A SIMULATION MODEL FOR ANALYZING FARM CAPITAL INVESTMENT ALTERNATIVES

By

MICHAEL LEROY HARDIN

Bachelor of Science
Oklahoma State University
Stillwater, Oklahoma
1971

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1973

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
July, 1978

A SIMULATION MODEL FOR ANALYZING FARM

CAPITAL INVESTMENT ALTERNATIVES

Thesis Approved:

Odell L. Walker
Thesis Advisor

Ted R. Nelson

Wayne D. Purcell

Daniel D. Klett

Billy B. Tucker

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGEMENTS

A debt of gratitude is owed Dr. Odell L. Walker, my major advisor, for his guidance and helpful comments in conducting the study and in preparing the thesis. Gratitude is also extended to committee members, Dr. Ted R. Nelson, Dr. Darrel D. Kletke, Dr. Wayne D. Purcell, and Dr. Billy B. Tucker, for the comments they made when reviewing the manuscript. I am thankful for the assistance provided by Dr. James E. Osborn, Head of the Department of Agricultural Economics, in the final stage of my dissertation.

Special recognition is due Dr. Ted R. Nelson, my project leader, for his advice and patience throughout my graduate program. Dr. James S. Plaxico, former Head of the Department of Agricultural Economics, is extended much deserved appreciation for his leadership and encouragement during my graduate program. Grateful appreciation is extended to Dr. James W. Richardson for his scholarly advice and personal friendship. I also wish to thank Dr. Clint Roush and Dr. Evan H. Drummond who provided valuable suggestions.

I want to thank Sandi Ireland for her typing excellence and Mrs. Mercer Lamb for her help in editing the final manuscript. I am especially grateful to my parents Mr. and Mrs. Talmage Hardin for their help and encouragement.

Finally, I wish to express deepest appreciation to my wife, Marian, to whom this thesis is dedicated, for her sacrifices and understanding. Without her help, this thesis would not be a reality.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table | Page

Table		Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The Problem

Capital investment decisions are among the most important decisions made by agricultural producers. Major capital items (e.g., land and machinery) are purchased relatively few times during a decision maker's planning horizon. Thus, investment experience is limited. However, the success of capital investment decisions can effect the decision maker, his family, and the viability of the entire farm firm.

Investments in land, machinery, and buildings are made for many reasons. Agricultural producers wish to increase their net worth, or they may be adopting new technology which will lower their cost of production. Investment in additional capital assets may allow the producer to utilize his excess machinery or labor. Whatever the reason, capital investments represent a fixed commitment of funds many years into the future. Depending on the financing terms, land investment requires a constant annual payment for 20 to 40 years. These major purchases use the firm's liquidity and its financial reserves, thus limiting the producer's future investment opportunities. Once made, these investment decisions cannot be easily changed. An improper investment decision may be remedied only by a partial or complete liquidation of the firm. Capital investment decisions are critical because a constant future commitment of funds must be met by highly variable future cash income.

While the amount of funds invested in machinery and buildings is growing, land purchase is the major investment decision faced by agricultural producers. Farm real estate debt in the United States totaled 56.6 billion dollars in 1977, more than half of the total farm debt outstanding (Agricultural Finance Outlook, November 1977). Land loans are financed over longer periods, thus the personal and financial flexibility of the decision maker is reduced by a longer schedule of constant outflows for the firm.

Long-term capital investments increase the proportion of production cost that are fixed, while future cash income used to meet these fixed commitments is subject to variation from many sources. Weather and insects influence farm income through their variable effect on product yields. Product price variability has increased in the last decade due to changing foreign demand, reduction of crop inventories, devaluation of the U. S. Dollar, and increased export activity. The combination of these events first eliminated the large grain surplus that had accumulated since World War II, then led it to a new buildup.

Table I lists the high and low annual wheat prices for 1958 to 1977. This annual range is an indication of price variation for a particular year. From 1973 through 1976, this annual range of two to three dollars was greater than the one to two dollar level of prices from 1958 to 1971. In recent years, annual price variation exceeds the level of prices from 1958 to 1971. During this period (1973 to 1976), prices of most agricultural products were well above support levels and the income generated by these unusually high prices was capitalized into land. Beginning farmers and others used borrowed funds to purchase additional production inputs. As a result of this competitive bidding for agricultural inputs and the

TABLE I

ANNUAL HIGH AND LOW WHEAT PRICES FOR OKLAHOMA, 1958-1977

Year	High	Low	Difference
1958	2.06	1.62	.44
1959	1.84	1.69	.15
1960	1.91	1.68	.23
1961	1.88	1.71	.17
1962	2.05	1.86	.19
1963	2.16	1.83	.33
1964	2.07	1.38	.69
1965	1.46	1.30	.16
1966	1.80	1.47	.33
1967	1.69	1.40	.29
1968	1.46	1.19	.27
1970	1.43	1.20	.23
1971	1.47	1.35	.12
1972	2.51	1.35	1.16
1973	4.86	1.96	2.90
1974	5.58	3.33	2.25
1975	4.00	2.87	1.27
1976	3.63	2.34	1.29
1977	2.52	1.99	.53

Source: U. S. Department of Agriculture, Agricultural Prices, Crop Reporting Board, Economics, Statistics and Cooperative Services.

effects of inflation, production input prices reached record levels. Between 1971 and 1973, production expenses in Oklahoma increased 61 percent from 1.02 billion to 1.79 billion (State Farm Income Statistics, September 1977). During the same period, the consumer price index increased 15 percent (News, Bureau of Labor Statistics, 1973). Thus, approximately one-fourth of the 61 percent increase in production expenses was due to general inflation.

In 1973, net farm income in Oklahoma was 723.8 million dollars; the net farm income dropped to less that $200 million in 1976 (State Farm Income Statistics, September 1977). However, the fixed commitment to machinery and land made when incomes were high still must be paid.

The above examples illustrate a high degree of variation in net farm income due to weather, insects, exports, fluctuations in exchange rates, and institutional influences, over which agricultural producers have very little control. Agricultural capital investment decisions in this environment are critically important, for the viability of an entire farm unit could depend on the success of such investment decisions.

Rapid advances in technology have allowed agricultural producers to grow more food on fewer acres to meet growing population demands for food and fiber here and abroad. New technology includes improved varieties, moisture conserving tillage practices, improved product storage and handling facilities, larger and more efficient machinery, soil conserving production practices, insecticides, and herbicides. This technology provides increases in output given the same dollar input or constant output using less dollar input. Agricultural producers invest in this new technology to increase net worth or to utilize excess land, labor, and capital resources.

However, frequent technological innovations have required agricultural producers to invest increasing amounts of money in order to remain competitive. In the past ten years, total farm debt outstanding has increased from $45.9 billion to $116.2 billion (Agricultural Finance Outlook, November 1977). Investment in production technology is a large part of the fixed costs associated with agricultural production. Adoption of new technology requires investment which increases the fixed commitment of the investor and reduces his financial flexibility. Investment and ownership strategies are needed that allow the producer to adopt new production technology and manage financial risk.

Given current relationships between costs, product price and land prices, a computer program is not required to determine the mathematical sign of the net present value of land investment. One decision rule of thumb commonly used by agricultural producers says, "if you can meet the cash flow, the price is not too high". Record rates of appreciation in land values the past few years may provide false support for this statement. While this rule of thumb lacks quantitative rigor, it may explain farmer's goals and investment alternatives. It indicates that maximizing firm size and net worth, given a small chance of financial disaster and bankruptcy, are important goals. Hatch (1973) indicated that goals of avoiding low profits or losses, increasing net worth, and maximizing annual profits appeared most frequently in the top-ranked position.

Usually an agricultural producer's limited familiarity with financial securities markets narrow his investment choices to agricultural assets such as land, machinery, and buildings. In short, most agricultural producers want to know the maximum possible bid price they can pay rather than the expected rate of return on the marginal investment. Thus, a producer's interpretation of a zero net present value of the proposed farm unit[1] is: if all cash flow and equity of the current farm unit[2] and the proposed investment are utilized, the expected rate of return to equity equals the discount rate. The capitalization of the current size unit's cash flow and equity into the net present value of the proposed investment may help to explain high equity farmers' ability to bid more for capital investments. More specifically, these farmers may have excess machinery, operator labor, or cash which can be utilized. By expanding their size of operation, the fixed cost of machinery and labor per unit can be reduced. This farmer has a lower production cost per unit than the farmer who must borrow money, buy machinery and hire labor to operate the proposed investment.

Many mathematical procedures exist to estimate the profitability of long-term capital investments, if the cash benefits and costs associated with these investments are assumed to be known with certainty. Inflation rates, world wide weather, insects, plant and animal diseases, technological advances, and institutional changes make the assumption of perfect knowledge of prices and yields highly artificial.

A method of realistically incorporating risks associated with agricultural production into the analysis of profitability of capital investments is needed. This method could provide research information necessary to help agricultural producers manage their sources of risk. Information

---

[1]Proposed farm unit includes the current farm unit and the proposed capital investment.

[2]Current farm unit is the land, labor, and capital currently managed by the operator.

is needed on the effects of inflation on land value, production cost, cost of capital, and product prices and these factor's resulting influence on the profitiability of alternative capital investments. The model could also be used by decision makers with the assistance of extension specialists.

Major Purpose

The major purpose of the study is to analyze potential farm investments in the uncertain farm business environment. It is intended to provide knowledge concerning investment risks and feasibility under stochastic conditions. Thus, it goes beyond contributions of studies which assume perfect knowledge.

Specific objectives are:

1) To estimate the potential gain and risk[3] associated with specified capital investments under uncertainty.

2) To estimate breakeven bid prices for capital investments under selected levels of key economic variables.

3) To evaluate effects of alternative futures with respect to rates of land appreciation, cost inflation, cost of borrowing, opportunity cost of capital and product price and yield trends on the level and distribution of farm returns.

4) To suggest extension and research programs which can serve farmers and ranchers by improving information on which investments are made.

---

[3]In this study, the terms risk and uncertainty will be used interchangeably to represent the variation in key agricultural variables, whether the variation is based on objective, or subjective data, or a combination of both.

Review of Literature

In 1963, Fredrick Hillier stated that:

> Capital budgeting literature has not yet given much consideration to the analysis of risk; and such procedures as have been suggested for dealing with risk have tended to be either quite simplified or somewhat theoretical. Thus, these procedures have tended either to provide management with only a portion of the information required for a sound decision or they have assumed the availability of information which is almost impossible to obtain (p. 443).

Until recently, most of the attempts to include risk in capital investment decisions, have been by corporate operations research staffs. The major application is portfolio management and corporate capital investment planning. Byrne, Charnes, Cooper and Kortanek (1968) outlined two groups of models which include risk in investment decisions. The first group includes models that reduce each investment alternative to a single figure-of-merit. Classical single figure-of-merit approaches deal with risk implicitly by adjusting the discount rate for risk, by changing the length of life of the project to reflect risk, or by using an interest rate appropriate for the degree of risk as the minimum acceptable internal rate of return. These approaches suffer the same disadvantage of suppressing information regarding the risk of the investment.

It is possible to include probabilistic occurrences explicitly within the models in this first group. The formal mathematical programming models in this group can be subdivided into three categories: 1) Stochastic linear programming (Sengupta et al., 1963). A distribution of outcomes is obtained by repeating the solution of a linear programming problem. A different approach by Johnson et al. (1967) allows any coefficients of the linear programming problem to be random variables with appropriate distributions. A set of variates drawn from the probability distribution of random variables is used for the stochastic parameters in the problem. The probability distribution of the objective function is obtained by repeating the process.

2) Linear programming under uncertainty (Danzig, 1955). Values of the first-stage decision variables are selected, followed by the observation of the random variables. Then, values for the second-stage decision variables are computed to optimize the overall process. 3) Chance Constrained Programming (Charnes and Cooper, 1959). In this method an objective function is maximized subject to probabilistic constraints on the occurrence of undesirable events. The second group includes models that develop probability distriubtions which represent the range of financial outcomes for the investments.

Simulation and Capital Investment

Jones (1972) described simulation as a "look before you leap" method of experiment with a model rather than costly real world experience. Denholm (1969), Wagner and Pryor (1971), Kennedy (1968), Carter (1971), and Sundem (1975) all utilize simulation for analyzing capital investment alternatives. Models of this type develop probability distributions of the outcomes of capital investment decisions.

Cohen and Elton (1967) used simulation to generate the input data used to calculate a variance-covariance matrix. First, probability distributions were developed for the factors that determine cash flow. Second, many simulations of these cash flows were used to determine the mean, variance, and covariance of the investment projects' net present value. Then, an intertemporal quadratic programming model was used to determine the portfolio of risky assets. According to Rae (1970), this method disregards the year-by-year variability effects on the investment program.

Hertz (1968) used computer simulation to develop "risk-based profiles". First, the leverage factors that influence cost and return variables are identified. Second, all available information (historical trends, market demands, manager judgments, likely price changes) is used to develop an uncertainty profile or probability distribution for each variable. Repeated sampling from these distributions yields the financial outcome of the combined variables for each time period. Thus, the probability distribution of possible financial outcomes is generated.

Halter and Dean (1965) demonstrated the use of simulation to evaluate management policies under uncertainty. Distributions for price of feeder cattle and range condition were developed from historic data. The decision rules, information sources, and other interactions of the organization's components were formulted and the model's behavior generated on a digital computer. By generating the same set of range conditions in each simulation run, the effects of alternative price prediction models and management strategies could be tested. They concluded that it would be difficult to improve the level of income or reduce variability of income by adjusting buying decisions. As expected, price and weather variance have the greatest effect on income variability. Given this knowledge, management can concentrate on improving technical efficiency or strategies to increase income and reduce variability.

In a similar study Zusman and Amiad (1965) determined the optimal organization and managerial policies of a farm operation under low and unstable rainfall conditions. Random weather events were generated using actual rainfall and number of rainy days during the first two periods for sixteen years. Missing data derived by correlating local observations were assumed to have a bi-variate normal distribution, and needed values were generated using random normal deviates. These studies employed objective frequency data to develop probability distributions for key variables. This explicitly assumes that the future will be just like the past.

These and other uses of simulation provided more information to the decision maker than single-valued estimates of returns. However, these models require the decision maker to specify the variation in terms of expected mean and variance of the key parameters or to rely on historic data to estimate the parameters. Use of these distributions sometimes assumes statistical independence among the variables. As a result, the relationship or correlation among product yields in a given year is not considered.[4]

Pouliquen (1970) stated that the main objective in choosing a method of incorporating variation was to make use of all available information. Officer and Anderson (1968) suggested that there is virtually no decision problem recognized by a decision maker for which he cannot formulate subjective probability. The decision maker is never in a state of complete ignorance about the lifely states of nature. The Bayesian approach can be used to adjust the prior probabilities based on additional information.

