Sensitivity to changes in leverage, long term interest rates and land values : a grain farm simulation
by Darrell Martin Johnson

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Applied Economics
Montana State University

Abstract:
This study evaluates the sensitivity of a grain farm's financial condition to financial variables. A cash flow simulation model is used. Long-term interest rates, land values, and leverage positions are the variables analyzed.

The model simulates financial changes over a ten-year period.

A total of 18 variable combinations are examined. Major year-to-year considerations include gross income, consumption, taxes, debt payments, and equipment replacement costs. Gross incomes are generated from historic yield trends and estimated future prices.

Findings indicate that changes in interest rates do not have a significant impact on the financial condition of the case farm.

A similar result occurred with land value changes at the lower of two leverage levels. At the higher leverage level changes in land values did substantially alter ending net worth.

A one percent increase in the interest rate caused short-term funds demanded to increase up to 8.89 percent. For all variable combinations, rates of return on total capital and net worth were low and showed little variation. Solvency problems occurred when higher values for the variables were used.

The minor effect of interest rate changes reveals the ability of the farm family to make adjustments in other areas to compensate for larger debt payments. This tendency is also shown with land value changes, The low returns and the large short-term fund demand shows the producer's inability to accumulate cash assets.

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SENSITIVITY TO CHANGES IN LEVERAGE, LONG TERM INTEREST RATES AND LAND VALUES: A GRAIN FARM SIMULATION

by

DARRELL MARTIN JOHNSON

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Applied Economics

Approved:

Chairperson, Graduate Committee

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MONTANA STATE UNIVERSITY
Bozeman, Montana

March, 1977

ACKNOWLEDGEMENTS

My appreciation is extended to my advisor, Dr. Dana Myrick, and members of my graduate committee, Dr. LeRoy Luft, for his assistance in the development of this thesis and Dr. Gilbert Giebink, for his thesis suggestions. In addition, my thanks are extended to Rudy Suta and Bernie Ries for their aid in the computer programming and to the secretarial staff for their contributions. Finally I wish to formally thank Dr. Richard McConnen for the support and direction he provided to me throughout the years I attended college.

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ABSTRACT

This study evaluates the sensitivity of a grain farm's financial condition to financial variables. A cash flow simulation model is used. Long-term interest rates, land values, and leverage positions are the variables analyzed.

The model simulates financial changes over a ten-year period. A total of 18 variable combinations are examined. Major year-to-year considerations include gross income, consumption, taxes, debt payments, and equipment replacement costs. Gross incomes are generated from historic yield trends and estimated future prices.

Findings indicate that changes in interest rates do not have a significant impact on the financial condition of the case farm. A similar result occurred with land value changes at the lower of two leverage levels. At the higher leverage level changes in land values did substantially alter ending net worth.

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The minor effect of interest rate changes reveals the ability of the farm family to make adjustments in other areas to compensate for larger debt payments. This tendency is also shown with land value changes. The low returns and the large short-term fund demand shows the producer's inability to accumulate cash assets.

Chapter 1

INTRODUCTION

THE PROBLEM

Investment decisions in agriculture, because of their long-run effects on production possibilities and capital improvements, are some of the most difficult and important decisions to be made. To evaluate alternative investments under these conditions requires accurate information on the financial history of a firm and its management as well as reasonable estimates of the prospective cash flows from each venture. It is important that proper criteria be used to analyze and evaluate the alternatives.

Traditionally, the farmer's financial position has been evaluated in terms of balance sheets and annual income statements, or some facsimile thereof, when available. Although these tools have gained wide acceptance, there are limitations to using them in evaluating firm growth alternatives. The income statement, for example, merely records revenues and expenditures over a relatively short period and then arbitrarily imputes the net returns to the fixed factors of production. This procedure may or may not reveal the actual productivity of the firm's capital, labor, and management resources. With the balance sheet, a major problem involves the realistic valuation of the firm assets.

An additional financial tool is the cash flow statement. It identifies the various sources and uses the cash in the business --

including credit transactions and family consumption -- and offers more precise information for ascertaining future cash flows from prospective operations.

In the fall of 1975 a survey of agricultural bankers was conducted in Montana in an effort to establish some background on financial statement use in the farming/ranching sector.[1] The results of this survey indicated that, in Montana, financial tools are not extensively used. Inconsistencies were evident in the format used for statements and in the types of information supplied. This makes early detection of cash flow problems more difficult. The survey indicated that producers, as financial managers, have a difficult time estimating changes in their year to year financial position.[2]

PURPOSE OF THIS STUDY

The ability of a particular farm firm to survive is dependent on numerous variables. These include large variances in incomes due to price and yield variations, interest rates, the farm firm's financial

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[1] Luft, LeRoy D. and Darrell M. Johnson, "Results of Survey of Agricultural Lenders on Financial Statements and Related Matters", Staff Paper 76-27, Agricultural Economics and Economics Department, Montana State University, 1976.

[2] Throughout this study producer, manager, operator and farmer are used synonymously. They all refer to the decision-maker, whether he is a paid manager, owner-operator or leasee.

position, land values, the individual producer' managerial ability and the farm's production capabilities. In Montana, dryland grain farming is highly sensitive to these variables. Consequently, their impact on the firm's success should be valuable information in the decision-making process.

There has been growing interest in recent years on the part of the non-agricultural financial community to develop a form of sensitivity analysis with which to test the impact of key variables on the ability of a business to survive. An analysis is made over an appropriately long period of time to determine the effect of operational fluctuations which are normal for that type of company and industry with respect to these variables. The analysis of past conditions is then projected into the future. The more sizable the fluctuations the less willing the lenders may be to provide financial support.

It is the purpose of this study to isolate some of the financial risks in the form of variables and to analyze their influence on the financial condition of a farm firm. In addition to the information provided by the analysis, this study will also show the effectiveness of simulation models for use in agricultural finance.

OBJECTIVES OF THIS STUDY

The primary objective of this study is to examine the impact of three influential variables on the financial condition of a farm firm over time. A technique of computerized sensitivity analysis is

employed as the examination tool. Used as a cash flow generator, this tool indicates the sensitivity of a farm firm to financial variables. The specific objectives are:

1) to develop a cash flow simulation model based on a representative farm firm patterned after existing farms in the triangle area of Montana;
2) to quantify the effect of price/yield fluctuations on the financial condition of this firm at various levels of land values, long-term interest rates, and leverages, using the above model; and,
3) to analyze the quantified results by use of a financial analysis computer program.

Chapter 2

HISTORICAL PERSPECTIVE

HISTORY OF FARM FINANCIAL MANAGEMENT

Bostwick describes financial management as the managerial process applied to financial resources.[3] It therefore partially overlaps the area generally conceded to farm production management. In general, production management concerns problems of resource organization for agricultural production, while financial management concerns itself with the financial means by which the acquired resources may be controlled.

These two kinds of management are separated for functional resource purposes, even though they often are not separated in practical farming situations. Research in farm financial management assumes the existence of physical resource requirements.

The financial requirements in agriculture have risen due to various economic and political forces. The resource mix, for example, has changed because of the exodus of farm labor and the introduction of capital inputs. The result has been a sharp increase in the financial needs in agriculture for both equity and borrowed funds.

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[3] Bostwick, Don, "Farm Financial Management Research: A Theoretical Analysis," ERS-389, Economic Research Service, USDA, November 1968, p. 1.

