER	268.55000	268.55000	92.82000	92.82000	.13870	.	.	.17900-	RETOPER
ACCTDEBT	.	.	.	.	.	.	.	1.00000	ACCTDEBT
ASSETS	.	.	.	.	1.00000	1.00000	1.00000	1.00000	ASSETS

TARGET MOTAD MODEL 1970 TO 1985

ACTIVITY	BUYLTCAP	LABHIRE	OFLAB	RENTIN	RENTOUT	LANDINV	COWINV	Z70	2....1 ACTIVITY
	.	.	.	.	.	.	.	.	
CJ	.16910-	3.88000-	3.88000	15.59000-	15.59000	1.52000-	10.69000-	.	CJ
FORCELD	.	.	.	.	.	1.00000	.	.	FORCELD
LANDOWN	.	.	.	.	1.00000	1.00000-	.	.	LANDOWN
LANDRENT	.	.	.	1.00000-	.	.	.	.	LANDRENT
COW	.	.	.	.	.	.	1.00000-	.	COW
OPERCAP	.	.	.	15.59000	.	.	.	.	OPERCAP
LTCAP	1.00000-	.	.	.	.	235.50000	459.64000	.	LTCAP
MAXBORR	1.00000	.	.	.	.	.	.	.	MAXBORR
LABOR	.	1.00000-	1.00000	.	.	.	.	.	LABOR
RENTMAX	.	.	.	1.00000	.	.	.	.	RENTMAX
GM1970	.25650-	4.26000-	4.26000	15.68000-	15.68000	2.00000-	6.43000-	1.00000	GM1970
GM1971	.21970-	4.03000-	4.03000	14.47000-	14.47000	7.00000	89.16000	.	GM1971
GM1972	.19800-	3.84000-	3.84000	14.45000-	14.45000	13.00000	115.95000	.	GM1972
GM1973	.18750-	3.61000-	3.61000	14.83000-	14.83000	24.00000	333.65000-	.	GM1973
GM1974	.18710-	4.14000-	4.14000	17.50000-	17.50000	12.00000	2.24000-	.	GM1974
GM1975	.18190-	3.96000-	3.96000	16.34000-	16.34000	10.00000	4.69000-	.	GM1975
GM1976	.17030-	4.07000-	4.07000	17.34000-	17.34000	7.00000	1.43000-	.	GM1976
GM1977	.15470-	3.82000-	3.82000	17.76000-	17.76000	6.00000	221.57000	.	GM1977
GM1978	.14350-	4.10000-	4.10000	17.17000-	17.17000	3.00000	27.97000	.	GM1978
GM1979	.14530-	4.12000-	4.12000	18.19000-	18.19000	22.00000	86.81000-	.	GM1979
GM1980	.15050-	4.04000-	4.04000	16.81000-	16.81000	2.00000-	84.98000-	.	GM1980
GM1981	.14880-	3.98000-	3.98000	14.73000-	14.73000	3.00000-	58.82000-	.	GM1981
GM1982	.15230-	3.74000-	3.74000	14.30000-	14.30000	23.00000-	28.98000-	.	GM1982
GM1983	.13910-	3.60000-	3.60000	13.77000-	13.77000	10.00000-	3.91000-	.	GM1983
GM1984	.13470-	3.46000-	3.46000	13.23000-	13.23000	54.00000-	42.57000-	.	GM1984
GM1985	.13610-	3.35000-	3.35000	12.90000-	12.90000	34.00000-	28.85000	.	GM1985
LAMBDA	.	.	.	.	.	.	.	.06250	LAMBDA
RETOPER	.16910-	3.88000-	3.88000	15.59000-	15.59000	.	.	.	RETOPER
RETGAIN	.	.	.	.	.	1.52000-	10.69000-	.	RETGAIN
ACCTDEBT	1.00000	.	.	.	.	.	.	.	ACCTDEBT
ASSETS	1.00000	.	.	.	.	.	.	.	ASSETS