A method of incorporating subjective probability into a decision framework is proposed by Sprow (1967). He chose the triangle distribution

---

[4]Exceptions include those studies which have utilized the procedure by Clements, Mapp and Eidman (1971) that correlates the variation among variables that are normally distributed. Feasibility studies by the World Bank, such as the Mogadiscio Port Project, include the effects of correlation among variables (Pouliquen, 1970).

over the PERT beta distribution for evaluating research expenditures using Monte Carlo methods. The triangle distribution can be uniquely specified by eliciting from the decision maker the minimum, maximum, and most likely value. Thus, the triangle distribution is useful when information available suggests a central tendency and when data is sufficient to estimate the modal value and the upper and lower limits. The decision maker can specify the parameters of the triangle distribution without knowledge of expected mean, variance, or probability.

Income Capitalization Method of Land Valuation

The traditional approach to determining the value of farmland is represented by:

$$V = \frac{I}{r} \tag{1.1}$$

where V = value of land,

I = annual return to land, and

r = discount or capitalization rate.

In this method, returns to land are calculated as gross income minus all costs except interest on land investment or land rents minus land ownership costs except interest on land investment. An annual return of $50 per acre and ten percent discount rate would yield a $500 land value. The method and use of comparable sales provide an estimate of the market value of land. While this procedure is straight forward and readily understood by farm operators, it is valid only if the following assumptions are met:

1) Annual returns to land are constant over time,

2) The discount rate does not change during the planning horizon and,

3) The planning horizon will be very long.

Willett and Wirth (1976) offer a model that relaxes some of the above restrictions. Additional data required of the decision maker includes:

1) Annual rate of change in returns to land

2) Annual rate of change in the general price level

3) Annual rate of change in land value

4) Length of farmer's planning horizon

5) Marginal tax rate and capital gain tax rate when the land is sold.

The following approach is used to determine the value of land.

1) Average annual before-tax gross crop receipts

2) Minus average annual before-tax costs, except interest on land

3) Equals average annual before-tax returns to land

4) Minus average annual income taxes paid on land returns

5) Equals average annual after-tax returns to land

6) Times the number of years in the farmer's planning horizon with annual land returns discounted at an interest rate of return, plus the annual rate of change in the general price level, minus the annual rate of change in land returns.

The approach determines the value of the land investment to the farm. Unlike the traditional capitalization approach, net return, land price, and general price level are allowed to trend upward. Also, the income and capital gain tax effects of interest and income when the land is sold are also explicitly considered. This procedure, however, assumes the land is purchased with equity capital. Since most land purchases utilize debt capital, the procedure should be modified to incorporate this option.

Willett and Wirth (1976) also provide a method to calculate the maximum financially feasible price the farm operator can pay with respect to cash flow. This maximum feasible price is determined by the equity funds available for downpayment and the maximum amount of debt the farm's cash flow will support. This price is the maximum amount the decision maker can feasibly pay. Market price, as estimated by capitalization of annual net returns or comparable sales, represents the amount someone is willing to pay. Maximum feasible price is the amount a decision maker could pay for agricultural purposes. The maximum feasible price for a particular decision maker may be higher or lower than market price. The decision maker can pay market value only if it is equal to or lower than his maximum feasible price.

A summary of this alternative method follows:

1) Average annual before-tax cash receipts for expanded business

2) Minus average annual before-tax cash costs for expanded business, excluding interest paid on debt used to finance added land

3) Equals average annual before-tax retained earnings

4) Minus income taxes paid on earnings

5) Equals the average annual after-tax retained earnings

6) Minus average annual principle payments on existing long-term (over one year) debt

7) Minus average annual funds set aside for replacement of depreciable assets

8) Minus average annual family living expenses

9) Equals annual funds available for servicing additional real estate debt

10) Times present value of annuity for the interest rate equaling after-tax interest rate on real estate loan and for the number of years in the loan repayment period

11) Equals maximum additional real estate debt that the business cash flow will support

12) Plus amount of equity funds available for land downpayment

13) Equals maximum price that the business will be able to pay for the land.

Willett and Wirth correctly point out some disadvantages of the procedure:

1) Income tax benefits from depreciation and investment credit are not considered, and,

2) Land value, general price level, and net returns to land can only be constant or increase at a constant rate, i.e., the risk and uncertainty associated with these variables is ignored.

Lee and Rask (1971) have developed a similar model that determines the maximum price a decision maker could bid given essentially the same data as in the Willett and Wirth model. Required input data include the following:

$\bar{P}$ = average price per acre from recent sales of comparable parcels,

CC = the buyer's opportunity cost of capital after taxes,

n = the buyer's planning horizon in years,

ANI = the expected annual net returns per acre before taxes,

GNI = expected annual rate of growth in annual net returns per acre,

MTR = the buyer's marginal income tax rate (combined federal and state tax rate based on estimated taxable income after the parcel is purchased),

DP = the down payment,

IR = the nominal rate of interest charged on the mortgage loan,

t = the amortization period on the loan,

INF = the expected annual rate of inflation in land values,

T* = the tax rate that will apply to capital gain income in year n when the parcel is sold,

P* = the maximum bid price, given values for the preceeding 11.

The formula for calculating P* (Lee and Rask, 1971) is much more complicated than the traditional approach and cannot be estimated easily by hand methods like the Willett and Wirth model. However, the calculations can be easily performed by computer and thus provide a vehicle for sensitivity analysis of the relevant variables. Of the variables listed above, changes in INF, expected annual rate of inflation; ANI, annual before-tax net returns; and GNI, expected growth rate of net income per acre had the largest effect on P*, the maximum bid price per acre.

This procedure, like the model by Willett and Wirth (1976), does not consider the depreciation and investment credit effects of capital assets purchased during the planning horizon that are necessary to operate the proposed investment. Also, annual net returns from the investment are held constant or trended over time at a constant rate.

Nelson (1976) developed a net present value type capital investment model which overcame these disadvantages. Investment credit, depreciation, deductible loan interest, and any additional capital investments are explicitly considered. In this model, the decision maker can specify the annual cash benefits and costs, and can adjust these flows to meet his specific situation. If the investment involves a new enterprise, income in early years can be discounted to represent a learning lag. Cash costs for later years can be increased to represent growing family living requirements.

The three models by Lee and Rask (1971), Willett and Wirth (1976), and Nelson (1976), provide an excellent framework from which to build a stochastic capital investment analysis model that considers all tax effects of the proposed investment and subsequent required capital investments. The model should be capable of utilizing stochastic variation in product prices and yields, the major determination of annual net returns.

Area of Study

Realistic input data are needed to analyze capital investments. North Central Oklahoma was chosen as the area of study. Enterprises representative of that area include winter wheat production, November to March stocker steers, November to May stocker steers, March to May stocker steers, grain sorghum, cow-calf production, forage sorghum, and alfalfa hay. Price and yield data for these enterprises are listed in Appendix B. Development of data and resource situations is described in a later chapter.

Organization of Remaining Chapters

The second chapter contains a more detailed description of the alternative methods of evaluating capital investments and methods of realistically incorporating the risk associated with capital investment. Also, a modified version of the internal rate of return method is proposed that allows determination of a breakeven bid price for capital investment in a stochastic environment. Chapter III includes a complete description of a Monte Carlo type simulation model designed to provide comparative before and after investment measures of profitability, solvency, liquidity, and survival for a farm unit. Required input data for all simulation experiments is presented in Chapter IV. Chapter V presents the results of the model and sensitivity analysis of the key parameters. Three different size and equity situations are analyzed to illustrate the measures of financial success. An analysis of breakeven prices in a stochastic environment is described in Chapter VI. These breakeven prices provide the decision maker an estimate of what he can afford to pay for land and the associated probability of a worse financial outcome. Use of the capital investment model in an extension setting is discussed in Chapter VII. Advantages and disadvantages of the simulation model are presented and ideas for future research are proposed. Chapter VIII summarizes the contents of this study.

CHAPTER II

CONCEPTUAL FRAMEWORK

Capital investments represent a long-term fixed commitment of funds by agricultural producers. However, the cash benefits and costs generated by these capital investments vary over time due to the many sources of risk such as weather, insects, foreign demand, and institutional factors. Agricultural producers invest in capital assets such as land, machinery, and buildings relatively few times during their lives. However, the viability of the entire farm unit could depend on the success of these investments.

Several methods of evaluating capital investments have been suggested and attempts to realistically represent variance in product prices and yields in a capital investment decision model were briefly reviewed in Chapter I. A method of capital investment analysis is needed that considers the effects of capital gain taxes and income taxes, and incorporates the risk associated with agricultural production. This method should incorporate realistic variation in projected cash benefits and cost over the planning horizon of the decision maker. A method of comparing the decision maker's current operating unit with the proposed expanded operating unit is needed to determine which investment alternative is superior and whether the investor would better meet his objectives by not investing.

This chapter reviews different methods of evaluating capital investments and proposes a modification of traditional net present value analysis which provides a more complete economic evaluation of a capital investment. A method of incorporating variation in projected cash benefits and costs which includes the decision maker's subjective evaluation of risk is discussed. Finally, a modified version of the internal rate of return method is outlined, which allows determination of breakeven bid prices for capital investments in a stochastic environment.

Steps in Capital Budgeting

Hopkin, Barry, and Baker (1973) emphasize that capital budgeting steps require: 1) an exhaustive search for profitable investment alternatives; 2) sound estimates of future returns associated with each investment alternative; and 3) an economic decision criterion. In estimating future returns, net cash flows or actual cash benefits and costs should be used rather than accounting profits. All cash flows which occur during the life of the proposed investment must be accurately estimated and included in the analysis. Depreciation and inventory affect accounting profit, but have no influence on cash flow.

The third step is "choose the economic criteria by which investment alternatives are ranked, accepted, rejected". Hopkin et al. (1973), is discussed in the next section. The following methods for evaluating capital investment alternatives are discussed: 1) payback period, 2) simple rate of return, 3) net present value, and 4) internal rate of return.

Capital Investment Evaluation Methods with Certainty

Payback Period

The payback period and simple rate of return methods are widely used methods of evaluating investment alternatives, due to the simplicity of their computation. In the payback period method, the decision maker simply estimates the number of years required to return the initial investment after his costs are paid. This method's major limitation is that it ignores profits earned after the initial investment has been recovered. An investment that returned the investment very quickly but had a short economic life would be chosen over a slow but steady return of investment from an asset over a long economic life.

Simple Rate of Return

The simple rate of return method is commonly computed by the formula (Aplin and Casler, 1973):

$$R = \frac{E - D}{C} \tag{2.1}$$

where R = the average annual rate of return,

E = the additional annual after tax earnings, before depreciation, expected from the investment,

D = the additional average annual depreciation, and

C = the amount of capital required by the investment.

Payback Period and Simple Rate of Return methods are clearly better than nothing, but they do not consider the time value of money or allow direct comparison of expected returns with the cost of borrowing or the returns foregone by not investing equity capital in alternative financial securities.

Net Present Value

The net present value method overcomes the weaknesses of the two previous methods. The basic concept is that money in hand today is worth more than an equal amount of money to be received at some future date. This is true because the money in hand today can be invested and yield a return equal to the rate of interest. Exact present value of a future sum depends on the interest rate and how often the interest is compounded or credited to the investment. Compounding is a procedure for determining the future value (FV) of a sum (S) invested today at a specified interest rate (.06) available at the end of N years.

$$FV = S(1 + .06)^N \tag{2.2}$$

A dollar invested today at six percent interest would have a future value of $1.06 at the end of one year.

The present value or discounted value (PV) is the value today of a sum (S) invested at a specified interest rate (.06) to be equal to the sum (S) at the end of N years.

$$PV = \frac{S}{(1 + .06)^N} \tag{2.3}$$

A little over .94 cents must be invested today at six percent interest to be equal to one dollar at the end of one year.

Net present value is a method of discounting the annual income and expense flows, associated with a capital investment, to a present value today. This present value can be accurately compared with present values of alternative investments which have varying annual income and expense flows. Aplin, Casler, and Frances (1977), outline four basic steps for determining the net present value of an investment alternative. First, an appropriate discount rate must be determined. This rate may represent the cost of borrowed capital, an average cost of borrowed and equity capital, the firm's minimum acceptable rate of return, or the opportunity cost or expected rate of return. The discount rate should be adjusted for the decision maker's marginal tax rate. The decision maker who requires a 7.5 percent after-tax rate of return and has 25 percent marginal tax rate, must specify a 10 percent before-tax discount rate. If the net present value procedure determines after-tax discounted cash flows, the decision maker should specify an after-tax discount rate. The investors must decide which rate is appropriate.

Step two involves the discounting of all cash benefits, while cash costs associated with the investment are discounted in step 3. In step 4, present value of net cash flows is determined by subtracting cash costs from cash benefits. Equation 2.4 indicates that the discounted salvage value of the investment is included as a cash benefit.

$$NPV = \frac{(I_1 - C_1)}{(1 + r)^1} + \frac{(I_2 - C_2)}{(1 + r)^2} + \cdots + \frac{(I_N - C_N)}{(1 + r)^N} + \frac{S}{(1 + r)^N} \qquad (2.4)$$

where NPV = the proposed investment's net present value,

$I_1, I_2, \ldots, I_N$ = after-tax income in years 1 to N,

$C_1, C_2, \ldots, C_N$ = expense in years 1 to N,

r = discount rate,

N = life of the investment in years, and

S = salvage value of the asset in year N.

The investor should accept all independent investments which have a positive net present value and reject all independent investments which have a negative net present value (Aplin et al., 1977). The investment amount which generates a zero net present value can be interpreted as the maximum amount an investor could afford to pay for the investment and just break even.

Net present value analysis incorporates the time value of money and the decision maker's discount rate to yield a method of analysis superior to the payback or rate of return methods. However, the analysis does not consider the magnitude of funds committed to the investment, because only net cash flows are considered. For example, a $100,000 investment may have the same net cash flow as a much smaller investment. Swirles and Lusztig (1968) provide an illustration, Table II, and propose a ratio of discounted cash benefits and cash costs to determine a relative measure of the funds committed to an investment. Project X has a ratio of 1.1 while project Y's ratio is 1.01.