While the amount of farm labor in recent years has declined to less than half the 1950 level, the quantities of other inputs, notably fertilizer, have risen significantly (Figure 1). Agricultural output per man-hour has more than tripled as a result of the substitution of capital for labor during this period. Overall resource productivity has also increased. In 1973, for example, total farm output per unit of input was over 50 percent above 1950 (Figure 2).

In the ten-year period ending in 1974, the total debt outstanding in the U.S. farming sector rose from $35 billion to $82 billion, an overall advance of 131 percent or an average yearly increase of 8.7 percent. In recent years farm debt has grown at an even more rapid pace, rising at an annual rate of 12.8 percent in the three-year period 1972-74. At the end of 1974, real estate debt totaled $46 billion while nonreal estate debt amounted to $35 billion.[4] This increase reveals, to some extent, agriculture's past ability to acquire more capital funds. Of primary importance is agriculture's future ability to attract the necessary funds and use them effectively and efficiently.

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[4]Hamblin, Mary, "Bank Lending to Agriculture: An Overview," Monthly Review, November 1975, p. 17.

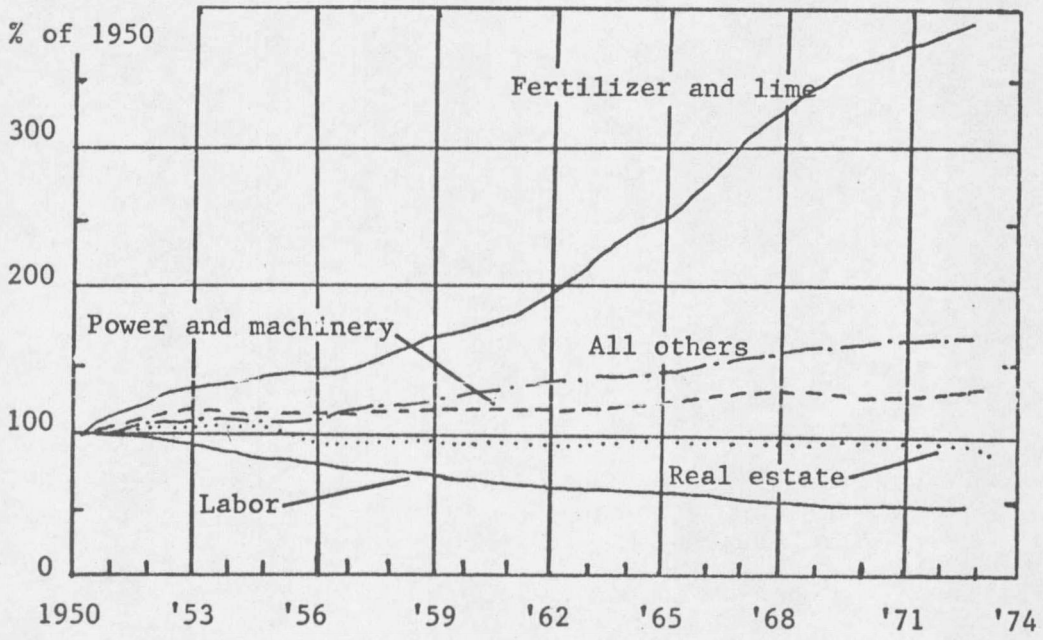

FIGURE 1: Quantities of Selected Farm Inputs, 1950-1974

Source: 1974 Handbook of Agricultural Charts, Agriculture Handbook No. 477, USDA, October 1974, p. 12.

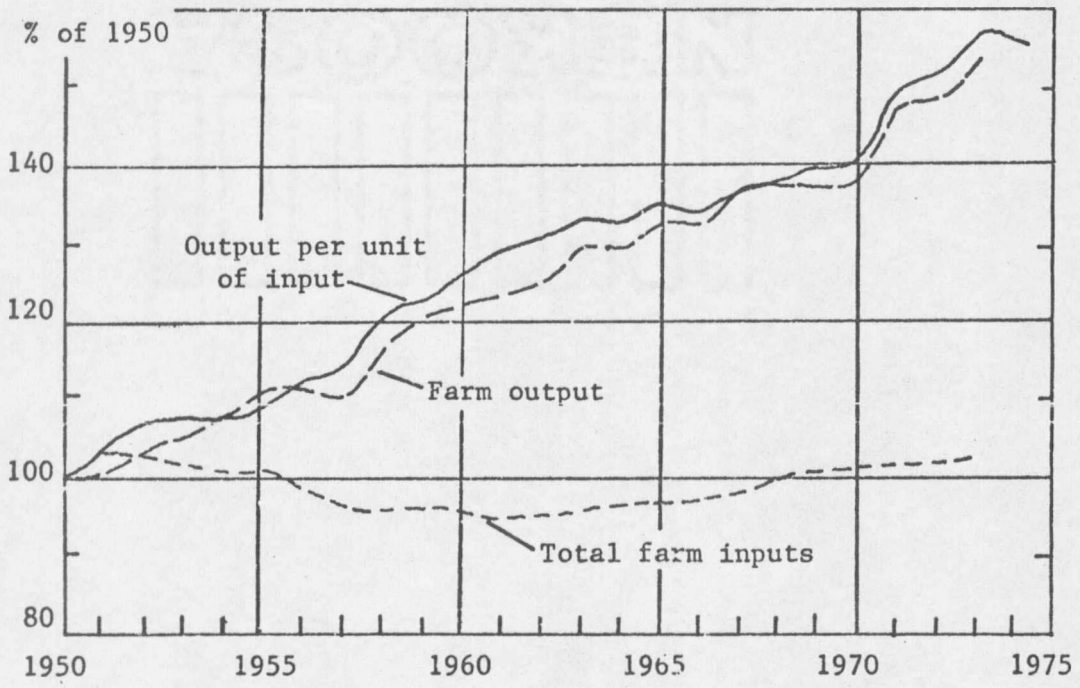

FIGURE 2: Farm Productivity 1950-1974

Source: 1974 Handbook of Agricultural Charts, Agricultural Handbook No. 477, USDA, October 1974, p. 16.

FARM MANAGEMENT GOALS

The viewpoint of financial management is similar to that of gestalt interpretations of human behavior. Management is seen as a collection of goals, attitudes, values, experiences, expectations, learning and present action choices. The variables and relationships among all of these phenomena are germane to an understanding of financial management processes.

The goals of management are the types and quantities of utility forms desired by the manager. Logic and observational evidence both suggest that the goals set by the farm manager are usually an hierarchy of goals, attitudes, and appropriate means and often there exists a degree of logical conflict between these. The hierarchy viewed at present time, t, will not be the same when viewed from time, t + n. The greater the difference between t and n, the greater the difference that is likely to be obtained between the two goal sets. The goals that are sought over a production cycle of a year may be relatively well defined and unchanging over that span of time. The goals that are sought at the beginning of an investment cycle of 30 years may change considerably before that cycle is complete. Since the future is uncertain, it is reasonable that proximate goals are more explicitly defined and bear more weight in the decision process than distant ones. An Iowa farmer survey indicated that factors found relevant in affecting goal rankings were: age, net worth,

education, family size and the solvency ratio.[5]

The financial management function regarding decision-making involves investment decisions and financing decisions. In nonfarm businesses, where management and ownership often are divorced, the primary objective of management is to maximize the present value of future earnings of the ownership group. Major investment decisions for the farm businesses are made at the household-family level and are concerned with the magnitude and composition of owned assets and the business-risk mix of the firm and relate to operation and expansion strategies. They must be compatible with family-living decisions.