TARGET MOTAD MODEL 1970 TO 1985

	Z71	Z72	Z73	Z74	Z75	Z76	Z77	Z78	3....1
ACTIVITY	.	.	.	.	.	.	.	.	ACTIVITY
GM1971	1.00000	.	.	.	.	.	.	.	GM1971
GM1972	.	1.00000	.	.	.	.	.	.	GM1972
GM1973	.	.	1.00000	.	.	.	.	.	GM1973
GM1974	.	.	.	1.00000	.	.	.	.	GM1974
GM1975	.	.	.	.	1.00000	.	.	.	GM1975
GM1976	.	.	.	.	.	1.00000	.	.	GM1976
GM1977	.	.	.	.	.	.	1.00000	.	GM1977
GM1978	.	.	.	.	.	.	.	1.00000	GM1978
LAMBDA	.06250	.06250	.06250	.06250	.06250	.06250	.06250	.06250	LAMBDA

TARGET MOTAD MODEL 1970 TO 1985

	Z79	Z80	Z81	Z82	Z83	Z84	Z85	B	4....1
ACTIVITY	.	.	.	.	.	.	.	.	ACTIVITY
FORCELD	.	.	.	.	.	.	.	640.00000	FORCELD
EQUITY	.	.	.	.	.	.	.	100000.00	EQUITY
MAXBORR	.	.	.	.	.	.	.	400000.00	MAXBORR
LABOR	.	.	.	.	.	.	.	2000.0000	LABOR
RENTMAX	.	.	.	.	.	.	.	6400.0000	RENTMAX
GM1970	.	.	.	.	.	.	.	25000.000	GM1970
GM1971	.	.	.	.	.	.	.	25000.000	GM1971
GM1972	.	.	.	.	.	.	.	25000.000	GM1972
GM1973	.	.	.	.	.	.	.	25000.000	GM1973
GM1974	.	.	.	.	.	.	.	25000.000	GM1974
GM1975	.	.	.	.	.	.	.	25000.000	GM1975
GM1976	.	.	.	.	.	.	.	25000.000	GM1976
GM1977	.	.	.	.	.	.	.	25000.000	GM1977
GM1978	.	.	.	.	.	.	.	25000.000	GM1978
GM1979	1.00000	.	.	.	.	.	.	25000.000	GM1979
GM1980	.	1.00000	.	.	.	.	.	25000.000	GM1980
GM1981	.	.	1.00000	.	.	.	.	25000.000	GM1981
GM1982	.	.	.	1.00000	.	.	.	25000.000	GM1982
GM1983	.	.	.	.	1.00000	.	.	25000.000	GM1983
GM1984	.	.	.	.	.	1.00000	.	25000.000	GM1984
GM1985	.	.	.	.	.	.	1.00000	25000.000	GM1985
LAMBDA	.06250	.06250	.06250	.06250	.06250	.06250	.06250	100000.00	LAMBDA

APPENDIX B

ABBREVIATIONS

ABBREVIATIONS

ROWS

LANDOWN	=	OWNED LAND
LANDRENT	=	RENTED LAND
COW	=	COW
OPERCAP	=	OPERATING CAPITAL
LTCAP	=	LONG-TERM CAPITAL
EQUITY	=	EQUITY
MAXBARR	=	MAXIMUM AMOUNT($)TO BE BORROWED
LABOR	=	LABOR
GM1970	=	GROSS MARGINS FOR 1970 TO 1985
LAMBDA	=	ROW TO ACCOUNT FOR NEGATIVE DEVIATIONS
RETOPER	=	RETURN TO OPERATION
ACCTDEBT	=	ACCOUNTING ROW FOR DEBT
ASSETS	=	ACCOUNTING ROW FOR ASSETS