TABLE II

NET PRESENT VALUE OF INVESTMENT PROJECT ALTERNATIVES

Project	Total Discounted Cash Benefits	Total Discounted Cash Costs	Net Present Values
X	11,000	10,000	1,000
Y	202,000	200,000	2,000

Source: John Swirles and Peter A Lusztig. "Capital Expenditure Decisions Under Uncertainty." Cost and Management, 1968, p. 15.

Project Y would be chosen by traditional net present value analysis, but project X may be preferable since its ratio of discounted total benefits to costs is larger.

Internal Rate of Return

The internal rate of return method of evaluating capital investments is very similar to the net present value method in that both utilize discounted cash flows. In the net present value method, the decision maker specifies the discount rate and equation 2.4 is solved for the net present value. The internal rate of return method involves setting net present value in equation 2.4 to zero and solving for the discount rate. The internal rate of return is the maximum rate of interest an investor could pay and break even. One disadvantage of the internal rate of return method is that it assumes that positive cash flows can be invested to yield the internal rate of return. The net present value method assumes that positive cash flows are reinvested at the discount rate. In this respect, net present value is superior because it may not be possible to actually reinvest excess funds that yield the internal rate of return.

The net present value and internal rate of return methods provide single-valued estimates of the rate of return a decision maker can expect from a proposed investment given perfect knowledge of the estimates of cash benefits and costs. These methods are clearly superior to the payback and rate of return methods of evaluating capital investments but do not provide a measure of risk. Lee and Rask (1971) illustrate the change in rate of return when key parameters such as cash benefits, inflation rate in cash benefits, and cash costs are allowed to vary. The example in Table II can be used to illustrate the effects of uncertainty. If economic conditions resulted in a five percent decline in actual cash benefits and a two percent increase in actual cash costs, the net present value of project X would be $250 and project Y's net present value would be -$12,100. Traditional net present value analysis, under the assumption of perfect knowledge, would have chosen project Y.

Capital Investment Evaluation Methods With Uncertainty

Adjustment of Discount Rate Method

Several methods of incorporating risk in capital investment decisions have been proposed. Hopkin et al. (1973) discuss the adjustment of discount rate and certainty-equivalent methods of incorporating the degree of risk into net present value analysis. The discount rate adjustment method involves specifying a higher discount rate to reflect the investment's degree of risk. If the decision maker's minimum acceptable rate of return for a riskless investment is seven percent, he may increase his minimum acceptable rate as the risk of the investment increases. Increasing the discount rate, if other things are equal, will reduce the net present value of the investment. Thus, risk is included by reducing the net present value of risky investments relative to investments that are not as risky. One disadvantage of the adjustment of discount rate method is that risk is assumed to increase exponentially over time, even when the risk adjusted discount rate is constant (Hopkin et al., 1973). The exponential increase in risk results when the discount rate is raised to a power that is equal to the year of the analysis. In most agricultural investments, the equity levels, experience of the decision maker, and problems associated with starting new enterprises, usually result in the first years of an investment being more risky than later years.

Certainty-Equivalent Method

The certainty-equivalent method allows the discount rate to reflect only the time value of money and incorporates risk according to equation 2.5.

$$NPV = \frac{A_1(I_1 - C_1)}{(1 + r)^1} + \frac{A_2(I_2 - C_2)}{(1 + r)^2} + \ldots + \frac{A_N(I_N - C_N)}{(1 + r)^N} + \frac{A_{N+1}(S)}{(1 + r)^N} \quad (2.5)$$

where NPV = the net present value of the investment,

I_i = the after tax annual income in years 1 to N,

C_i = the annual expenses in years 1 to N,

A_i = the adjustment factor which would make the projected cash flow equal to a certain cash flow for years 1 to N. A_{N+1} is the adjustment factor which converts the expected salvage value of the investment in year N to a certain cash equivalent,

r = the discount rate,

N = the life of the investment, and

S = the salvage value of the investment.

Each A_i, risk adjustment factor, can be specified to reflect the degree of risk associated with each annual net cash flow. The risk adjustment factor can vary from zero, which would indicate very high risk and thus zero certain returns, to a value of one which would indicate a certain value equal to the expected cash value. If the risk associated with an investment is expected to decrease over time, due to an increase in equity and experience of the decision maker, each annual risk adjustment factor would be increased to reflect a larger certain value. The inclusion of risk adjustment factors that are less than one will, if other things are equal, reduce the net present value of the investment. Relative differences in net present values of the investment measure the degree of risk associated with the investment alternatives.

The decision maker's estimate of the risk adjustment factor is based theoretically on his individual indifference curve for risk and money income. Halter and Dean (1971) and Officer and Halter (1974) have shown that an individual's risk preference function may be different for each investment, nonlinear with respect to the amount of money involved, and change over time. In practice, it is difficult to elicit directly risk adjustment factors from a decision maker.

Both the discount rate adjustment and certainty-equivalent methods require the decision maker to specify a single-valued estimate of annual cash benefits and costs. Using these methods, the net present values associated with certainty and varying degrees of risk can be compared, but they represent single-valued estimates of the expected return from alternative investments adjusted for risk.

Monte Carlo Simulation Techniques

Monte Carlo simulation techniques offer another method for incorporating risk into capital investment decision models. These methods, used by Cassidy, Rogers, and McCarthy (1973), Sprow (1967), and Hess and Quigley (1962), involve specification of objective and/or subjective probability distributions for the parameters that most influence investment feasibility. Random values drawn for these key parameters are used to calculate the net present value of the investment. By repeating the analysis many times, a probability distribution of net present values can be developed. Using these methods, risk can be measured by the range in net present value or the percent chance that the net present value will be greater than a specified level. The decision maker can evaluate the lowest to highest net present value that he can expect, given his subjective evaluation of risk. The ability to generate a probability distribution of outcomes rather than a single-valued estimate which has been adjusted for risk is an important advantage to the decision maker.

Partial (Marginal) Analysis

Aplin et al. (1977) state that projected cash costs should include only those costs associated with the proposed investment. They emphasize that committed or sunk costs are the result of some past decision and will not change the proposed investment result. The same is true for cash benefits. Apparently they advocate a partial analysis. Using this method, appropriate annual marginal tax rates must be estimated to accurately determine after-tax cash benefits. Tax savings associated with the proposed investment due to investment credit, 20 percent bonus first year depreciation, accelerated depreciation methods, and deductible interest expense can influence the profitability of the investment.

Partial analysis will provide a measure of the profitability of the additional investment whether measured by net present value or internal rate of return. However, partial analysis does not measure solvency[1] of

---

[1]Generally accepted measures of solvency include net worth and equity ratio.

the proposed investment. Also, the liquidity[2] and solvency effects of the new investment on the current operating unit, and vice versa, are not considered. If the additional investment's cash benefits were negatively correlated with those of the current operating unit, even the measures of the investment's profitability, net present value, or internal rate of return would not reflect the true picture of profitability for the total firm.

Whole Firm Comparative Analysis

To obtain more complete information about the effect of a proposed investment on the current operating unit, a detailed before and after analysis of the firm is proposed. This approach will require an estimate of cash benefits and costs, net worth, and borrowing and repayment cash flows, associated with the current operating unit. Market values for all assets and liabilities for the current operating unit are necessary to determine annual changes in net worth. Costs associated with borrowing funds or income from investing excess cash should be included as a part of the projected cash benefits and costs. In addition, any capital investment that is required to operate the current unit throughout the planning horizon should be included in projected cost.

Given that the required input data has been collected, a modified version of a net present value or an internal rate of return method would be required to estimate net present value or internal rate of return for the current operating unit. In addition, annual cash flow and net worth information should be calculated to determine the liquidity and solvency of the current operating unit. The procedure will be repeated to estimate

---

[2] Generally accepted measures of liquidity include current ratio and cash flow analysis.

cash cenefits and costs, and calculate the net present value, cash flows, and net worth of the proposed operating unit.

If certain knowledge is assumed, single-valued estimates of net present value, cash flows, and net worth are provided for the current operating unit and the proposed unit using the comparative procedure outlined above. Because this procedure provides comparative data for not only profitability but also liquidity and solvency, it yields more complete information than a traditional net present value analysis of investment alternatives. However, under assumptions of perfect knowledge, the method provides no measures of the risk associated with the cash benefits, costs, and profitability of the investment.

Advantages and Disadvantages of Whole Firm Comparative Analysis

An advantage of a whole firm comparative analysis method is that the correct marginal income and capital gain tax rate can be used to determine after-tax cash benefits. Since taxable income and deductible expenses are known for the current operating unit and the proposed operating unit, actual tax liabilities and after-tax benefits can be correctly calculated. Another advantage of this method allows direct comparison of the current operating unit and the proposed operating unit which includes the current firm and the proposed investment. Comparison of the mean level and variance in annual cash flow and net worth would provide an indication of the degree of correlation and risk among the current operating unit and the proposed investment. Also, the potential gain in net worth could be weighed against the probability of negative net present value or financial disaster.

An obvious disadvantage of this method is the requirement of relatively larger amounts of input data for the current operating unit. Also, by evaluating the entire firm instead of the marginal cost and cash benefits associated with the proposed investment, the value of some resources associated with the current operation will be capitalized into the bid price for the proposed investment (e.g., machinery and labor). While this method does not estimate the net present value of the proposed investment alone, it can be calculated by subtracting current firm net present value from the net present value of the proposed size firm. Wholefirm comparative analysis does allow the investor to determine the maximum bid price that his net worth and cash flow situation can support.

Incorporation of Risk

As described earlier, Monte Carlo simulation techniques can be employed to incorporate risk into a capital investment decision model. By specifying objective or subjective probability distributions for key economic variables, the decision maker's personal experience with respect to risk of the investment can be explicitly considered. The analysis could be repeated many times to generate a probability distribution, rather than a single-valued estimate of the net present value, annual cash flow, and net worth. Richardson and Mapp (1977) point out the importance of evaluating a distribution of annual cash flows rather than a single estimate.

The comparative analysis of the firm, before and after the investment is included as part of the operating unit, can be made assuming imperfect knowledge of the projected cash benefits and costs. Monte Carlo repetition of the analysis will generate probability distributions for annual cash flow, net present value, and annual net worth of the current operating unit and the proposed operating unit. Risk can be measured by the probability that net present value will be positive, or the dispersion (variance) about the expected value of net present value. Comparison of the distributions of annual cash flow and net worth will give an indication of the change in variability over the life of the investment.

Criteria for Ranking Measures of Investment Success

When the utility or preference function of the decision maker is known and incorporated into the investment analysis, each investment alternative could be ranked by a direct measure of expected utility. Utility functions are difficult to estimate, however. The decision maker may prefer the "safety first" philosophy for ranking the desirability of alternative capital investments.

Distributions of key measures of investment success can be compared and ranked for each investment alternative. Stochastic dominance has been suggested as a criterion for comparing cumulative distribution functions (Anderson, Dillion, and Hardaker, 1977). The cumulative distribution for net present value of investment alternative A is presented in Figure 1. Net present value is measured on the horizontal axis while the cumulative probability is measured on the vertical axis. This example indicates that the chance of a negative net present value is four percent. The cumulative distribution function of investment alternative B is also presented in Figure 1. Its chance of a net present value less than zero is 38 percent. In fact, at every level of probability, the net present value of investment alternative A is greater than the net present value of investment alternative B. Anderson et al. (1977) defines this

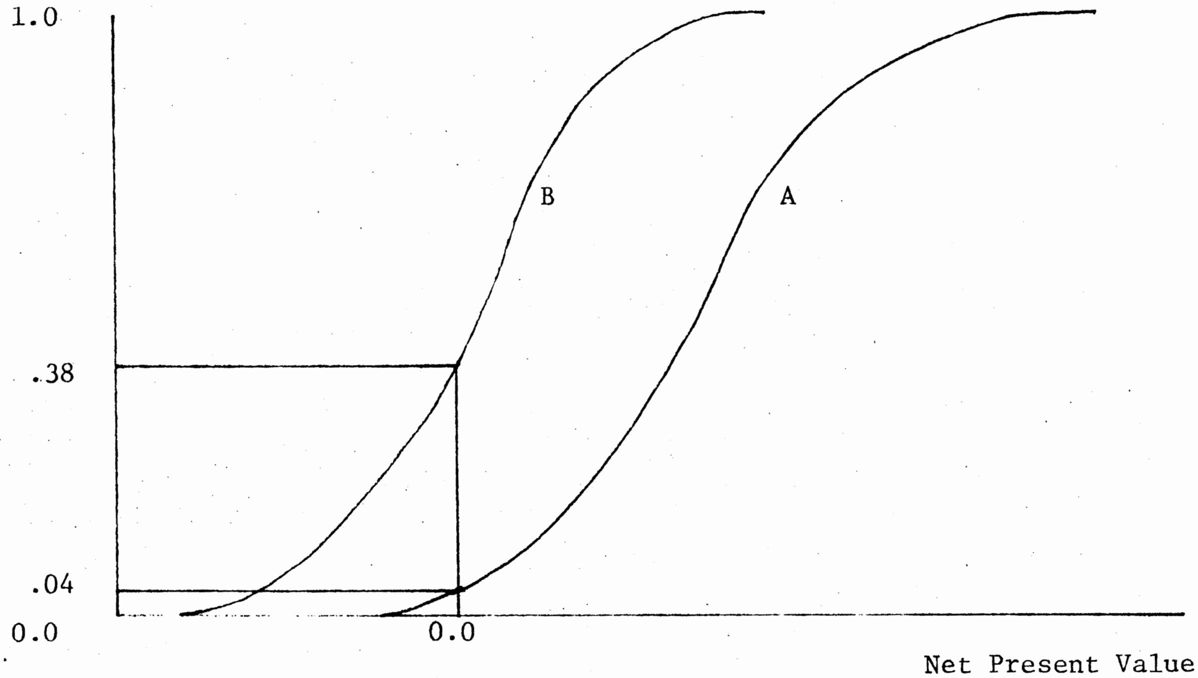

Figure 1. Graphical Representation of First Degree Stochastic Efficiency

situation as first degree stochastic efficiency. Investment alternative A dominates alternative B at every level of cumulative probability. A profit maximizing decision maker would choose alternative A.

Evaluation of the cumulative distributions of net present value for investments C and D in Figure 2, requires an additional criterion. Alternative D's probability of a net present value below zero is .10, while alternative C's probability is .24. The probability of a low net present value is less for alternative D. However, at a higher level of net present value (e.g., $10,000) alternative C's probability of a net present value less than $10,000 is .70, while alternative D's probability is 76 percent. Clearly a tradeoff exists between risk of a low net present value and the potential for a large net present value. The safety first criteria would select alternative D which has a smaller probability of a low net present value.