CAPITAL FINANCING IN AGRICULTURE

In the planning process, the farmer is faced with the problem of allocating a bundle of scarce resources among competing alternatives in such a way as to achieve a set of goals and objectives. As financial manager he must control the flow of financial resources through the farm firm in such a way as to insure the firm's continued existence while remaining consistent with the stated goals and objectives.

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[5] Warrack, A. A., "Changes over Time in Goals of Farm People," unpublished M.S. thesis, Iowa State University Library, 1963.

The financial manager may rely on retained earnings, borrowed funds, and equity funds. Agricultural investments are generally costly and involve a lengthy payback period. Since few farmers are able to meet capital outlays for new improvements wholly out of retained earnings, a majority of operators depend on borrowed funds to finance their farm businesses, and, to a lesser extent, outside equity funds.

The capital structure plays a crucial role in the success or failure of a firm. Agriculture relies heavily on debt financing. Costs incurred in borrowing include a cost for loss of liquidity, through loss of credit reserve, as well as more tangible interest costs. They also include debt aversion as well as the opportunity cost of investment funds. An optimizing borrower, with no constraints, should require funds up to the point at which the cost of borrowing one more dollar equals the marginal value product of that dollar to the borrower. If constraints are present, the borrower should use the funds available, ceteris paribus, for that input which returns the highest marginal value product for the last dollar invested.

Credit availability is important to the growth of the farm firm. Long-term loan limits are important in determing the rate at which the farmer can expand. Low long-term loan limits retard the rate at which an economically productive farm size can be attained. Long-term loan limits must reflect the managerial ability

of the farm operator. Too liberal credit can allow the farmer to expand beyond his capability to make debt and interest payments while maintaining a satisfactory level of family consumption expenditures. Recently researchers have devoted time toward the measurement of the impact of variables such as loan limits on the success of the farm firm.

REVIEW OF FIRM ANALYSIS MODELS

In the non-agricultural community, growth and merger have long been the trend of economic life. A fundamental issue in studying growth is the interrelating of the short-run production theory, involving fixed resources, and the longer run investment expansion theory, which has no fixed resources. The process of growth requires obtaining funds to purchase these resources from internal and/or external sources. All other variables, including family consumption levels, business profitability, capital markets, lender attitudes, tax management, and price and yield variability serve as constraints within which the process can operate. The two crucial aspects in considering growth are:

1) the concept of the decision process used, and

2) the handling of internal and external flows of funds.

Models developed to analyze firm growth are generally one of the following types: multiperiod linear programming, recursive

linear programming, dynamic programming, or a family of simulator models.

As an alternative to full-scale simulation, Brigham and Pappas noted that instead of using probability distributions for each of the variables in the problem, the results can be simulated by starting with best-guess estimates for each variable, then changing the values of the variables (within reasonable limits) to reveal the effects of such changes on the rate of return.[6] Typically, the rate of return is highly sensitive to some variables, less sensitive to others. Attention is then concentrated on the variables to which profitability is most sensitive. This technique, known as sensitivity analysis, is considerably less expensive than full-scale simulation and yet provides similar data for decision-making purposes.

Using simulation techniques, Patrick found that enterprise management ability of the farm operator (technical transformation rates) is a major factor in determining the rate of growth of the farm firm. High levels of technical efficiency resulted in high levels of farm income, net worth accumulation, and the possibility of higher levels of consumption. Improvement of the technical rates of transformation by 10 percent increased the farmer's net worth

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[6] Brigham, Eugene F. and James L. Pappas, Managerial Economics, Hinsdale, Illinois, Dryden Press, Inc., 1972, pp. 75-76.

about $2,000 per year.[7]

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[7]Patrick, George F., "The Impact of Managerial Ability and Capital Structure on Farm Firm Growth," unpublished M.S. thesis, Purdue University, 1966.

Chapter 3

THE MODEL

CHARACTERISTICS OF FARMING IN HILL COUNTY, MONTANA

A great deal of variability exists in the farming conditions within the Plains of Montana.[8] The short growing season (average 110 days) limits the choice of crops to the cereals -- mainly wheat, barley, and oats -- and grasses which are ecologically compatible to dryland farming. The climate is semiarid, characterized by moderately low rainfall, dry atmosphere (low humidity), cold winters, hot summers and a large number of sunny days. Seasonal precipitation is highly variable over time and its distribution over the area depends on elevations and normal storm paths.

Hill County is one of seven counties that make up what is termed the "triangle area" of Montana. It is located in northcentral Montana, which is the northwestern part of the Plains of Montana. This area is predominantly agricultural, specializing in grain production. Annual precipitation generally ranges between eight and fourteen inches per year. Because of this modicum rainfall average, a cropfallow farming rotation is the ascendant agricultural

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[8]The Plains of Montana extends eastward from the foothills of the Rocky Mountains. This area is part of the continental slope which has a slight inclination toward the east.

practice. Winter wheat and barley are the two most widely grown cash crops.

CASE FARM FAMILY AND FARM

The hypothetical farm in this study consists of a manager in his forties, his wife and two teenage children. The manager was raised on a farm, has a college education, and has been farming for fifteen years. He would be classified as an "above average" manager.

The hypothetical farm is 2200 dryland acres. Each year 900 acres of winter wheat and 200 acres of barley are grown. There are 1100 acres in fallow. No livestock enterprises exist, which is a realistic assumption in this area.

PRODUCTION COST DATA

An enterprise cost study in Hill County was completed in early 1976.[9] The subsequent "typical" farm in Hill County was the result of producers answering questions about the sequence of operations, machinery performance rates, fuel consumption and typical grain storage capacity as well as the size of shops and machine sheds for dryland farms. This formed a series of costs considered typical for

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[9]Schaefer, Jerry M., LeRoy D. Luft and M. S. Stauber, "Enterprise Costs for Fallow, Winter Wheat and Barley in Hill County," Bulletin 1138, Montana Agricultural Experiment Station, March 1976.

an above average level of management for dryland farms in Hill County. This "above average" upward bias is assumed because of the respondents. All were quite successful farm managers, thus implying a lack of randomness in those farmers questioned.

Total winter wheat production costs are $32.95 per acre. This is comprised of $25.34 per acre for seeded land and $7.61 per acre for summer fallow. Total production costs for barley are $30.32 per acre, $22.71 per acre for seeded land and $7.61 per acre for summer fallow. These figures exclude an explicit cost for labor, since the family labor supply is assumed adequate to operate this business. In addition, these figures do not as yet include any real estate costs. A complete breakdown of production costs is listed in Appendix A. Appendix B contains a machinery inventory and valuation from which depreciation figures are derived in this study.

YIELD DATA

Data on crop yields for individual tracts of land in Montana are difficult to find. Larson analyzed Montana wheat yield characteristics for the period 1940-1964 using data from state land tracts in several counties.[10] However, mean yields and other statistical

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[10] Larson, Donald K., M. S. Stauber and O. R. Burt, "Montana Dryland Wheat Sample and Yield Characteristics," Bulletin 654, Montana Agricultural Experiment Station, February 1974.