COLUMNS

CCOWN	=	COW/CALF ON OWNED LAND
CCRENT	=	COW/CALF ON RENTED LAND
STKOWN	=	STOCKERS ON OWNED LAND
STKRENT	=	STOCKERS ON RENTED LAND
CD	=	CERTIFICATE OF DEPOSITS
EQOP	=	EQUITY USED FOR OPERATING EXPENSES
EQLT	=	EQUITY USED FOR LONG-TERM EXPENSES
BUYOPCAP	=	BORROWING (BUY) OPERATING CAPITAL
BUYLTCAP	=	BORROWING (BUY) LONG-TERM CAPITAL
LABHIRE	=	HIRED LABOR
OFCAB	=	WORKING OFF THE FARM
RENTIN	=	RENTING LAND IN
RENTOUT	=	RENTING LAND OUT
LANDINV	=	INVESTING IN LAND
COWINV	=	INVESTING IN COWS
Z70	=	COLUMN TO TRANSFER NEGATIVE DEVIATIONS

APPENDIX C

GROSS RETURNS AND VARIABLE COSTS

TABLE X

COW/CALF DATA

Year	October Str Calf Price	Str Calf Yield	Total	October Hef Calf Price	Str Calf Yield	Total
1970	36.98	2.116	78.25	31.64	1.305	41.29
1971	41.04	2.116	86.84	35.09	1.305	45.79
1972	49.36	2.116	104.45	42.05	1.305	54.88
1973	62.04	2.116	131.28	51.17	1.305	66.78
1974	30.16	2.116	63.82	25.17	1.305	32.85
1975	34.99	2.116	74.04	26.29	1.305	34.31
1976	40.09	2.116	84.83	31.04	1.305	40.51
1977	44.09	2.116	93.29	35.54	1.305	46.38
1978	73.28	2.116	155.06	62.64	1.305	81.75
1979	94.82	2.116	200.64	76.86	1.305	100.30
1980	80.64	2.116	170.63	67.80	1.305	88.48
1981	69.71	2.116	147.51	56.70	1.305	73.99
1982	65.40	2.116	138.39	55.66	1.305	72.64
1983	67.95	2.116	143.78	54.26	1.305	70.81
1984	66.89	2.116	141.54	55.06	1.305	71.85
1985	71.61	2.116	151.53	58.88	1.305	76.84

TABLE X (Continued)

Year	Cutter Cattle		
	Jan. Price	Yield	Total
1970	19.64	0.285	5.60
1971	19.54	0.285	5.57
1972	21.57	0.285	6.15
1973	25.48	0.285	7.26
1974	31.00	0.285	8.84
1975	14.94	0.285	4.26
1976	20.98	0.285	5.98
1977	22.73	0.285	6.48
1978	24.93	0.285	7.11
1979	46.26	0.285	13.18
1980	46.09	0.285	13.14
1981	41.13	0.285	11.72
1982	36.88	0.285	10.51
1983	35.12	.0285	10.01
1984	32.29	0.285	9.20
1985	36.19	0.285	10.31

TABLE X (Continued)

Year	March Price	Yield	Total	October Comm Cow Price	Yield	Total	Comm Cow Total
1970	21.54	0.38	8.19	18.98	0.4365	8.28	22.07
1971	21.19	0.38	8.05	20.28	0.4365	8.85	22.47
1972	23.47	0.38	8.92	24.12	0.4365	10.53	25.59
1973	31.33	0.38	11.91	30.70	0.4365	13.40	32.57
1974	29.76	0.38	11.31	16.36	0.4365	7.14	27.28
1975	17.82	0.38	6.77	16.93	0.4365	7.39	18.42
1976	25.43	0.38	9.66	19.72	0.4365	8.61	24.25
1977	25.08	0.38	9.53	21.11	0.4365	9.21	25.22
1978	30.60	0.38	11.63	36.17	0.4365	15.79	34.52
1979	52.92	0.38	20.11	45.47	0.4365	19.85	53.14
1980	45.60	0.38	17.33	40.35	0.4365	17.61	48.08
1981	41.60	0.38	15.81	37.87	0.4365	16.53	44.06
1982	38.46	0.38	14.61	34.72	0.4365	15.16	40.28
1983	41.84	0.38	15.90	33.81	0.4365	14.76	40.67
1984	40.40	0.38	15.35	31.58	0.4365	13.78	38.34
1985	40.78	0.38	15.50	32.25	0.4365	14.08	39.89

TABLE X (Continued)