Second degree stochastic efficiency as defined by Anderson et al. (1977) indicates that a risk averse decision maker would select alternative D if the shaded area, Y, is larger than the striped area, Z, in Figure 2. Alternative D's smaller risk of a low net present value outweighs alternative C's potential for a higher net present value. This criterion assumes the decision maker prefers more to less and is averse to risk.

Additional assumptions about the decision maker's utility function allow stochastic efficiency criteria that further reduce the number of inferior investment alternatives. These criteria are presented by Anderson et al. (1977). For this study, the first and second degree stochastic efficiency criterion are sufficient to rank alternative capital investments.

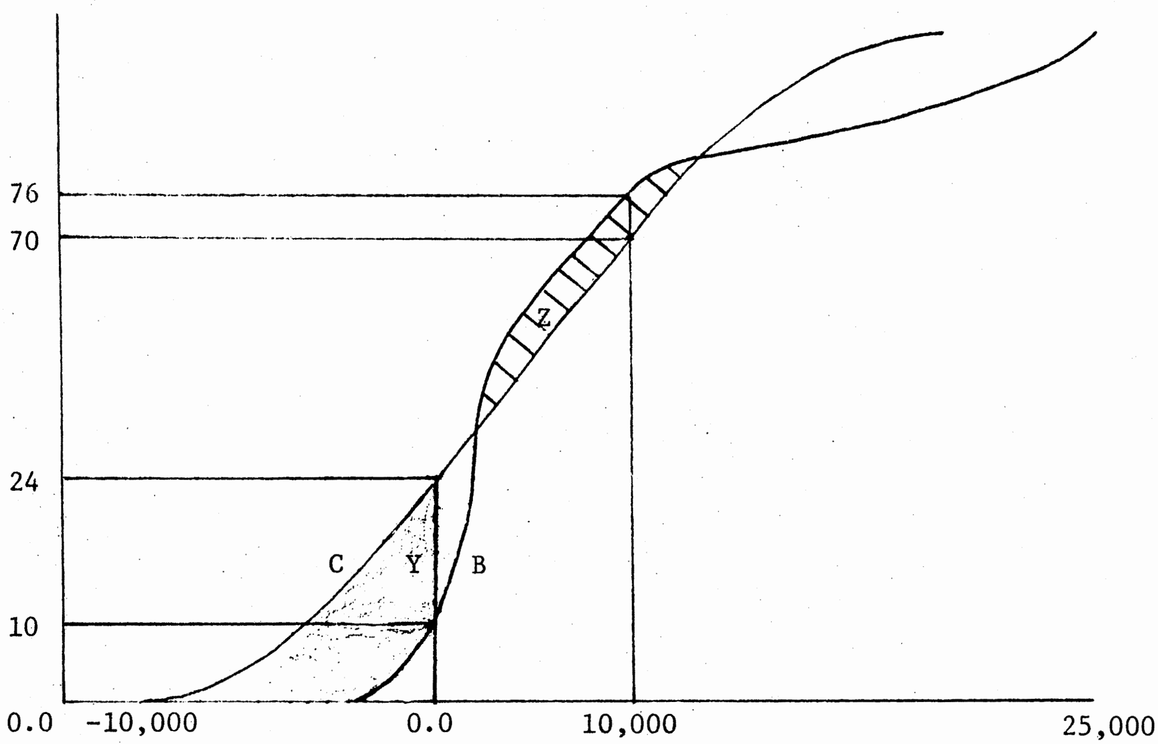

Figure 2. Graphical Representation of Second Degree Stochastic Efficiency

Measures of Firm Survival

A measure of the chance of financial failure or survival would provide additional information about the desirability of the investment. A specified minimum equity level, say 20 percent, can be established below which the firm cannot borrow funds. Positive cash flow and accrued interest from previous years would be used to meet cash losses until exhausted. Financial failure of the firm would occur when the firm's equity is not sufficient to borrow funds to meet cash flow deficits. That is, a firm would fail the survival test if during any year of the planning horizon, the equity of the firm did not allow borrowing to meet cash flow deficits. If the analysis over the planning horizon is repeated many times, risk of non-survival can be measured by the number of years in the planning horizon that the firm could not borrow and the number of replications in which the firm could not borrow in at least one year. Unlike a static model which generates an expected value, whole farm comparative analysis provides an estimate of the chance (probability) of financial failure. This additional information is important to decision makers who consider financial survival as well as profit maximization.

Statistical Test of Firm Survival

A decision maker may specify the minimum chance of financial failure he will accept. The binomial distribution equation 2.6 allows calculation of the probability of obtaining X successes in N independent trials, given that only two outcomes, success and failure, are possible.

$$f(x) = \frac{N!}{x!(N - x)!} \cdot P^x(1 - P)^{N-x} \qquad (2.6)$$

where N = the number of repeated independent trials,

P = the probability of success for a single trial,

1-P = the probability of failure for a single trial,

x = the number of successes, and,

f(x) = the probability of having x failures in N trials given P and 1-P (Conover, 1971).

The binomial test can be approximated by equation 2.7 for repeated trials, N, greater than 20.

$$t_1 = NP^* \pm W_{.05} \cdot NP^*(1 - P^*) \qquad (2.7)$$

where N = the number of failures,

P^* = probability of success for a single trial,

$W_{.05}$ = value from standard normal table which represents the five percent level of confidence, and,

t_1 = the maximum number of failures allowed with a five percent chance of financial disaster (Conover, 1971).

Stochastic Breakeven Bid Prices

Internal rate of return, yield of investment method, and marginal efficiency of capital are all names applied to the trial and error procedure for determining the discount rate which yields a zero net present value. In this process, the discount rate is adjusted until the discounted cash benefits are just equal to the discounted cash costs.

The decision maker may also be interested in knowing how much he can pay for a proposed investment, given the discount rate which represents minimum acceptable rate of return on investment. To obtain this result, the investment cost should be adjusted until the net present value of cash benefits and costs is zero. In a deterministic analysis where the cash benefits and costs are assumed to be known with certainty, the initial investment outlay can be adjusted until the net present value of the cash benefits and costs is zero.

If uncertainty is allowed in the analysis of capital investment, the cash benefits and costs will vary for each replication of the analysis. Repeated Monte Carlo simulation trials which allow variation in cash benefits and costs through random sampling of subjective probability distributions of product prices and yields will generate many estimates of net present value. Assuming a 20 year planning horizon for the decision maker, one Monte Carlo trial has associated with it 20 years of random product prices and yields, and Monte Carlo trials may be repeated 100 or more times. To reduce the number of breakeven analyses, the net present value for all 100 trials could be ranked from smallest to largest and a breakeven bid price estimated for selected ranks.

A solution procedure is needed to adjust the investment cost or bid price until the discounted cash benefits and costs yield a zero net present value given the decision maker's discount rate. Kuester and Mize (1973) have assembled a number of routines which are appropriate for nonlinear, multivariate minimization problems. The problem described is not a minimization, but involves iteratively changing investment outlay until the net present value of cash benefits and costs are zero. This can be accomplished by minimizing the deviation of net present value about the zero value. The Fibonacci Algorithm (Kuester and Mize, 1973) is an interval elimination search method that when given initial boundaries for the independent variable, investment outlay, will reduce the interval which contains the optimum value of net present value to a desired accuracy about the optimal value, zero.

Given a nonlinear unimodal function like Figure 3, and interval boundaries, a_1 and b_1, the Fibonacci Algorithm minimizes a function F(x), subject to x being with the range, a_1 to b_1. One Fibonacci number is required for each iteration or evaluation of the objective function represented by equation 2.8.

$$Y = f(x) \tag{2.8}$$

Where Y = net present value, and

x = investment outlay.

Iteratively adjusting the investment outlay will affect the net present value through resulting changes in total interest, principle, investment credit, income tax, depreciation, and net cash flow. All other parameters in the model would be held constant while the investment outlay that yields a zero net present value is iteratively determined.

Equation 2.9 identifies the number of function evaluations and thus the desired accuracy or size of the optimal interval.

$$\alpha = .01/N \tag{2.9}$$

where α = the desired accuracy, and

N = the number of function evaluations desired.

The Fibonacci numbers, F_N, are calculated based on equation 2.10.

$$F_N = F_{N-1} + F_{N-2} \tag{2.10}$$

where $F_0 = 1.0$,

$F_1 = 1.0$,

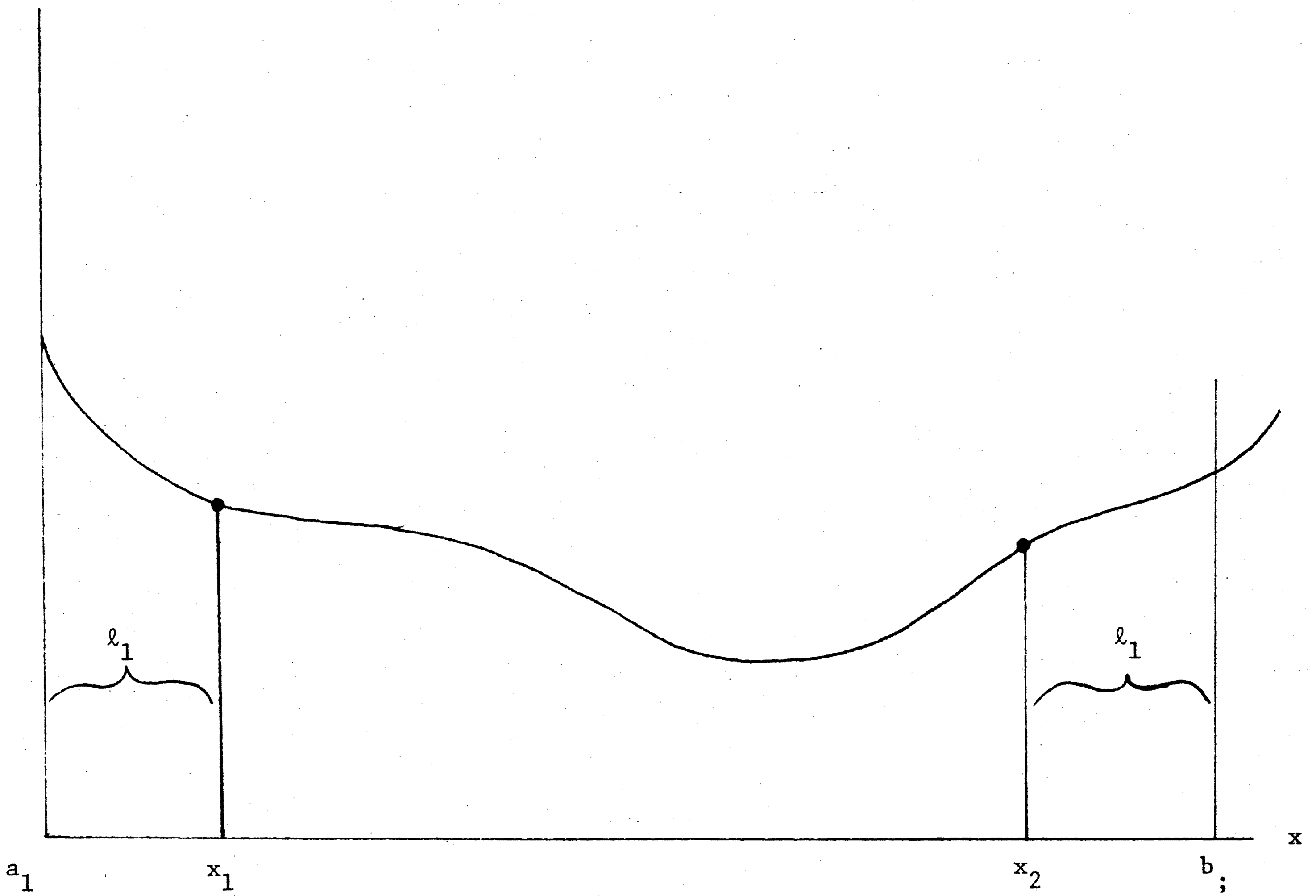

Figure 3. Graphic Illustration of the Fibonacci Single Variable, Non-Linear Optimization Procedure.

$N \geq 2$, and

F_N is a Fibonacci number.

These Fibonacci numbers are used to determine the points, X_N, to be evaluated. A point, X_N, is placed within the range from a_1 to b_1, a certain distance ℓ_1 from each boundary.

$$\ell_1 = \frac{F_{N-2}}{F_N} \cdot L_1 \qquad (2.11)$$

where ℓ_1 = the distance from each boundary the points X_1 and X_2 are placed,

L_1 = the range a_1 to b_1, and

F_N = the Fibonacci numbers.

Equations 2.12 and 2.13 define the location of the first two points X_1 and X_2.

$$X_1 = a + \ell_1 \qquad (2.12)$$

$$X_2 = b_1 - \ell_1 \qquad (2.13)$$

If X_1 is less than X_2, the new search interval is a_1 to X_2. If X_2 is less than X_1, the new search interval becomes X_1 to b_1. The example in Figure 3 indicates that X_2 is less than X_1, so the new search interval, L_2, is X_1 to b_1. For the second step, X_1 becomes a_2 and b_1 becomes b_2. The next point for evaluation is placed a distance ℓ_2 from one of the new boundaries a_2 or b_2. Equation 2.14 illustrates the calculation of ℓ_2.

$$\ell_2 = \frac{F_{N-3}}{F_{N-1}} \cdot L_2 \qquad (2.14)$$

where ℓ_2 = the distance X_3 should be placed from a_2,

L = the new search interval, and

F_{N-3} and F_{N-1} are Fibonacci numbers.

X_3 is the third point to be evaluated. Equation 2.15 indicates the location.

$$X_3 = a_2 + \ell_2 \quad \text{or} \tag{2.15}$$
$$X_3 = b_2 - \ell_2$$

Since X_2 was less than X_1, and X_1 became a_2, the location of X_3 equals $a_2 + X_2$. The above procedure is repeated until all Fibonacci numbers are used to determine the optimum value of Y, investment outlay.

Cost may prohibit analysis of very many of the 100 Monte Carlo trials. However, by selecting from the ranked list of net present value, those of most interest to the decision maker could be solved. If only the largest and smallest net present value situations were analyzed, the decision maker would know the minimum and maximum bid price he could pay, given his discount rate, as net present value varies from smallest to largest.