Table 1

HILL COUNTY 20 YEAR YIELD STATISTICS PLUS
ARBITRARY LOW AND HIGH YIELDS TO COMPENSATE FOR
POSSIBLE GREATER VARIATION FROM AVERAGE

YEAR	WHEAT BUSHELS PER ACRE	BARLEY BUSHELS PER ACRE
1955	29.0	23.5
1956	26.0	22.0
1957	23.6	16.0
1958	25.5	25.0
1959	27.0	18.5
1960	27.0	15.0
1961	19.0	8.0
1962	17.0	15.0
1963	18.0	14.0
1964	21.5	17.5
1965	26.5	16.5
1966	30.0	24.0
1967	22.0	14.0
1968	27.0	20.0
1969	21.0	18.7
1970	23.9	24.0
1971	26.7	21.0
1972	20.0	20.0
1973	22.6	14.0
1974	25.0	20.0
Arbitrary Yields	5.0	5.0
Arbitrary Yields	10.0	10.0
Arbitrary Yields	15.0	15.0
Arbitrary Yields	35.0	35.0
Arbitrary Yields	40.0	40.0
Arbitrary Yields	45.0	45.0

coefficients were not computed for state land tracts in Hill County because most of the yield series were not continuous over the 1940-1964 period. Consequently, annual average yields by county, as reported by the Statistical Reporting Service, are used for yield data.[11] It should be noted that these averages probably have less yield variability over time than would individual observations. Variance, both in standard deviations and relative terms, of average county yields tend to be less because of the greater acreage involved and the chance of a low yield in one part of the county being offset by a high yield in another part of the county in any given year. To compensate for this, low and high yields have arbitrarily been included. The individual yield additions are five, ten, fifteen, thirty-five, forty, and forty-five bushels for both wheat and barley (Table 1).

PRICE DATA

The dilemma in selecting a range of prices is depicted in Figure 3. The large increase in the 1972-1975 period precludes using a meaningful historic long-term price trend. A predictive future price trend is needed for accurate income assessment.

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[11] Montana Agricultural Statistics, Montana Crop and Livestock Reporting Service, USDA, Vol. 6-15, 1956-1974.

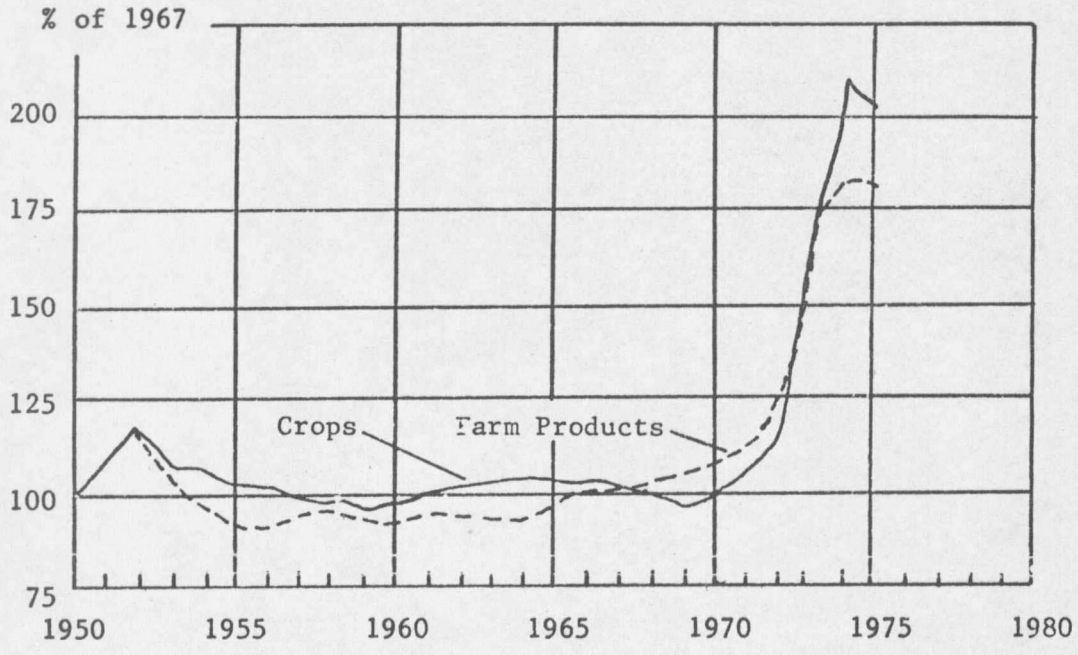

FIGURE 3: Prices Received by Farmers, 1950-1975, U.S. Average

Source: 1975 Handbook of Agricultural Charts, Agricultural Handbook No. 491, USDA, October 1975, p. 8.

Ray and Tweeten estimated crop prices two ways for the period 1975-1979.[12] Single-valued projections of average corn and wheat prices assuming normal crop yields and normal exports are presented in Table 2. A third row, barley prices, is included as a direct

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[12] Ray, Daryll and Luther Tweeten, "Alternative Agriculture and Food Policy Directions for the U.S. -- With Emphasis on Continuation of Minimal Provisions of the 1973 Agriculture and Consumer Protection Act," Oklahoma Agricultural Experiment Station.

Table 2

PROJECTED FARM PRICES UNDER NORMAL CROP YIELDS AND EXPORTS, 1975-1979, ACTUAL 1971-1974

	1971-73 (average)	1974	1975	1976	1977	1978	1979
Corn $/bu	1.73	3.10	2.50	2.20	2.10	2.20	2.45
Wheat $/bu	2.37	4.10	3.40	3.00	2.70	2.65	2.65
Barley $/bu	1.50	2.65	2.15	1.90	1.80	1.90	2.10

Source: Ray, Daryll and Luther Tweeten, "Alternative Agriculture and Food Policy Directions for the U.S. -- With Emphasis on Continuation of Minimal Provisions of the 1973 Agriculture and Consumer Protection Act," Oklahoma Agricultural Experiment Station, p. 8.

function of corn prices, based on the differences between per bushel weights. Prices are crop year averages. The price predictions are below 1974 levels for the remainder of the 1970s.

A second estimation was made with expected values of crop prices based on random yields and exports. These projected values are very near the values in Table 2. Results are shown in Table 3. Barley prices are included as a direct function of feed grain prices, based on the number of bushels of barley per ton. The variability in yields and exports in the stochastic simulation results in a wide range of prices about the expected values. The widest range in feed grain prices is from $38.45 per ton to $138.88 per ton ($.92 to $3.33 per bushel for barley) in 1979. The minimum wheat prices decline each

Table 3

PROJECTED FARM PRICES, 1976-1979,
ASSUMING RANDOM YIELDS AND EXPORTS

	Feed Grains $/ton	Wheat $/bu	Barley $/bu
		1976	
Mean	76.03	3.01	1.82
Standard deviation	15.38	.47	.27
Minimum	38.45	1.93	.92
Maximum	120.92	4.47	2.90
		1977	
Mean	73.29	2.74	1.76
Standard deviation	17.50	.54	.42
Minimum	38.45	1.54	.92
Maximum	126.83	5.95	3.04
		1978	
Mean	77.34	2.63	1.86
Standard deviation	18.06	.54	.43
Minimum	38.45	1.37	.92
Maximum	127.65	4.90	3.06
		1979	
Mean	82.41	2.59	1.98
Standard deviation	19.80	.54	.48
Minimum	38.45	1.37	.92
Maximum	138.88	5.84	3.33

Source: Ray, Daryll and Luther Tweeten, "Alternative Agriculture and Food Policy Directions for the U.S. -- With Emphasis on Continuation of Minimal Provisions of the 1973 Agriculture and Consumer Protection Act," Oklahoma Agricultural Experiment Station, p. 16.

year until they reach a low of $1.37 per bushel in 1978 and 1979. The maximum wheat price is nearly $6.00 per bushel in 1977 and 1979.