Year	Aged Bull Price	Yield	Total	Price	Heifers 6-700# Yield	Total
1970	26.21	0.136	3.56	30.00	0.242	7.26
1971	26.12	0.136	3.55	29.96	0.242	7.25
1972	31.99	0.136	4.35	34.62	0.242	8.38
1973	41.14	0.136	5.60	46.05	0.242	11.14
1974	33.98	0.136	4.62	33.78	0.242	8.17
1975	26.69	0.136	3.63	27.99	0.242	6.77
1976	32.94	0.136	4.48	37.59	0.242	9.10
1977	34.08	0.136	4.63	36.20	0.242	8.76
1978	46.50	0.136	6.32	54.58	0.242	13.21
1979	65.05	0.136	8.85	78.43	0.242	18.98
1980	54.95	0.136	7.47	63.15	0.242	15.28
1981	54.40	0.136	7.40	57.72	0.242	13.97
1982	51.72	0.136	7.03	59.49	0.242	14.40
1983	50.88	0.136	6.92	59.36	0.242	14.37
1984	47.76	0.136	6.50	56.01	0.242	13.55
1985	48.16	0.136	6.55	61.14	0.242	14.80

TABLE X (Continued)

Year	Gross Income	GNP Deflator	Real Income	Minus Prod. Cost	Gross Margin
1970	152.43	2.6595	405.39	101.33	304.06
1971	165.91	2.5158	417.39	101.33	316.06
1972	197.64	2.4022	474.78	101.33	373.45
1973	247.36	2.2566	558.19	101.33	456.86
1974	136.75	2.0685	282.86	101.33	181.53
1975	137.17	1.8836	258.37	101.33	157.04
1976	163.16	1.7702	288.83	101.33	187.50
1977	178.29	1.6597	295.91	101.33	194.58
1978	290.86	1.5471	449.99	101.33	348.66
1979	381.91	1.4211	542.73	101.33	441.40
1980	329.95	1.3034	430.05	101.33	328.72
1981	286.93	1.1883	340.96	101.33	239.63
1982	272.73	1.1170	304.64	101.33	203.31
1983	276.54	1.0761	297.59	101.33	196.26
1984	271.78	1.0333	280.83	101.33	179.50
1985	289.60	1.0000	289.60	101.33	188.27

TABLE XI

STOCKER CATTLE DATA

Year	May Stocker Purchase	Yield to Buy	Total	GNP Deflator	1985 Cost	Stoker Prod. Cost	Net Cost
1970	37.59	5.05	189.83	2.6595	504.85	20.10	524.95
1971	38.24	5.05	193.11	2.5158	485.83	20.10	505.93
1972	40.94	5.05	206.75	2.4022	496.65	20.10	516.75
1973	56.12	5.05	283.41	2.2566	639.53	20.10	659.63
1974	39.83	5.05	201.14	2.0685	416.06	20.10	436.16
1975	32.55	5.05	164.38	1.8836	309.62	20.10	329.72
1976	44.79	5.05	226.19	1.7702	400.40	20.10	420.50
1977	43.41	5.05	219.22	1.6597	363.84	20.10	383.94
1978	62.72	5.05	316.74	1.5471	490.02	20.10	510.12
1979	94.66	5.05	478.03	1.4211	679.33	20.10	699.43
1980	73.63	5.05	371.83	1.3034	484.65	20.10	504.75
1981	66.64	5.05	336.53	1.1883	399.90	20.10	420.00
1982	69.19	5.05	349.41	1.1170	390.29	20.10	410.39
1983	71.43	5.05	360.72	1.0761	388.17	20.10	408.27
1984	66.39	5.05	335.27	1.0333	346.43	20.10	366.53
1985	71.17	5.05	359.41	1.0000	359.41	20.10	379.51

TABLE XI (Continued)