Stochastic Product Prices and Yields

Variation in the prices and yields of agricultural products represent a large proportion of the income variability faced by farmers. Weather, insects, institutional influences, and exports which are the major factors that cause variation in gross farm income, can be reflected through their effect on product price and yield.

A method is needed to realistically include variation in cash flows associated with capital investment. Given the extreme variation in product prices and yields over the last decade, the assumption of certain knowledge of future cash flows becomes less acceptable. The most commonly used method of incorporating uncertainty is to specify average or mean expected values and the dispersion or variance about that mean for key parameters. Hinman and Hutton (1970) and Hess and Quigley (1962) illustrate the mathematical formulas required to generate a normal probability density function. Because most decision makers are not familiar with probability as specified by mean and variance, normal distributions relied almost wholely on historic or objective probabilities. More restricting however, is the assumption that these probability distributions be statistically independent.

Clements et al. (1971) developed a computer routine which utilizes the correlation coefficients of related agricultural data. Thus, the bias associated with ignoring the correlation of agricultural yields (in a given year) can be eliminated. The disadvantages of computational complexities and reliance on objective probabilities remain.

Sprow (1967) suggests that a probability distribution should possess certain desirable characteristics. 1) The function should contain parameters that are familiar to most estimators and be specified completely by economic estimates. 2) The function should be capable of being skewed or non-symmetric about the mean. 3) The distribution should be ameanable to mathematical analysis. Sprow proposed the triangular distribution which he used to evaluate research expenditures. Cassidy et al. (1970) used the triangular distribution in a farm planning and investment situation. The triangular distribution can be completely specified by estimating a value for the 1) minimum, 2) maximum, and 3) the most likely or modal occurrence of the variable. These parameters are better understood by decision makers than mean, variance, or probabilistic estimates of the parameters. A triangular distribution can be skewed simply by specifying a most likely value that is closer to either the minimum or maximum value.

Computationally, the probability density function, Figure 4, of a triangular distribution is specified by equations 2.16 and 2.17.

$$f(X) = \frac{2(x-a)}{(c-a)(b-a)} \quad , \quad a \leq x \leq b \tag{2.16}$$

$$f(X) = \frac{2(x-c)}{(c-a)(b-c)} \quad , \quad b \leq x \leq c \tag{2.17}$$

where a = minimum value,

b = most likely value,

c = maximum value, and

X = the value of the particular variable.

By integrating the probability density functions equations 2.18 and 2.19 result.

$$F(X) = \frac{(x-a)^2}{(c-a)(b-a)} \quad , \quad a \leq x \leq b \tag{2.18}$$

$$F(X) = 1 - \frac{(x-c)^2}{(c-a)(c-b)} \quad , \quad b \leq x \leq c \tag{2.19}$$

a, b, c, and X defined as above.

Equations 2.18 and 2.19 can be solved in terms of X to yield 2.20 and 2.21. In this form, a value of the stochastic variable can be determined by a random selection of a value for F(X) between zero and one. The value of x can be determined by solving equation 2.20 or 2.21 given the random selection of F(X) between zero and one. Figure 5 illustrates the cumulative probability function for a triangular distribution.

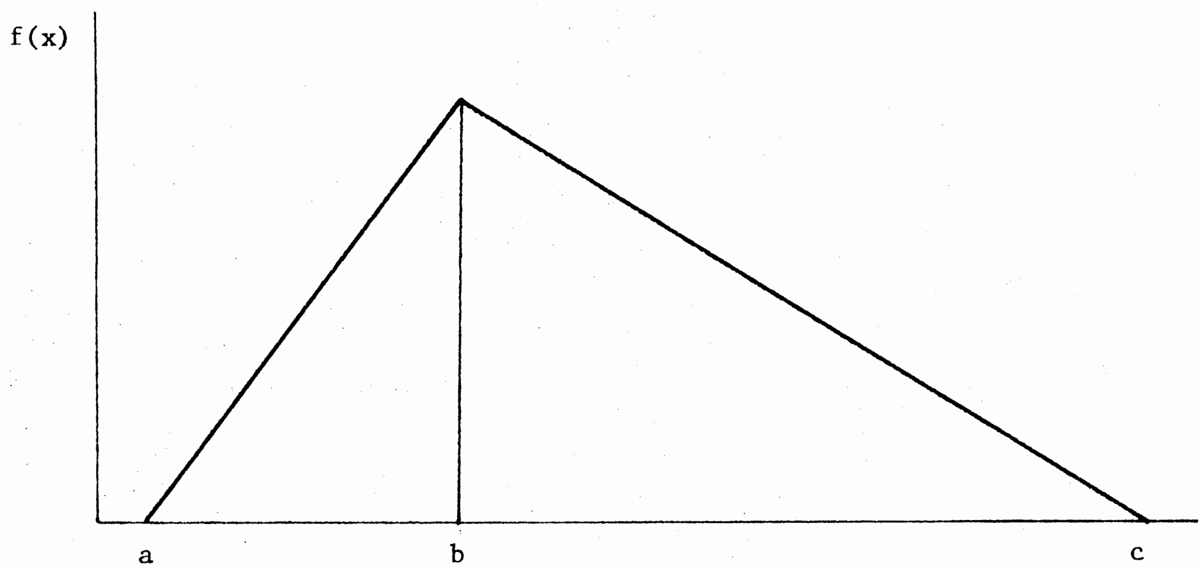

Figure 4. Graphical Illustration of a Triangular Probability Density Function

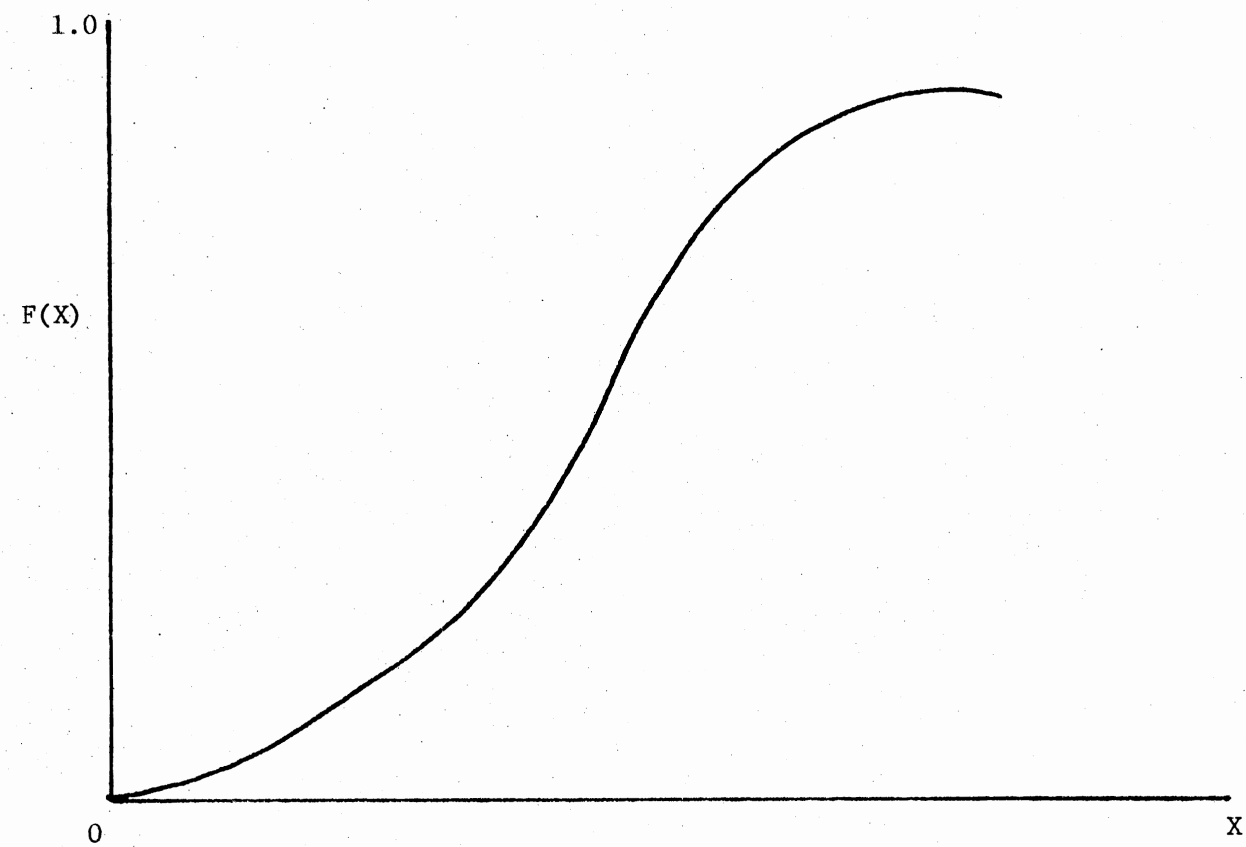

Figure 5. Graphical Illustration of a Triangular Cumulative Probability Distribution

$$X = a[F(X)(c-a)(b-a)]^{\frac{1}{2}}, \quad a \leq X \leq b \tag{2.20}$$

$$X = c - [1 - F(X)(c-a)(c-b)]^{\frac{1}{2}}, \; b \leq X \leq c \tag{2.21}$$

The triangular distribution can be incorporated in a capital investment model as a means of including the decision maker's subjective evaluation of the price and yield variability that he faces. Given the high degree of variability in yields from county to county, farm to farm, and even among parcels of land within a farm, specification of the minimum, maximum, and most likely yield expected could be superior to methods of incorporating yield variability based on historic data. If the decision maker is unsure of the parameters of the price or yield distribution, he may elect to use a normal distribution based on historic data.

The inclusion of the correlation among normally distributed variables is based on the historic variance and covariance of those variables. Triangular distributions can utilize the decision maker's personal estimate of his price and yield variability. However, the correlation among triangular distributions of prices and yields at this point is not considered. Each subjective specification of the triangular distribution's parameters would yield a different standard deviation and thus a different variance-covariance. The procedure developed by Clements et al. (1971) can be used to correlate triangular distributions. Unpublished work by Richardson (1977) indicates that triangular distributions can be correlated by factoring the correlation coefficient matrix instead of the variance-covariance matrix. The correlation coefficient matrix represents the correlation among variables, but is not scaled by the standard deviations of the variables. By using a modified version of the Clements (et al., 1971) procedure and the historic correlation coefficient matrix, stochastic triangularly distributed prices and yields can be generated that exhibit a correlation coefficient matrix statistically equivalent to the correlation coefficient matrix of the historic data. As a result, the triangular distributions used in this model are a combination of subjective parameter estimates by the decision maker and correlations among prices or yields based on historic data.

R. A. Fisher developed a statistical test to pairwise compare the correlation coefficients of two matrices. The test is simplified by the Z transformation listed in equation 2.22.

$$Z = \tfrac{1}{2} \mathrm{LN} \frac{1 + r}{L - r} \tag{2.22}$$

The test statistic d equals:

$$d = \frac{Z_1 - Z_2}{\sqrt{1/N_1 - 3 + 1/N_2 - 3}} \tag{2.23}$$

Decision rules would be:

$$\begin{aligned} &\text{Accept } H_0 \text{ if } |d| \leq Z_{\frac{1}{2}} \alpha \\ &\text{Accept } H_1 \text{ if } |d| \geq Z_{\frac{1}{2}} \alpha \end{aligned} \tag{2.24}$$

(Morrison, 1976)

Equality of the historic correlation coefficient matrix and the matrix resulting from repeated generation of triangularly distributed stochastic prices and yields is the hypothesis to be tested.

$$H_0 = \rho_1 = \rho_2 \tag{2.25}$$

where ρ_1 = the correlation coefficient from the historic matrix and

ρ_2 = the correlation coefficient generated by the stochastic triangular procedure.

To complete this test, each of the generated price coefficients and yield coefficients must be compared pairwise to the historic values. If results indicate failure to reject the null hypothesis, ρ_1 and ρ_2 at the 0.05 level of significance, the correlation coefficient matrix resulting from repeated generation of triangularly distributed prices and yields is statistically equal to the historic matrix.

The next chapter provides a detailed description of the Monte Carlo type simulation model, a verbal description of the program logic, an organization of the main program and called subroutines, and a description of input data and mathematical equations.

CHAPTER III

THE SIMULATION MODEL

The major purpose of the model is to analyze capital investments in an intertemporal and stochastic environment. With minor modifications the model applies equally well to emperical research questions and to farmer problems which may be brought to extension workers. It is specifically designed to determine the profitability, solvency, liquidity, and the chance of firm survival, for alternative capital investments. Direct comparison of the current operating unit and the proposed operating unit after the investment will provide an accurate estimate of the investment's net effect on the current firm. Probability distributions of net present value, annual net worth, cash flow, and firm survival allow the potential gain to be weighed against the risk of financial disaster.