The probability distribution of feed grain prices over the projection period is nearly symmetrical around the $70-$80 per ton ($1.70 - $1.90 per bushel for barley) price range (Figure 4). Over the four year period 21 percent of the observations fall in this range.

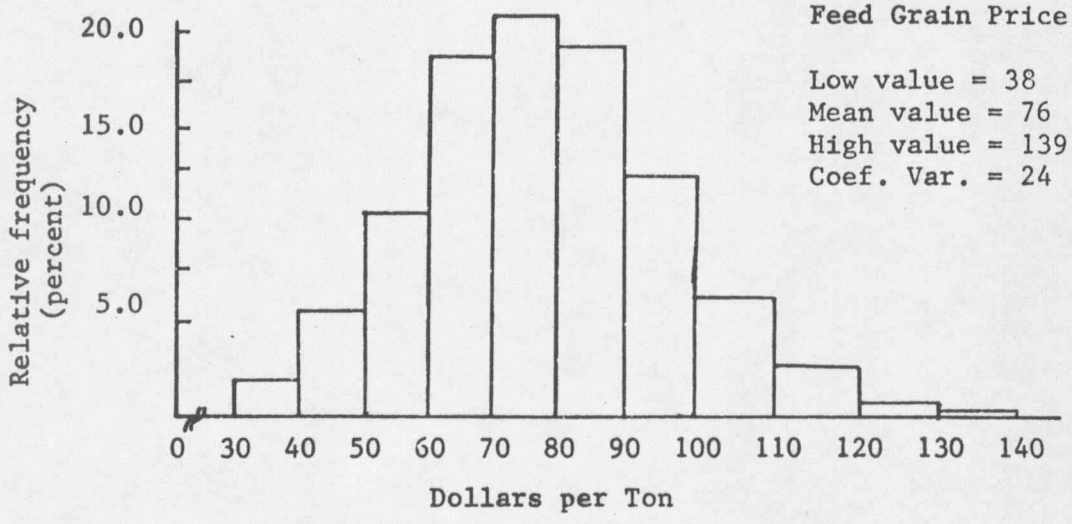

FIGURE 4: Projected Price Distribution for Feed Grains, 1976-1979

Source: Ray, Daryll and Luther Tweeten, "Alternative Agriculture and Food Policy Directions -- With Emphasis on Continuation of Minimal Provisions of the 1973 Agriculture and Consumer Protection Act," Oklahoma Agricultural Experiment Station, p. 21.

Combining price ranges, there is a 29 percent probability of feed grain prices being between $50 and $70 per ton and a 32 percent probability of $80 to $100 per ton feed grain prices ($1.20 - $.170 and $1.90 - $2.40 per bushel for barley, respectively). Seven times out of 100 feed grain prices fall below $50 per ton and ten times out of 100 the price of feed grains exceeds $100 per ton.

Wheat prices are between $2.50 and $3.00 per bushel for 36 percent of the observations (Figure 5). There is a 28 percent chance

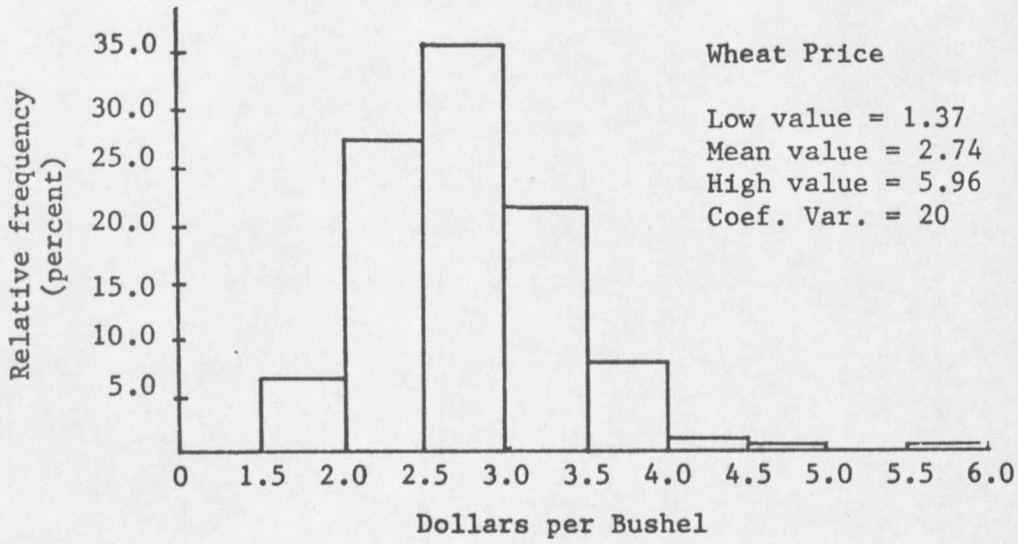

FIGURE 5: Projected Price Distribution for Wheat, 1976-1979

Source: Ray, Daryll and Luther Tweeten, "Alternative Agriculture and Food Policy Directions -- With Emphasis on Continuation of Minimal Provisions of the 1973 Agriculture and Consumer Protection Act," Oklahoma Agricultural Experiment Station, p. 21.

of wheat prices in the $2.00 to $2.50 per bushel range and there is a 22 percent chance of wheat prices between $3.00 and $3.50 per bushel. Eight times out of 100 wheat prices are in the $3.50 to $4.50 range but there is only one chance in 200 of prices exceeding $5.00 per bushel.

To determine the price range used in this study a consideration must be given to the Agricultural and Consumer Protection Act of 1973. If market price falls below the crop's target price, each participating farmer is paid the difference between the target price and the market price for the first five months of the marketing year or the difference between the market price and the loan rate, whichever is smaller, for each bushel of normal production on his allotted acreage. The target prices are to be adjusted directly for changes during the preceeding year in the index of prices paid by farmers for production items (including interest, taxes and wage rates), and inversely for changes in three-year moving averages of yield. For 1976 this resulted in target price levels in Montana of $1.28 per bushel for barley and $2.29 per bushel for wheat.

A final consideration requires comparing Montana and U.S. average wheat and barley prices in order to see if adjustments in the above prices are necessary. A graphic comparison (Figure 6 and Figure 7) shows that the yearly averages are quite similar, not deviating

more than $.17 per bushel for wheat and $.19 per bushel for barley. Therefore, no price adjustments are necessary.

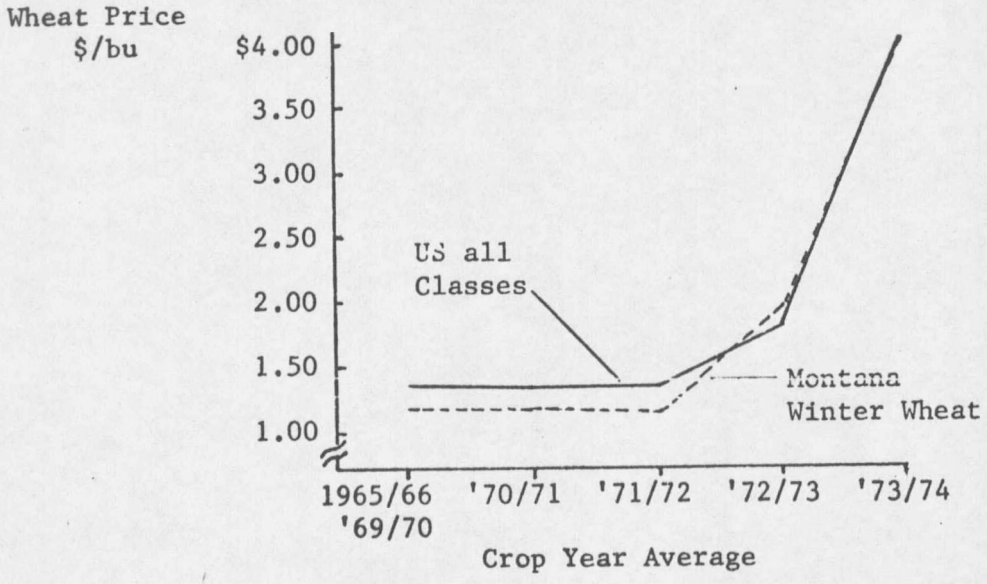

FIGURE 6: Montana and U.S. Average Wheat Prices Received by Farmers, Average 1965-1970

Source: Ryan, Mary E., "Montana Grains in the U.S. and World Grain Economics," Staff Paper 74-9, Agricultural Economics and Economics Department, Montana State University, p. 5.