Year	October Stocker Sell	Yield to Sell	Total	GNP Deflator	Gross Income	Gross Margin
1970	31.88	6.90	219.97	2.6595	585.02	60.06
1971	35.75	6.90	246.68	2.5158	620.58	114.65
1972	43.05	6.90	297.05	2.4022	713.56	196.81
1973	51.87	6.90	357.90	2.2566	807.64	148.01
1974	28.69	6.90	197.96	2.0685	409.48	-26.68
1975	36.13	6.90	249.30	1.8836	469.58	139.85
1976	35.53	6.90	245.16	1.7702	433.98	13.48
1977	40.00	6.90	276.00	1.6597	458.08	74.14
1978	63.90	6.90	440.91	1.5471	682.13	172.01
1979	79.11	6.90	545.86	1.4211	775.72	76.29
1980	75.22	6.90	519.02	1.3034	676.49	171.74
1981	63.50	6.90	438.15	1.1883	520.65	100.65
1982	63.35	6.90	437.12	1.1170	488.26	77.87
1983	58.59	6.90	404.27	1.0761	435.04	26.76
1984	64.11	6.90	442.36	1.0333	457.09	90.56
1985	62.08	6.90	428.35	1.0000	428.35	48.84

TABLE XII

CD INTEREST RATES

Year	3 Month CD Yield	GNP Deflator	Real CD Interest
1970	0.0756	2.6595	0.2011
1971	0.0502	2.5158	0.1263
1972	0.0464	2.4022	0.1115
1973	0.0839	2.2566	0.1893
1974	0.1027	2.0685	0.2124
1975	0.0643	1.8836	0.1211
1976	0.0529	1.7702	0.0936
1977	0.0558	1.6597	0.0926
1978	0.0825	1.5471	0.1276
1979	0.1122	1.4211	0.1594
1980	0.1307	1.3034	0.1704
1981	0.1591	1.1883	0.1891
1982	0.1227	1.1170	0.1371
1983	0.0907	1.0761	0.0976
1984	0.1037	1.0333	0.1072
1985	0.0825	1.0000	0.0825

TABLE XIII

INTEREST RATES

Year	Nominal Short Term Interest	Stock Adjustment	Adjusted Interest	GNP Deflator	S-T Interest
1970	0.0898	0.9	0.0998	2.6595	0.2654
1971	0.0728	0.9	0.0809	2.5158	0.2035
1972	0.0702	0.9	0.0780	2.4022	0.1874
1973	0.0809	0.9	0.0899	2.2566	0.2028
1974	0.0943	0.9	0.1048	2.0685	0.2167
1975	0.0891	0.9	0.0990	1.8836	0.1865
1976	0.0824	0.9	0.0916	1.7702	0.1621
1977	0.0788	0.9	0.0876	1.6597	0.1453
1978	0.0881	0.9	0.0979	1.5471	0.1514
1979	0.1071	0.9	0.1190	1.4211	0.1691
1980	0.1286	0.9	0.1429	1.3034	0.1862
1981	0.1489	0.9	0.1654	1.1883	0.1966
1982	0.1434	0.9	0.1593	1.1170	0.1780
1983	0.1149	0.9	0.1277	1.0761	0.1374
1984	0.1268	0.9	0.1409	1.0333	0.1456
1985	0.1173	0.9	0.1303	1.0000	0.1303

TABLE XIII (Continued)

Year	Nominal Long Term Interest	Stock Adjustment	Adjusted Interest	GNP Deflator	L-T Interest
1970	0.0868	0.9	0.0964	2.6595	0.2565
1971	0.0786	0.9	0.0870	2.5158	0.2197
1972	0.0742	0.9	0.0824	2.4022	0.1980
1973	0.0748	0.9	0.0831	2.2566	0.1875
1974	0.0814	0.9	0.0904	2.0685	0.1871
1975	0.0869	0.9	0.0966	1.8836	0.1819
1976	0.0866	0.9	0.0962	1.7702	0.1703
1977	0.0839	0.9	0.0932	1.6597	0.1547
1978	0.0835	0.9	0.0928	1.5471	0.1435
1979	0.0920	0.9	0.1022	1.4211	0.1453
1980	0.1039	0.9	0.1154	1.3034	0.1505
1981	0.1127	0.9	0.1252	1.1883	0.1488
1982	0.1227	0.9	0.1363	1.1170	0.1523
1983	0.1163	0.9	0.1592	1.0761	0.1391
1984	0.1173	0.9	0.1303	1.0333	0.1347
1985	0.1225	0.9	0.1361	1.0000	0.1361