General Model Description

A general description of the basic components of the program, along with Figure 6, will provide an introductory orientation. Execution of the program logic can be divided into two major sections. First, the model reads all data and calculates values which do not change in each replication of the analysis. The amortized cost of existing liabilities, market values of present assets, off-farm income, and the cost associated with asset replacement, affects all replications of the analysis equally

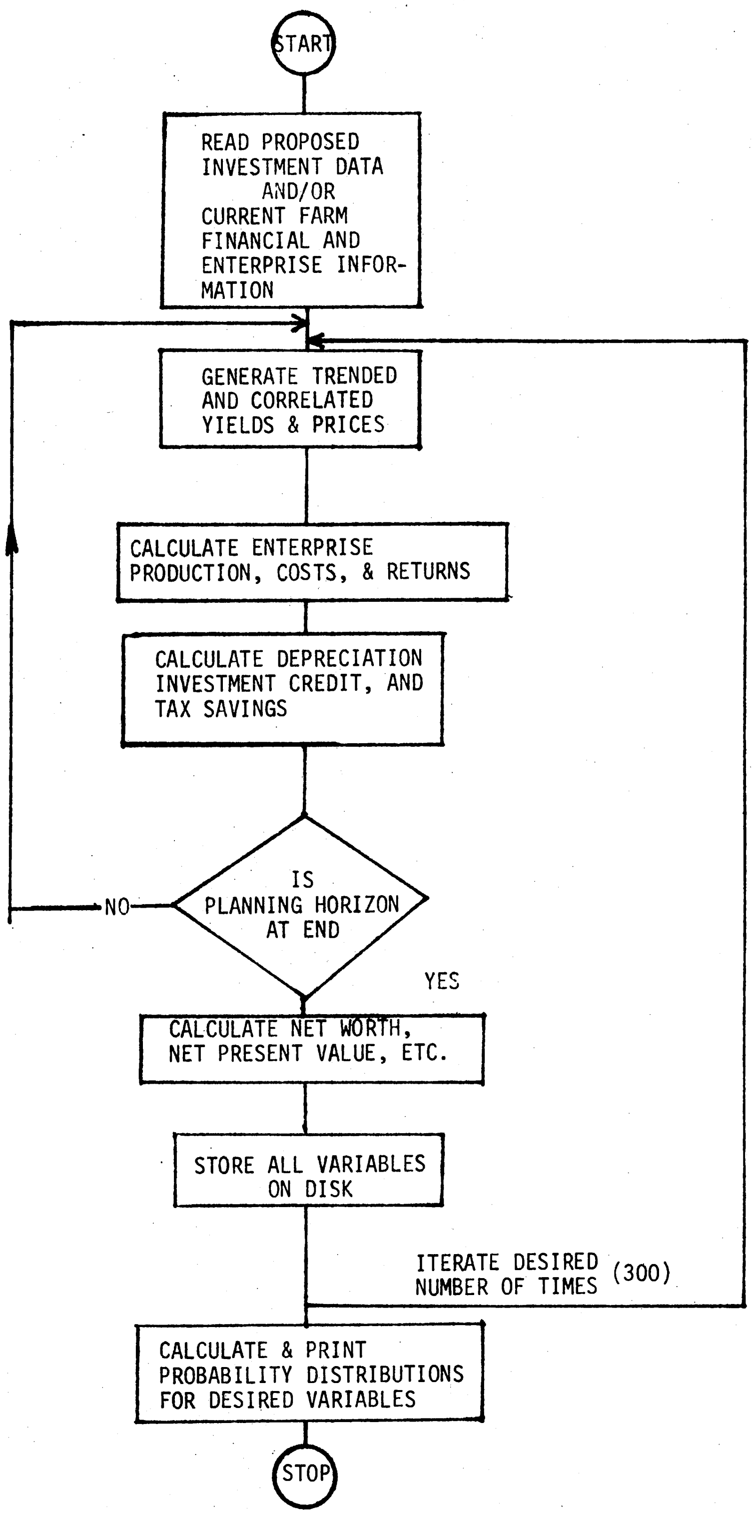

Figure 6. Flow Chart: Capital Investment Decision Simulator

and do not change with stochastic variables. They are "deterministic" and may have trends and cyclic variables. To efficiently utilize computer time, these values are calculated and stored in arrays, one time, and then added each time the analysis is repeated.

The remaining program logic is an analysis loop which can be repeated a specified number of times. This loop begins with the calculation of stochastic prices and yields. Then enterprise costs and returns are calculated. These enterprise costs and returns and the non-stochastic costs and returns described above are used to determine net worth, net present value, and firm survival for each repetition. The main program reads the input concerning assets, liabilities, the kinds of crop enterprises and number of acres, the kinds and number of head of livestock enterprises, family living requirements, non-farm income, and other relevant data for the current size operating unit. Existing assets are valued for net worth purposes, and annual liabilities are recorded. Capital assets purchased during the planning horizon are depreciated for tax purposes and are valued for net worth. Liabilities associated with these investments are amortized, and annual payments are specified.

The model utilizes either trended and correlated stochastic product prices and yields that exhibit a normal distribution based on historic data, or trended and correlated stochastic product prices and yields that are triangularly distributed and based on subjective estimates of variation. For each iteration, the prices, yields, and numbers of units of each enterprise are combined to generate gross enterprise income and enterprise costs. Production costs are trended through time as are family living costs.

Net cash flows are determined and discounted for each year in the planning horizon. Family living is paid and taxes are deducted. If net cash is positive, it is accumulated for future use. If it is negative, equity levels are calculated to determine whether funds can be borrowed to meet the cash flow deficit. If not, the iteration fails the survival test. Net worth, net present value, and cash flows are calculated for each year in the planning horizon.

The analysis of the current situation is repeated a specified number of times to provide data necessary for probability distributions of annual net worth, cash flow, and net present value. This data is stored for future statistical analysis.

For the proposed farm unit, the main program now reads bid price, loan interest rates, repayment period, discount rate, proposed enterprises, additional machinery or other necessary capital purchases, and required data for the proposed investment. The procedure described above is repeated for the proposed size operating unit which includes the current operating unit and the proposed capital investment. Statistical analysis of both sets of data provide probabilistic comparisons of the current operating unit and the proposed operating unit.

Detailed Description of Main Program Functions

Required input data, definitional equations, and model capabilities will be discussed according to Figure 6, the model flow diagram. Appendix C provides a card by card specific description of each input item. Beginning inventory of liabilities, machinery, and buildings are read as input in the main program. Other input includes both depreciable and non-depreciable assets purchased during the planning horizon. Net worth and cash flow effects of the above input are accounted as described in the following sections.

Amortization of New and Existing Liabilities

Card number 13, row 66 through 70 of Appendix C, is used to input the inventory of liabilities as well as the liabilities associated with non-depreciable assets purchased during the planning horizon. If principle and interest due each year is reported, the interest is added to deductible cash expenses and the principle payment is added to non-deductible cash expenses. The total amount of the liability is added to intermediate liabilities if the loan life is seven years or less, or added to long-term liabilities if the loan life is greater than seven years. Each time a principle payment is made, the appropriate liability account is reduced by that amount. If the principle and interest amount is not known, but a loan amount is given, the program will amortize the loan and then cash flow and net worth entries are made exactly as previously explained.

Valuation of Beginning Inventory of Machinery and Buildings

Inventory values of machinery, buildings, and land are components of net worth. Inflation causes the list price of most machinery and buildings to increase. Other things equal, the cost of purchasing used machinery will also increase. To more accurately reflect the market value of used assets, purchase cost is inflated by a constant annual percentage. This inflated purchase cost is depreciated to determine market value for calculation of net worth. If the salvage value of an asset were normally ten percent of the purchase cost, a four percent inflation rate would result in a salvage value of approximately 15 percent of the original purchase cost.[1]

Input includes market value of machinery and buildings, the average age of these assets, and the annual rate of inflation in value of these assets.

Market value of beginning machinery inventory in year n equals:

$$VALUE = MKVALMH * (1.0 + INFRATE)^{YR} * [1 - (1.0 - SALV) * ((AGE + 1)/10)] \quad (3.1)$$

where MKVALMH = market value of machinery, year n-1,

INFRATE = annual rate of inflation for machinery and buildings,

SALV = ratio of salvage value to list price,

AGE = age of the asset, and

YR = year in the planning horizon.

Similarly, market value for buildings equals:

$$VALUE = MKVALBLD * (1.0 + INFRATE)^{YR} * [1 - (1.0 - SALV) * ((AGE + 1)/20)] \quad (3.2)$$

where MKVALBLD = market value of machinery, year n-1, and

other variables are previously defined.

The first year market value of machinery and buildings is added to intermediate and long-term assets, respectively. Each year, the change

---

[1]This approximation assumes a ten year asset life, straight-line depreciation, ten percent salvage value, and no first year bonus depreciation.

in value or market value of machinery is added (algebraically) to intermediate assets while the change in market value of buildings is added to long-term assets. When, at the end of useful life, the assets have been reduced to salvage value, they are sold and subtracted from intermediate or long-term assets. The salvage value is added to the current assets, cash. Equation 3.1 is also used to determine market value of new assets purchased during the planning horizon. Purchase cost is substituted for MKVALMH, market value.

The four functions of the main program 1) read input, 2) initialize variables, 3) amortize new and existing liabilities, and 4) value inventory and new purchases of machinery and buildings have been described at this point.

Stochastic Prices and Yields

The model is designed to operate using either deterministic (fixed) incomes and expenses for the planning horizon or stochastic yields and prices that exhibit either a normal distribution or triangular distribution. The first step in developing these normal distributions of prices and yields was to collect yield and price series for the commodities produced in the study area--North Central Oklahoma. The linear regression package Omnitab was used to detrend the data. A polynomial function of time, first through fifth degree, was used to evaluate the variation in the dependent variables, price and yield. The regression or set of residuals which had the most significant t-values were used. The M by N matrix of residuals was read into the Omnitab package to compute a correlation matrix, where M = the number of years of price data and N = the number of commodity prices in the study region. A variance-covariance matrix for prices and yields was calculated by multiplying the correlation coefficient matrix for the variables by the standard deviation of each of the variables. The Clements et al. (1971) computerized procedure was used for factoring this variance-covariance matrix into a unique upper triangular matrix. This procedure factors the variance-covariance into the product of a unique upper and lower right triangular matrix that can then be matrix multiplied by a vector of random normal deviates to determine a set of trended, correlated, and normally distributed observations.

The model builds $\hat{Y}$ or average values for prices and yields from trend and intercept coefficients read into the model. The $\hat{Y}$ used in this model is represented by equation 3.3.

$$\hat{Y} = a + bT \tag{3.3}$$

where a = the intercept coefficient,

b = the trend coefficient, and

T = time in years.

This flexibility allows changing either the trend or intercept of any of the equations used to predict prices or yields. In this model, first degree equations of the independent variable, time, are used to predict prices and yields, if the t-value associated with the trend coefficient is significant. Otherwise, the intercept is used.

The unique upper right triangular factored variance-covariance matrices for prices and yields are read into the model as input. The stochastic prices and yields are calculated based on the following equation:

$$PRICE(I, L) = \hat{Y}(I, L) + SUMP(L) \tag{3.4}$$

where PRICE(I, L) = a matrix of stochastic normally distributed, trended, and correlated prices,

$\hat{Y}$ = a matrix of trended prices, (based on equation 3.3),

SUMP (L) = the product of the matrix multiplication of the appropriate elements of the factored variance-covariance matrix and a random normal deviate,

(I) = 1, to number of years in the planning horizon, and

(L) = i, to number of prices or yields.

In the above discussion, prices and yields have been mentioned together. There is a separate variance-covariance matrix for prices and yields. The separate matrices are both factored into separate unique upper right triangular matrices so that the equation for stochastic yields is represented by 3.5:

$$\text{YIELD (I, L)} = \hat{Y}\text{ (I, L)} + \text{SUMY (L)} \qquad (3.5)$$

where the variables are defined as those above substituting yield for price.

Polynomial functions of the independent variable were used to estimate from the price and yield observations the true or random variation. It is very important to use truly random residuals to generate the variance-covariance matrices and thus the factored triangular variance-covariance matrices. By doing so, this gives a great deal of flexibility in constructing the stochastic prices and yields, whereby any equation of any variable can be used to predict the $\hat{Y}$ value of prices and yields. $\hat{Y}$ can be the average value, a trended value, or any functional form using any explanatory variables.

Total Enterprise Costs for the Farm

Input required to determine total farm enterprise costs and returns include production cost per unit (acre or head), the annual percentage inflation rate in cost per unit, and the number of units, head or acres, to be produced. Given the inflation rate, costs can be trended over time. In the model, trended enterprise costs are multiplied by the specified number of units for each enterprise to determine total cost per enterprise. Some stochastic variation in cost is introduced through livestock enterprise buy prices. These stochastic buy prices are determined in the same way as the product prices.

Based on the additional machinery and equipment necessary to operate a proposed capital investment, the model calculates the principle and interest cost of this machinery and equipment. It is assumed that the decision maker can predict machinery and equipment needs only a determinant distance into the future. At this point, average depreciation cost based on enterprise budgets is charged. Cost per unit of a particular enterprise should not include depreciation cost.

Total Farm Enterprise Income

Gross enterprise returns are determined by combining stochastic prices, yields, and number of units of a particular enterprise. Simulation experiments conducted in this study utilize winter wheat, custom harvest, owned and leased land, and November to March stocker cattle grazed on owned and leased land. This section describes the calculation of gross income for all enterprises in the model. Gross income for wheat, grain sorghum, alfalfa, and forage sorghum is determined according to equation 3.6.

GROSS INCOME = PRICE x YIELD x NOUNITS (3.6)

where NOUNITS = the number of acres produced.

Gross income for November-March stockers, November-May stockers, and March-May stockers is determined according to equations 3.6 through 3.9.

SELWT = BUYWT + (RATEGN x Days on Pasture) (3.7)

GROSS INCOME = SELPRICE x (SELWT/100) x NOUNITS (3.8)

BYCOST = BUYWT x BUYPRICE/100 x NOUNITS (3.9)

where SELWT = weight of the stocker steer at sale time,

SELPRICE = stochastic price for the sale month,

BUYPRICE = stochastic price for the purchase month,

BUYWT = weight of stockers at purchase time (specified as input),

BYCOST = total purchase cost of stocker steers,

NOUNITS = number of head,

RATEGN = stochastic gain rate in pounds per day, and

GROSS INCOME = total gross income for the enterprise.

Gross income for cow-calf enterprises is influenced by the stochastic determination of weaning weights and calving percentages. The degree of variation is determined by the input of the minimum, maximum, and most likely values of the weaning weight and calving percentage. Equation 3.10 specifies the determination of gross income for cow-calf enterprises.

GROSS INCOME = SLCOWPR x SCWT x (CP x NOUNITS) + (CALFPR)

x (NOUNITS x CLFPR) x (WEANWT/100) (3.10)

where CALFPR = calf price per cwt,

CLFPR = calving percentage,

WEANWT = weaning weight,

SLCOWPR = sale price for slaughter cows per cwt.,

GROSS INCOME = total gross income for the enterprise,

NOUNITS = number of brood cows,

SCWT = slaughter cow weight in hundredweight, and

CP = culling percentage.

Based on the determination of enterprise gross income and enterprise cost, the net returns for the enterprises are calculated as follows: equation 3.11 specifies net returns for crop enterprises, and equation 3.12 specifies net returns for stocker and cow-calf enterprises.

$$\text{NETRET} = \text{GROSS INCOME} - \text{COST} \tag{3.11}$$

$$\text{NETRET} = \text{GROSS INCOME} - \text{COST} - \text{BUY COST} \tag{3.12}$$

where NETRET = net return,

BUYCOST = the buy cost of livestock purchased for resale, and

COST = production cost of enterprises produced.

Depreciation and Investment Tax Credit

Depreciation is an important and often ignored influence on the feasibility of a capital investment. Deductible depreciation reduces the tax liability. The model calculates tax deductible depreciation on the eligible portion of the proposed capital investment and any additional machinery and equipment purchases made during the planning horizon to operate the capital investment. Depreciation is calculated using the straight-line or double declining balance method according to the guidelines in the Farmer's Tax Guide.