To reduce the number of variables, prices and yields were combined to yield a single variable, gross income. This required making an assumption about relative price movements between wheat and barley. As Figures 4 and 5 show, both price ranges are fairly symmetrical. As Figures 6 and 7 show, wheat and barley prices have

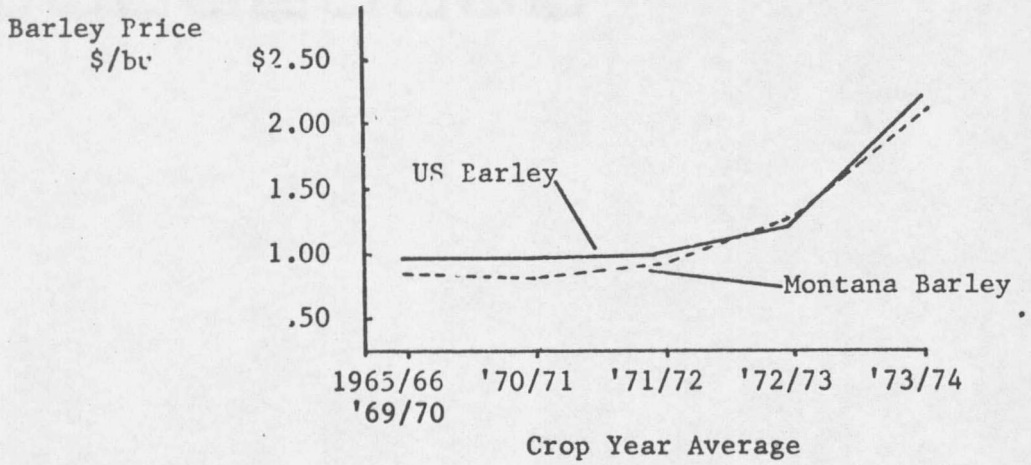

FIGURE 7: Montana and U.S. Average Barley Prices Received by Farmers, Average 1965-1970

Source: Ryan, Mary E., "Montana Grains in the U.S. and World Grain Economics," Staff Paper 74-9, Agricultural Economics and Economics Department, Montana State University, p. 5.

historically moved together. It therefore was assumed that if the mean price of one was selected, the corresponding mean price of the other was also used, and so on for deviations from their means. This is an heroic assumption but it is necessary to keep the simulation manageable. Since gross income is the variable used, this assumption tends to cancel opposite price movements of wheat and barley, making it more acceptable.

Using the stochastic probabilities mentioned earlier, 26 prices each were calculated for wheat and barley. Only prices above the 1976

target prices were allowed. Yields were combined such that when a wheat yield from a given year was used, the corresponding barley yield from that year was also used. The first wheat price was multiplied by all 26 wheat yield values. The first barley price was likewise multiplied by all 26 barley yield values. These per acre income values were then multiplied by the number of seeded acres (900 for wheat, 200 for barley). The resulting incomes for wheat were added to the corresponding incomes for barley, yielding 26 gross incomes. The procedure was then repeated for each subsequent wheat price and barley price. This generated 676 separate gross income observations. Since prices were grouped around a mean and yields were concentrated in the 20-30 bushel per acre range, the gross income observations were most heavily concentrated in a range from $60,000 - $80,000.

As noted previously, the production cost figures used in this study were compiled from data provided by above-average managers. It is reasonable to assume that these producers also have above-average incomes. To remain consistent with the assumptions regarding the hypothetical farm firm, the lowest 10 percent of the gross income observations were eliminated, leaving 608 income values.

CONSUMPTION

Consumption expenditures serve as a major capital leakage in the firm growth process, reducing the amount of farm income available

for reinvestment. Regardless of the financial success of the farm business, at least a minimum amount of money is needed for family consumption, a necessary condition for survival of the farm operation.

No literature was found on the consumptive habits and expenditures of Montana farm families. Several empirical studies have been done, however, in other parts of the United States. Brake did an empirical study that was based on a cross-section of United States farm family consumption patterns.[13] The consumption function is:

$$C_o = 22.96\ P^{0.410} NFI^{0.590} S^{0.163}$$

where: C_o = current consumption

P = ratio of current (1975) to 1961 indexes of prices paid, $P = 1.9667$

NFI = net income after taxes; and

S = family size.

This equation is based on mean values and the coefficients for NFI and S are elasticities rather than marginal propensity values. The consumption function is illustrated in Figure 8, where the amount withdrawn for consumption increases at a decreasing rate as NFI increases. For large values of NFI, the consumption function approxi-

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[13] Brake, John R., "Firm Growth Models Often Neglect Important Cash Withdrawals," American Journal of Agricultural Economics, August 1968, pp. 769-771.

mates a linear but positively sloped relationship. The consumption expenditure is an explicit function of disposable income in the period in which the income is derived from gross sales.