TABLE XIV

MINIMUM WAGES

Year	Minimum Wage	GNP Deflator	Real Minimum Wage
1970	1.60	2.6595	4.26
1971	1.60	2.5158	4.03
1972	1.60	2.4022	3.84
1973	1.60	2.2566	3.61
1974	2.00	2.0685	4.14
1975	2.10	1.8836	3.96
1976	2.30	1.7702	4.07
1977	2.30	1.6597	3.82
1978	2.65	1.5471	4.10
1979	2.90	1.4211	4.12
1980	3.10	1.3034	4.04
1981	3.35	1.1883	3.98
1982	3.35	1.1170	3.74
1983	3.35	1.0761	3.60
1984	3.35	1.0333	3.46
1985	3.35	1.0000	3.35

TABLE XV

PASTURE RENTS

Year	Pasture Rent	GNP Deflator	Real Rent
1970	5.90	2.6595	15.68
1971	5.75	2.5158	14.47
1972	6.02	2.4022	14.45
1973	6.57	2.2566	14.83
1974	8.46	2.0685	17.50
1975	8.67	1.8836	16.34
1976	9.80	1.7702	17.34
1977	10.70	1.6597	17.76
1978	11.10	1.5471	17.17
1979	12.80	1.4211	18.19
1980	12.90	1.3034	16.81
1981	12.40	1.1883	14.73
1982	12.80	1.1170	14.30
1983	12.80	1.0761	13.77
1984	12.80	1.0333	13.23
1985	12.90	1.0000	12.90

TABLE XVI

LAND VALUES

Year	OK Land Index	1982 = 100	Pasture Values	GNP Deflator	1985 Values	Capital Gain/Loss
1970	45	27	69	2.6595	182	-2
1971	47	29	72	2.5158	180	7
1972	51	31	78	2.4022	187	13
1973	58	35	88	2.2566	200	24
1974	71	43	108	2.0685	224	12
1975	82	50	125	1.8836	235	10
1976	91	55	139	1.7702	246	7
1977	100	61	152	1.6597	253	6
1978	110	67	168	1.5471	259	3
1979	121	74	184	1.4211	262	22
1980	143	87	218	1.3034	284	-2
1981	156	95	238	1.1883	283	-3
1982	164	100	250	1.1170	279	-23
1983	156	95	238	1.0761	256	-10
1984	156	95	238	1.0333	246	-54
1985	126	77	192	1.0000	192	-34
1986	107	65	163	.0989	158	

TABLE XVII

BROOD COW VALUES

Year	Brood Cows Price	Brood Cows Yield	Brood Cows Total	GNP Deflator	1985 Total	Capital Gain/Loss
1970	20.12	9.5	191.14	2.6595	508.34	-6.43
1971	21.00	9.5	199.50	2.5158	501.90	89.16
1972	25.90	9.5	246.05	2.4022	591.06	115.95
1973	32.98	9.5	313.31	2.2566	707.02	-333.65
1974	19.00	9.5	180.50	2.0685	373.36	-2.24
1975	20.74	9.5	197.03	1.8836	371.13	-4.69
1976	21.79	9.5	207.01	1.7702	366.44	-1.43
1977	23.15	9.5	219.93	1.6597	365.01	221.57
1978	39.91	9.5	379.15	1.5471	586.58	27.97
1979	45.52	9.5	432.44	1.4211	614.54	-86.81
1980	42.62	9.5	404.89	1.3034	527.73	-84.98
1981	39.22	9.5	372.59	1.1883	442.75	-58.82
1982	36.18	9.5	343.71	1.1170	383.92	-28.98
1983	34.72	9.5	329.84	1.0761	354.94	-3.91
1984	35.76	9.5	339.72	1.0333	351.03	-42.57
1985	32.47	9.5	308.47	1.0000	308.47	28.85
1986	36.62	9.5	347.89	0.9696	337.31	

VITA 2

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