Input necessary for calculating depreciation on the proposed capital investment is specified on Card 1, row 1 through 5 of Appendix C. It includes salvage value, amount eligible for 20 percent first year bonus depreciation, the amount of the investment which is depreciable, and the depreciation method, straight-line or double declining balance. Input necessary to calculate depreciation on additional purchases of machinery and equipment is specified on Card 12, Appendix C. Required data includes the amount of the investment, salvage value, the amount eligible for 20 percent first year bonus depreciation, and the depreciation method, straight-line or declining balance.

Double declining balance depreciation is calculated by the model based on equations 3.13 through 3.15.

$$DEPRAT = 2.0/DEPLIFE \quad (3.13)$$

$$DEPRE = DEPRAT \times REMVAL \quad (3.14)$$

$$REMVAL = REMVAL - DEPRE \quad (3.15)$$

where DEPRAT = the rate of double declining balance depreciation based on the life of the asset,

DEPRE = annual depreciation,

REMVAL = undepreciated basis, and

DEPLIFE = asset useful life.

Salvage value, for tax purposes, has no effect on cash flow or net worth. The market value at the time of salvage is subtracted from intermediate or long-term assets and added to the current asset, cash. All assets are replaced at the end of their useful life. Gains due to depreciation are assumed to be insignificant, thus income from salvage asset sales are taxed at ordinary income rates.

Straight-line depreciation is calculated by the model based on equation 3.16.

DEPRE = [(ASSETCOST - SALV) - BONUSDEP]/DEPLIFE (3.16)

where DEPLIFE = depreciation life of the asset,

DEPRE = the annual calculated tax depreciation,

BONUSDEP = the amount of 20 percent first year bonus depreciation, and

SALV = salvage value of the asset.

For both the proposed capital investment and the additional purchases of machinery and equipment, 20 percent first year bonus depreciation is based on the amount specified as eligible on the input card. Since limitations for 20 percent first year depreciation are different for corporate, partnership, and sole proprietor types of ownership, the different values are not built into the model. Care must be exercised in not specifying an eligible amount or total eligible amounts which yield 20 percent first year bonus depreciation greater than the applicable limitation. Equation 3.17 specifies calculation of bonus depreciation.

BONUSDEP = (.2 x ASSETCOST) (3.17)

where ASSETCOST = the purchase price or boot paid for the asset, and

BONUSDEP = the amount eligible for 20 percent first year bonus depreciation.

Depreciable Investments During the Planning Horizon

Depreciable investments made during the planning horizon (other than year 0) are reported on Card 12, rows 57 through 65 of Appendix C, Other

Investments. Information on this card allows calculation of actual tax depreciation, amortization of the liability associated with these purchases, and determination of the market or net worth value of the asset. The depreciation method, asset cost, and asset life provide the information necessary to calculate tax deductible depreciation, 20 percent first year bonus depreciation, and ten percent investment tax credit.

The depreciation is a tax deductible expense, but does not affect cash flow. Cash expenses associated with this investment included principle which is added to total cash expenses and interest which is added to deductible cash expenses. The total amount of the investment is added to intermediate or long-term liabilities, and the principle payment is subtracted annually.

To complete the net worth effects of the other investments, the annual market value is determined according to equation 3.1 and 3.2. The cost or beginning value is added to the initial year asset category and changes in value are made annually, until the value is reduced to salvage and sold.

Investment Credit

Investment tax credit allows a reduction of the tax liability equal to ten percent of the new amount invested in qualified capital assets. Assuming taxable income or a tax liability exists, the cost of a qualified capital investment is reduced to 90 percent of the purchase price by investment tax credit alone. The effects of annual and 20 percent first year bonus depreciation on taxes reduce the effective cost further. These are extremely important considerations in determining the feasibility of a proposed capital investment.

Investment credit is calculated for the eligible portion of the proposed capital investment and any additional purchases of machinery and equipment necessary to operate the capital investment. Input on card 1, rows 1 through 5 in Appendix C, and card 12, rows 57 through 65 in Appendix C, requires only the amount of the investment which is eligible for investment tax credit. Limitations exist on the amount of investment tax credit allowable in a particular year. The amount specified as eligible for tax credit should not exceed the applicable limitation. Investment tax credit is calculated simply by multiplying .1 times the eligible amount of investment. The tax savings due to investment tax credit is limited to the amount of the tax liability. Unused investment tax credit is carried forward to reduce tax liabilities for seven years.

Capital Gain Taxes

Capital gain taxes should not be overlooked in determining the profitability of a capital investment. Capital gain taxes are calculated on the land portion of the proposed capital investment as though the land is sold at the end of the planning horizon. This equation, 3.18, can be bypassed if desired.

$$CPGNTI = .5 \times (MKLANDV - LANDCOST) \tag{3.18}$$

where CPGNTI = income which is being allowed capital gain tax treatment and will be taxed as ordinary income,

MKLANDV = the market value or sales price of the land, and

LANDCOST = the purchase price or cost (basis) of the land.

Taxable Income

Equation 3.19 describes the components of gross taxable income.

$$TINCOM = GROSIN + PERMIN + FINCOM \tag{3.19}$$

where TINCOM = the total taxable income from all sources,

GROSIN = taxable income from the production of agricultural commodities,

PERMIN = this category allows all income to be specified deterministically or it can be used to include other income such as oil royalities, custom work income, or off-farm employment income, and

FINCOM = family income...this allows inclusion of the spouse's or other family members' taxable income.

Equation 3.20 lists the components of tax deductible expenses.

$$DEXPEN = COST + BUYCOST + PERMDE \tag{3.20}$$

where DEXPEN = total tax deductible expenses for the current firm,

COST = deductible costs of production of agricultural commodities,

BUYCOST = the stochastic purchase cost of (non-capital purchases) livestock enterprises, and,

PERMDE = the deductible interest cost on other liabilities.

Equation 3.21 describes net taxable income.

$$NETINC = TINCOM - DEXPEN - DEPRE + CPGNTI - (PRTXEX \times 750) \tag{3.21}$$

where NETINC = the net taxable income,

TINCOM = gross taxable income,

DEXPEN = deductible expenses,

DEPRE = deductible depreciation associated with the current firm and any machinery and equipment purchased during the planning horizon,

CPGNTI = taxable income which has had capital gains treatment, and

PRTXEX = the number of personal exemptions.

The tax liability is calculated using the schedule Y, married individuals filing jointly and surviving spouses, found in the U. S. Master Tax Guide, 1978. The standard deduction is incorporated into this tax table. The result of equation 3.21, net taxable income, is multiplied by the appropriate tax rate. The following calculations are used when estimating tax liability for the current size operating unit.

$$TAX = NETINC \times TAXRATE - (.1 * TXCRED1) \qquad (3.22)$$

where TXCRED1 = amount of investment tax credit.

Tax Savings

The model is designed to calculate the tax effects of a proposed capital investment, including the tax savings which might be reflected when the tax paid on the current operating unit is compared with the tax liability of the current situation plus the proposed investment.

For example, a decision maker is currently operating one-half section of land in North Central Oklahoma. Based on his income and expense situation, the tax liability is $5,000. He is considering buying 160 acres of land, associated buildings, and the additional machinery and equipment necessary to operate the new total unit. A tax savings results when the income, expense, depreciation, interest, and investment tax credit of the new size operating unit yield a tax liability less than the $5,000 for the new total unit.

Income tax (negative tax savings), and tax savings are calculated based on the following equations: Tax liability for the current size unit is calculated by equation 3.22. Equation 3.23 is used to determine comparative tax liability of the proposed firm which includes the capital investment. NETINC, in equation 3.23, is the result of equations 3.21, net taxable income for the current operating unit. Other variables in 3.23 represent values for the proposed capital investment.

$$\text{COMBTINC} = \text{NETINC} + \text{TINCOM} - \text{DEXPEN} - \text{INTEREST} - \text{DEPRE} + \text{CPGNTI} \quad (3.23)$$

$$\text{COMBTAX} = \text{COMBTINC} \times \text{TAXRATE} - [.1 \times (\text{TXCRED1} + \text{TXCRED2})] \quad (3.24)$$

$$\text{TAXSV} = \text{TAX} - \text{COMBTAX} \quad (3.25)$$

where COMBTINC = the sum of taxable income from the current equity situation and the income and expense situation generated by the proposed capital investment,

NETINC = net taxable income from the current size operating unit,

TINCOM = additional gross taxable income from the proposed investment,

DEXPEN = deductible expenses for the proposed investment,

INTEREST = interest charged on the proposed investment,

DEPRE = total depreciation for the proposed investment and additional capital purchases necessary for operating the new investment,

CPGNTI = capital gain income taxed at ordinary income rates,

COMBTAX = the combined tax liability of the income and expense situations of both the current situation and the proposed capital investment,

TAXRATE = the appropriate tax percentage based on the total taxable income,

TXCRED1 = the amount of investment eligible for investment tax credit due to the proposed capital investment,

TXCRED2 = the amount of qualified investment eligible for investment tax credit due to the current size operation,

TAXSV = the dollar tax savings when comparing the current size operation's tax liability with the tax liability associated with the combined proposed operating unit which includes both the current unit and the proposed capital investment, and

TAX = results of equation 3.22, tax liability for the current firm.

If the tax liability associated with the current firm is greater than the tax liability of the proposed new size firm, then tax savings, the result of equation 3.25, is positive. Thus tax savings is added to after tax income. Negative tax savings is a liability and is algebraically added to decrease after-tax income.

Net Present Value

The net present value is an accepted method of evaluating proposed capital investment. The income and expense flows are discounted or given a "today's value" based on the discount rate. Usually the discount rate is the rate of return that the decision maker could receive on his next best alternative investment. A positive net present value indicates that investment in this asset will yield a rate of return greater than the discount or opportunity cost rate.

The basic building blocks of the net present value calculation are total income and total expense per year. The model accounts these values as follows:

$$TOTINC = TINCOM + TXSV \qquad (3.26)$$

where TOTINC = all income associated with the proposed capital investment,

TINCOM = taxable income as defined in equation 3.19, and

TXSV = tax savings as defined in equation 3.25.

If the expenses associated with adding a capital investment reduce total taxes, tax savings is positive. If total tax liability increases, tax savings is negative.

$$TOTEXP = DEXPEN + INTEREST + LOANPY + PERMEX + FEXPEN \quad (3.27)$$

where TOTEXP = all expenses associated with the proposed capital investment,

DEXPEN = total deductible expenses as defined in equation 3.20,

INTEREST = the annual interest associated with the capital investment,

LOANPY = the principle portion of the annual loan payment,

PERMEX = the principle payment associated with liability, payments associated with non-depreciable assets, and the payments on the purchase of additional machinery and equipment, and

FEXPEN = family and non-farm expenses.

Net present value is the accumulated total of the differences in discounted annual income and expenses.

$$NPV = [(TOTINC - TOTEXP)/(1 + DISRATE)^{YR}] \quad (3.28)$$

where NPV = net present value of the proposed capital investment,

DISRATE = discount rate (after-tax rate), and

YR = the year in the planning horizon.

The net present value analysis is completed even if some or all annual cash flows are negative. The model is designed to calculate net present value apart from an accounting of the cash flow. When annual cash flow is negative, alternative ways to meet cash flow deficits include: 1) use accumulated cash from previous years (as explained in the next section), 2) refinance the long-term land loan and pay a service charge if the long-term asset equity ratio is above a specified minimum percentage, and 3) borrow against intermediate assets if the intermediate equity ratio is above a specified minimum.

If negative cash flow can be met by borrowing, the decision maker can continue in business. If cash reserves are exhausted and the long and intermediate-term equity ratios are below the minimum acceptable level, the decision maker is insolvent or bankrupt. By using these options, the decision maker can evaluate the feasibility of a proposed capital investment based on its net present value and its effect on cash flow and net worth. Also, the decision maker can compare the net worth and cash flow situation at the end of the planning horizon for his current unit and the proposed larger size unit. While it may be possible to meet the cash flow requirements of the new larger size unit, ending net worth may be greater if the additional investment were not made.

Meeting Cash Flow Deficits

When an annual cash flow deficit is encountered, the model will draw on accumulated cash from previous years. If accumulated cash is exhausted, and the long-term equity ratio is above a specified minimum, the model will refinance the long-term liability. The equity ratio is calculated as follows:

$$LTEQTYR = (LTASET - LTLIAB - DEFICIT)/LTASET \qquad (3.35)$$

where LTEQTYR = long term equity ratio,

DEFICIT = the amount of negative cash flow not met by excess cash,

LTASET = total long-term assets, and

LTLIAB = total long-term liabilities.

If the ratio exceeds the specified minimum when the new loan is included as a liability, then funds are borrowed and the new total liability equals:

$$LTLIAB = LTLIAB + NEW\ LOAN * 1.015 \tag{3.36}$$

The service cost on any new long-term liability is 1.5 percent. The loan life is 25 years and the interest rate is specified as an input item.

If the long-term equity ratio is below the specified minimum, the model attempts to borrow against intermediate assets. The intermediate equity ratio is calculated exactly as equation 3.35, substituting intermediate assets and liabilities. The intermediate liability has a loan life of five years, and an interest rate specified as input.

$$ITLIAB = ITLIAB + NEW\ LOAN \tag{3.37}$$

For both the intermediate and long-term loans, liabilities are amortized as explained in Appendix A. The principle is added to the total expense, and the interest is added to deductible expenses. The total amount of the liability is added to the intermediate or long-term liability category in the year of the loan, and the principle payment subtracted in the year paid.

Computation of Annual Net Worth

The beginning inventory of liabilities, the beginning inventory of machinery and buildings, and the non-depreciable and depreciable assets purchased during the planning horizon have a determinant effect on cash flow and net worth. These effects are added to the current assets and liability categories at the beginning of each replication. The net worth and cash flow effects of cash usage and borrowing during an iteration to meet cash flow deficits will be different for each iteration depending on the stochastic income and expense flows. The intermediate and long-term liability totals for a specific year in a specific iteration are as follows:

$$IL = PERMILIAB + ITLIAB \quad (3.38)$$

$$IL = PERMLLIAB + LTLIAB \quad (3.39)$$

where PERMILIAB = the sum of the permanent adjustments to intermediate liability,

PERMLLIAB = the sum of permanent adjustments to long-term liability,

ITLIAB = the sum of annual adjustments in intermediate liabilities due to intermediate borrowing during the iteration, and

LTLIAB = the sum of annual adjustments in long-term liabilities due to the long-term borrowing during the iteration.