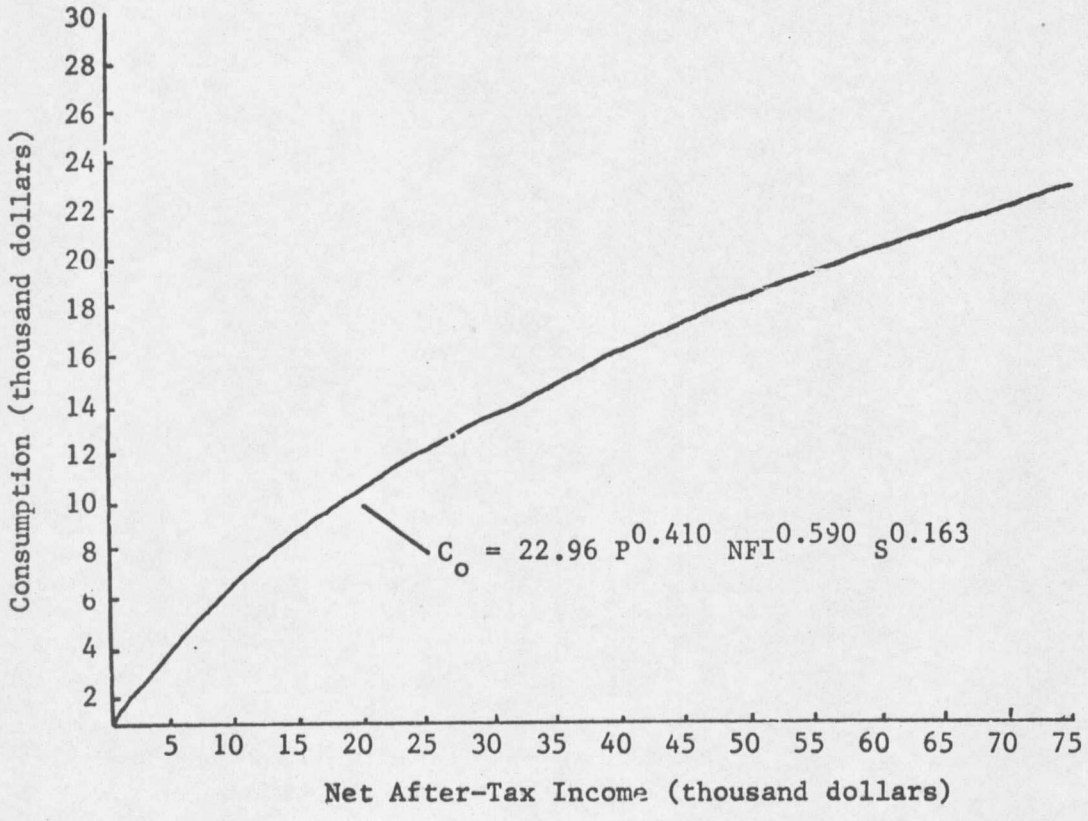

FIGURE 8: Illustration of a Consumption Function For a Family of Four, 1975

Generally, consumption expenditures are considered to lag in adjustment to yearly fluctuations in income. A further lag in the response of consumption to income is the result of the seasonal nature of farm income. For example, a typical grain farmer has most of his sales concentrated in the last quarter of the year. Therefore, income in year t-1 would be more influential in determining consumption in year t than would income in year t.

The determining factor is the marketing strategy employed. This study assumed that all grain sales were transacted during the last four months of each year. To make allowance for this, consumption for the first nine months of year t is based on the net after-tax income in year t-1. For the last quarter of year t, consumption was based on net after-tax income in year t.

Brake and Holm found that a family of four with an income of $4,000 before taxes spent almost that amount for consumption.[14] Above the $5,000 income level, consumption by farm families tended to increase rather slowly. The minimum consumption expenditure required for survival in this study is $4,500. It is increased by 4.4

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[14] Brake, John R. and C.R. Holm, "The Influence of Household Size and Income on Farm Family Expenditures in Michigan, 1960," Quarterly Bulletin, Michigan Agricultural Experiment Station, February 1962.

percent annually.[15]

In 1973, farm families in the United States spent an average of $9,317 or $776 per month.[16] An upper limit of $1,000 per month was placed on consumption in this study. This has the effect of holding net after-tax income, upon which consumption is based, at about $26,000.

CASE FARM FAMILY GOALS

It is assumed that age affects farm firm goals in the following way. A tendency of young farm operators is for physical resource expansion, specifically land and machinery. This early goal is attempted at the particular expense of family consumption.[17] With expansion in the resource base beyond the initial farming years, producers shift goals to increased family expenditures. This is due to the foregone comforts of earlier years plus the increasing needs of

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[15] For justification of this inflation rate, see page 39.

[16] "Farm Operator Family Living Expenditures for 1973," Crop Reporting Board, Statistical Reporting Service, USDA, September 1975.

[17] Bailey illustrated the critical importance to the farm family of keeping living expenses to a minimum in the early years of farming. Increasing consumption expenditures delayed the rate of growth. From: Warren R. Bailey, "Necessary Conditions for Growth of the Farm Business," Agricultural Economics Research, Vol. XIX, No. 1, January 1967.

their children. It is assumed the farmer of this study is in this latter position, having attained an acceptable farm size. The growth goal then becomes one of reducing the exogenous investment required by the farm firm.

To isolate the impact of certain variables in this study, the size of the farm and the yearly crop acreage are held constant. This is feasible if (1) the size of the firm under consideration is, under normal circumstances, adequate to provide an economically productive unit and (2) the firm is capable of sustaining a farm family in a fashion consistent with their goals and objectives.

The firm size used in this study was established from a concensus by farmers that it represented a "typical" production unit in that geographic area. A factor influencing a farmer's adjustment process to new conditions and financial success is predicated on the economies of size in agriculture. One study found that the long-run average cost curve for agriculture shows no strong tendency to rise as output increases.[18] Therefore, small firms have a substantial incentive to adopt new techniques and expand output to take full advantage of the lower unit costs. Further, while evidence frequently shows that there are no further cost advantages from

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[18] Carter, H.O. and G.W. Dean, "Cost-Size Relationships for Cash Crop Farms in a Highly Commercialized Agriculture," Journal of Farm Economics, Vol. 43, May 1961, pp. 264-277.

expanding beyond this point, output can often be increased substantially without incurring any diseconomies. This phenomenon partly explains why many smaller farmers are able to operate competitively with some of the larger ones.

VARIABLES TO BE ANALYZED

Three key elements are considered as to the effect they have on the financial condition of the hypothetical farm firm. The first variable is incorporated at two levels; the other two are incorporated at three different levels for all combinations of the three variables, or a total of 18 variables.

The first variable considered is indebtedness. The initial position has long-term debt as the only financial liability of the firm. It is based on total real estate value. The two initial liability levels are 25 and 50 percent.

Long-term interest rate is the second variable examined. It enters the analysis through its effect on the amortization payment that is due annually. Higher interest rates increase the amount of the payment. The three rates used are eight, nine, and ten percent.

The third variable, land value, is based on per acre real estate prices of $200, $250, and $300. Included within these prices is the value of all real property except the family dwelling. In this study land values are said to be constant at these levels. They actually

are appreciated in value each year of the simulation. However, to simplify the explanation of variable combinations, land values are only quoted at their initial values.

SIMULATION MODEL FORMULATED

Simulation, in its methodological sense, is an abstract mathematical formulation of a real world situation. In this study this technique is used to evaluate the cash flow effect of certain exogenous variables on a particular farm firm. The following flow chart (Figure 9) serves as a guide to the simulation model.

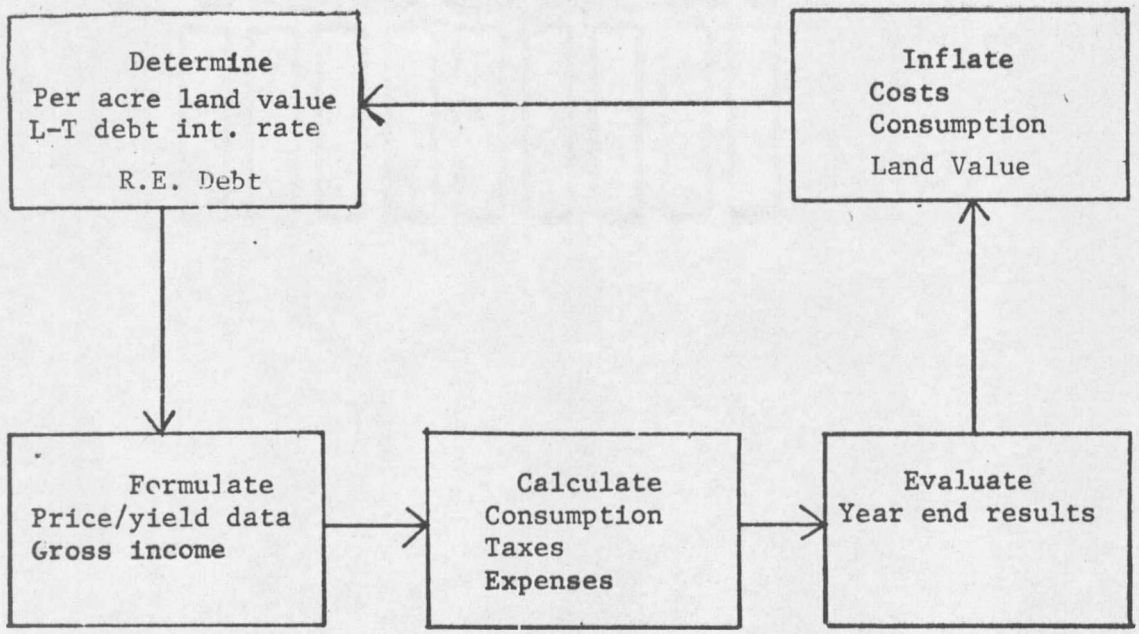

FIGURE 9: Simplified Cash Flow Simulation Flow Chart

PROCEDURE

A computer program was written to assist in the analysis.[19] It parallels the flow chart described in the previous section. After determination of a land value, interest rate, and indebtedness, the simulation was run for a ten-year period. Yearly payments necessary for the firm's short-run survival include production expenses, consumption, taxes, and all interest owed. Additional payments not necessary for short-run survival but required for long-run continuation are all debt principal payments and depreciation/replacement expense.

Consumption for the first nine months is calculated and added to the monthly production expenses. At the beginning of each month the cash balance is checked against the expense for that month. The beginning cash balance each year is the net cash income balance from the previous year. A $300 minimum is always maintained. If the cash balance, excluding $300, is greater than the monthly expense, the expense is deducted and the cash balance is invested in a short-term savings account at an annual percentage rate of five percent. If the cash balance is less than the expense for that month the cash balance, minus $300, is subtracted from the monthly expense. This

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[19] A complete listing of this computer program can be found in Appendix C.

residual amount becomes part of an operating loan principal, which carries an annual interest charge of nine percent. For each of the first nine months this procedure is repeated.

At the end of this nine month period, a new gross income is formulated. This value is one of ten incomes in a row of an income matrix. There are 30 sets of ten income observations generated, making a 30 x 10 matrix of individual observations. Individual data observations were selected using a table of random numbers.[20] All data values were given an equally likely chance of occurring, and they were chosen with replacement. Taxes for the year were calculated using 1975 tax rate schedules for a married couple filing jointly, claiming two dependents. Consumption is then derived for the last three months.

The simulation proceeds through a series of checks to determine whether using any value for consumption between the minimum and the estimated value will force the cash income balance below zero. If it will, a consumptive figure is used that will make the cash income zero, unless doing so would necessitate using a value that is less than the minimum allowed. The consumption figure used is added to the taxes, long-term debt interest, operating debt interest, and

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[20] Snedecor, George W. and William G. Cochran, Statistical Methods, Ames, Iowa, Iowa State University Press, 6th Edition, pp. 543-546.

remaining production expenses for the year. The resultant sum is deducted from gross income. At this stage in the simulation, if the cash balance is negative, the firm has become illiquid. Illiquidity is defined as inadequate loan repayment capacity occurring when cash obligations are larger than the amount of cash available at the end of a given year. When this occurs the simulation run for this ten-year period is terminated with the financial condition being noted.

A positive difference between gross income and the aforementioned expenses continues the simulation. Operating and long-term principal payments are deducted. If there is an insufficient amount to cover these payments, the difference is carried over and has a one percent penalty assessed in addition to the regular interest charge. The cash balance becomes zero.

Depreciation/replacement expense is then considered. The depreciation period is ten years. The first year replacement cost is $9,672. Depreciation/replacement cost is the last deduction from income before the year-end analysis. If only part of the depreciation/replacement expense can be paid before the cash balance becomes zero, it is paid and the remainder is carried over to the following year's replacement expense. The cash balance becomes zero. If the cash income balance was already zero after deduction of principal payments, the current year's depreciation/replacement expense is added to next year's replacement cost. When this

happens the firm is existing by using depreciation since it is using equipment beyond its normal replacement cycle. Should it continue to do so, the firm's survival would be in jeopardy. This would be partially reflected in the deterioration of its asset base on the balance sheet. However, the need for a larger expenditure in the future for equipment would not be readily obvious.

Year-end evaluation comprises itemizing various figures, including those described above. This gives a brief but accurate description of the changes that occur.

Unlike industries characterized by a few large firms, the domestic farming industry cannot directly pass on inflation spurred production cost increases. Agriculture is not a cost-plus industry in its structural make-up. Following the year-end simulation analysis, production costs, consumption constraints, depreciation/replacement costs, and land values are increased at an annual rate of 4.4 percent. This figure is a best guess estimate. It is a rate projected as the annual rise in the Consumer Price Index through 1985.[21]

The above pattern is replicated through year ten. At the end of this ten-year run, a new land value, interest rate and indebtedness

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[21] Tweeten, Luther, "Government Programs for the Farming Economy in the Great Plains," paper presented at the Seminar of Great Plains Resource Economics Committee of the Great Plans Agricultural Council, New Mexico State University, October 1974, p. 24.

are chosen and the simulation is rerun using the same gross income values. This procedure is repeated until all combinations of variables have been analyzed using the same ten income observations. Then a new set of ten income values are selected and the entire process is redone, making a total of 30 complete simulations for all possible combinations of the variables. The 30 simulations are then averaged for each variable to arrive at one set of results per variable.

Chapter 4

RESULTS

INITIAL FINANCIAL POSITION OF SIMULATED FARM

Land values, long-term interest rates, and long-term liabilities are the controlled variables in this study. However, they are not the only variables affecting outcomes. The interaction between the controlled variables, consumption, operating loan principal and interest, taxes, and equipment replacement purchases caused some adjustment in the results. For example, in a given year it was possible that a higher interest rate actually increased the ending cash balance compared to a lower interest rate due to a reduction in one of the other variables, such as consumption. While revealing all of the internal changes is not relevant to this study, it is necessary to acknowledge their importance in the yearly cash flows.

Analysis of the data produced by the simulation was aided by use of a financial analysis computer program called FINAN.[22] FINAN summarizes the financial changes for a farm business from year to year. It determines rates of return on farm investment and net

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[22] Hawkins, Richard O., and Kenneth H. Thomas, "FINAN," Economic Information Report R72-9, Minnesota Agricultural Extension Service, 1973.

worth, and computes financial well-being in terms of financial ratios.

The beginning financial position of the case farm is shown in Table 4. Net worth calculations at the 25 percent indebtedness level range from a low of $475,200 to a high of $640,200. With long-term indebtedness at 50 percent of the value of real estate, net worth varied from a low of $365,200 to a high of $475,200. The land payments associated with the various levels, amortized over 30 years, are also listed. These payments went from $9,768 at 8 percent interest, $200 land value, and 25 percent indebtedness to $35,013 at 10 percent interest, $300 land value, and 50 percent indebtedness. All variable combinations were started with the same cash balance and machinery and building inventory. Current/intermediate liabilities were zero at the beginning of the simulation.

Simulation runs involving all land value and interest rate variables at the 25 percent indebtedness level were continuously liquid. When long-term indebtedness was incremented to 50 percent of the total real estate value, some simulation runs became illiquid (Table 5). With a $250 land value, two runs were illiquid at 9 percent interest and six were illiquid at 10 percent interest. The first time a particular run became illiquid, the year and amount needed to make it liquid were noted. All larger land value and