The intermediate and long-term assets are equal to the permanent storage values for each, since adjustments to meet cash flow deficits affect only the liquid asset, cash. The accumulation of these influences determine net worth as follows:

$$NET\ WORTH = IA - IL - LL + LA + CUMCSH \quad (3.40)$$

where IA = total annual intermediate assets,

LA = total annual long-term assets,

IL = total annual intermediate liabilities,

LL = total annual long-term liabilities, and

CUMCSH = any accumulated cash which draws interest at six percent annually.

CHAPTER IV

REQUIRED INPUT DATA AND SIMULATION EXPERIMENTS CONDUCTED

The basic purpose of the simulation model is to evaluate alternative capital investments. Land is the most common investment alternative for agricultural producers. Producers want to know the potential gain in net worth, the expected rate of return on investment, and the chance of firm failure. Future financial flexibility and cash flow planning for credit needs are also important investment considerations. All financial and physical measures of investment success must be weighed by the decision maker to determine if the investment will contribute sufficiently to his long range goals. The simulation model described in Chapter III, and the input data for the applications explained in this chapter are designed to answer producers' questions concerning investment success, and provide evaluative financial information about the expected success of capital investment in North Central Oklahoma. Input data required for a simulation experiment are divided into subsections: 1) input data for the proposed capital investment and related financial information which are the same for all simulation experiments conducted in this study. 2) Input data which are specific to each experiment.

Three resource situations are developed to illustrate the capabilities of the simulation model and test effects of key variables. Basic differences in the situations are total farm acreage, machinery complement size, beginning inventory levels, and off-farm employment. Each resource situation experiment is composed of two parts. First, a simulation run is made for the current size operating unit managed by the decision maker. Then the simulation is repeated for the proposed size operating unit, including the current size operating unit and the proposed capital investment. Simulation results for each resource situation experiment are compared in Chapter V to determine the investment's net effect on the current firm.

Required Input Data Common to All Experiments Conducted

Factored variance-covariance matrices, as described earlier in this chapter, must be read as input to generate trended, correlated, and normally distributed prices and yields. Matrices for North Central Oklahoma conditions are presented in Table III. Also intercept and slope coefficients must be specified for equation 3.3 for each product price and yield. While these coefficients were calculated based on historic data, the decision maker can adjust them to represent his expectations more realistically.

Factored correlation coefficient matrices for product prices and yields, Table IV, must be read as input to generate trended, correlated, and stochastic prices and yields which are triangularly distributed. These prices and yields are based on the decision maker's specification of expected product prices and yields, and the historic correlation of these variables. The slope coefficients can be used for either type of distribution. It would also be possible for the decision maker to specify a different set of price and yield expectations for each simulation.

TABLE III

FACTORED VARIANCE-COVARIANCE MATRICES FOR NORMALLY DISTRIBUTED PRICES AND YIELDS, NORTH CENTRAL OKLAHOMA

YIELDS	STOCKER GAIN	COUNTY GRN SORG	COUNTY WHEAT	FORAGE SORG	COUNTY ALF
STOCKER GAIN	0.12394	-0.00540	0.01576	0.01093	0.04429
COUNTY GRAIN SORGHUM	0.00000	3.57051	1.68539	0.63093	2.42055
COUNTY WHEAT	0.00000	0.00000	3.85723	0.35898	0.11890
FORAGE SORGHUM	0.00000	0.00000	0.00000	0.76225	0.11245
COUNTY ALFALFA	0.00000	0.00000	0.00000	0.00000	0.17813

PRICES	WHEAT PRICE	GRAIN SORG	NOV STKRS	MAR STKRS	MAY STKRS	COW PRICE	CALF PRICE	ALFALFA HAY	WILD HAY PR
WHEAT PRICE	0.20323	0.10756	-0.02932	-0.07790	-0.06083	-0.01598	0.16697	-0.00385	0.21448
GRAIN SORG	0.00000	0.24892	-0.03777	-0.11380	-0.03761	-0.00581	0.0833	0.11634	0.26695
NOV STKRS	0.00000	0.00000	1.21485	0.91392	1.20516	-0.05554	4.61634	0.14919	-1.45583
MAR STKRS	0.00000	0.00000	0.00000	1.27725	2.93637	0.96808	2.19441	-0.10432	-1.92824
MAY STKRS	0.00000	0.00000	0.00000	0.00000	2.95911	1.26949	1.24529	-0.19336	-1.78774
COW PRICE	0.00000	0.00000	0.00000	0.00000	0.00000	0.88406	3.13046	0.67135	-0.47886
CALF PRICE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	4.74769	0.73318	-0.61911
ALFALFA HAY	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	2.02375	3.71975
WILD HAY PR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	3.36964

TABLE IV

FACTORED CORRELATION COEFFICIENT MATRICES FOR TRIANGULARLY DISTRIBUTED PRICES AND YIELDS, NORTH CENTRAL OKLAHOMA

	YIELDS				
	STOCKER GAIN	COUNTRY GRN SORG	COUNTY WHEAT	FORAGE SORG	COUNTY ALF
STOCKER GAIN	0.6676	-0.0506	0.0851	0.0589	0.2390
COUNTY GRAIN SORGHUM	0.0000	0.4316	0.2306	0.0764	0.2885
COUNTY WHEAT	0.0000	0.0000	0.8908	0.0824	0.0268
FORAGE SORGHUM	0.0000	0.0000	0.0000	0.8760	0.1240
COUNTRY ALFALFA	0.0000	0.0000	0.0000	0.0000	1.0000

	PRICES								
	WHEAT PRICE	GRAIN SORG	NOV STKRS	MAR STKRS	MAY STKRS	COW PRICE	CALF PRICE	ALFALFA HAY	WILD HAY PR
WHEAT PRICE	0.4029	0.2133	-0.0581	-0.1545	-0.1206	-0.0317	0.3310	-0.0076	0.4253
GRAIN SORG	0.0000	0.4781	-0.0725	-0.2186	-0.0722	-0.0112	0.1601	0.2235	0.5128
NOV STKRS	0.0000	0.0000	0.1844	0.1387	0.1829	-0.0085	0.7007	0.0226	-0.2209
MAR STKRS	0.0000	0.0000	0.0000	0.2390	0.5495	0.1812	0.4107	-0.0195	-0.3609
MAY STKRS	0.0000	0.0000	0.0000	0.0000	0.8473	0.3635	0.3566	-0.0554	-0.5119
COW PRICE	0.0000	0.0000	0.0000	0.0000	0.0000	0.2101	0.7441	0.1596	-0.1138
CALF PRICE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9765	0.1508	-0.1273
ALFALFA HAY	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3523	0.6477
WILD HAY PR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000

Price and Yield Distribution Parameters

The decision maker can incorporate his subjective evaluation of the variation in product prices and yields. A triangular distribution of prices and yields can be completely specified by the minimum, maximum, and most likely values, for each product price and yield. Table V lists the parameters of product prices and yields used in all simulation experiments.

A portion of the required input data is the same for all simulation runs. Detailed input for the proposed investment and related financial information is presented in Table VI. Land is valued at $800 per acre with no downpayment. This price is generally representative of recent land sales in North Central Oklahoma with location and mineral values excluded. The land has depreciable buildings, fences, and improvements which have a current value of $10,000 and a salvage value of $1,000. The purchase price is $138,000, to be repaid in 20 years. One-hundred percent financing can be obtained with amortized repayment at 8.5 percent interest.

The planning horizon of the decision maker is assumed to be 20 years. Likewise, the loan life and depreciation life of the buildings and improvements is 20 years. Shorter loan repayment periods are not economically feasible for low-equity buyers. Opportunity cost or discount rate of the decision maker is 7.5 percent, and the expected rate of appreciation in land value is 6 percent. Long-term financing can be obtained at 8.50 percent interest, if the long-term equity ratio is above .20. Intermediate-term financing can be obtained at 9 percent interest if the intermediate-term ratio is above .30.

TABLE V

DECISION MAKER'S SUBJECTIVE PRICE AND YIELD DISTRIBUTION PARAMETERS

Name	Unit	Minimum	Mode	Maximum
Stocker Gain Rate Per Day	LBS/DAY	0.50	1.65	3.00
Grain Sorghum Yield	BU/ACRE	0.01	42.85	81.50
Wheat Yield	BU/ACRE	0.01	30.00	58.00
Forage Sorghum Yield	TONS/ACRE	0.01	4.50	10.50
Alfalfa Yield	TONS/ACRE	0.50	1.99	4.50
Wheat Price	$/BU	1.90	2.35	3.00
Grain Sorghum Price	$/CWT	1.90	2.10	6.50
November 400# Stocker Steer Price	$/CWT	46.00	51.85	58.00
March 500-700# Steer Price	$/CWT	40.00	45.50	50.00
May 500-700# Steer Price	$/CWT	42.00	47.00	52.00
Slaughter Cow Price	$/CWT	28.00	32.00	36.00
Calf Price	$/CWT	43.00	51.00	57.00
Alfalfa Hay Price	$/TON	35.00	56.94	80.81
Prairie Hay Price	$/TON	28.00	44.97	62.35

TABLE VI

INPUT DATA FOR THE PROPOSED CAPITAL INVESTMENT

Purchase Price	$138,000.00
Down Payment	0.00
Salvage Value of Depreciable Portion of Purchase	1,000.00
Amount Eligible for Investment Credit	10,000.00
Amount Eligible for 20% Bonus Depreciation	10,000.00
Land Value	128,000.00
Loan Life	20
Planning Horizon	20
Depreciation Life	20
Loan Code	Amortized
Discount Rate	7.5
Loan Interest Rate	8.5
Land Inflation Rate	6.0
Number of Enterprises	3
Number of Other Liabilities	3
Number of Other Investments	22
Number of Personal Tax Deductions	3
Minimum Long-Term Equity Ratio	.20
Minimum Intermediate-Term Equity Ratio	.30
Intermediate-Term Interest Rate	9.0
Long-Term Interst Rate	8.5
Will Land Sell at End of Planning Horizon?	Yes

Initial experimentation with the model indicated that the firm was frequently unable to meet the equity minimum in the first and second years of the investment since equity in these years is very low. It was assumed that if the decision maker experienced a bad income situation in the first or second year in the planning horizon, a lender would supply operating capital regardless of the equity minimum specified. In other years, if the decision maker cannot borrow funds based on the equity of his firm, the firm is determined to be insolvent.

The number of enterprises, the number of other liabilities, and the number of other investments must be specified for use in allocating internal computer storage and efficiently utilizing computer processing time. These variables indicate the size of problem that is to be solved and assist in keeping the costs of a solution at a minimum.

Organizational Characteristics Common to the Three Resource Situations

The three resource situations are identified as small, medium, and large, based on their relative size. Each will be expanded by a 160 acre purchase. The 160 acre tract to be purchased is composed of 155 acres of tillable land and five acres for building, fences, and waste land. For each resource situation, wheat is produced on owned and leased land. Wheat pasture is grazed from November 15 to March 15, using 400 pound stocker steers at a one-head per acre rate. The per acre cash charge for leased land is $25. A detailed explanation of enterprise costs per unit will be presented later in this chapter.

The beginning inventory of liabilities, Table VII, includes machinery, buildings, and land for each firm size. Beginning value of each

TABLE VII

RESOURCE SITUATIONS FOR THE SMALL, MEDIUM, AND LARGE SIZE FIRM

	Small Firm Size	Medium Firm Size	Large Firm Size
Proposed Purchase	160 Acres	160 Acres	160 Acres
Acres of Owned Land	160 Acres	480 Acres	640 Acres
Market Value of Owned Land	$128,000	$384,000	$512,000
% Equity in Owned Land	50%	50%	50%
Cash Lease Land	320 Acres	480 Acres	640 Acres
Cost per Acre	$25	$25	$25
Enterprise Information:			
Custom Harvest Wheat	310 Acres	620 Acres	775 Acres
Cost per Acre	$44.56	$45.77	$46.57
Nov.-Mar. Steers	620 Head	1085 Head	1395 Head
Cost per Acre	$29.43	$30.41	$30.08
Cash Lease Wheat	310 Acres	465 Acres	620 Acres
Cost per Acre	$69.56	$70.77	$71.57
Beginning Inventory:			
Assets:			
Machinery	$40,810.00	$61,645.00	$81,165.00
Buildings	$20,000.00	$40,000.00	$60,000.00
Liabilities:			
Machinery Note	$20,405.00	$30,822.50	$40,582.50
Buildings Note	$10,000.00	$20,000.00	$30,000.00
Land Note	$64,000.00	$192,000.00	$256,000.00
Net Worth	$94,405.00	$242,822.00	$326,582.00

liability is assumed to be one-half the beginning market value of the asset. Thus the beginning equity ratio is .50 for all three firms. The dollar amount of equity or net worth is listed at the bottom of Table VII for each firm size.

Field operations for winter wheat production include moldboard plowing, tandom disking, springtooth harrowing, and planting. Each of the three firms have two tractors. For the medium and large size firms, all field operations are performed by the large tractor except nitrogen application in the spring, which is performed by the small tractor. For the small size firm, both tractors share the moldboard plowing responsibility.

Required Input Data That Is Specific For Each Simulation Experiment

Resource Situation

The following input data is required for a simulation experiment. This data will be unique to each decision maker and his complement of resources. Required data include enterprise cost per unit, beginning inventory of assets and liabilities, and the proposed investment.

Small Size Firm

The small size firm is representative of a beginning farmer who has 50 percent equity in 160 acres of land, is cash leasing 320 acres and is interested in purchasing an additional 160 acres of land. Dollar values of the beginning inventory of assets and liabilities for the small size firm are presented in the first column of Table VII. The dollar value of machinery inventory is the sum of "first year values", which is the first column of Table VIII. Each machine value is based on the simulation year zero's (0) list price and the assumed age of the asset. Estimated life of the assets are based on total hours of life and the annual hours of usage.

Equipment for stocker cattle includes one mile of electric fence, one water tank, and one water heater for each 155 head of stocker cattle, or quarter section of wheat pasture. Also, one working chute, portable corral, portable chute, and stock trailer are assumed to be adequent for four quarter sections of stocker cattle.

Medium Size Firm

The medium size firm is representative of an established farmer who has 50 percent equity in 480 acres of land, is cash leasing 480 acres, and is interested in the feasibility of purchasing an additional 160 acres of land. Dollar values of beginning inventory of assets and liabilities of the medium size firm are presented in the second column of Table VII. The dollar value of machinery inventory, $61,645, is the sum of the first year values in the first column of Table IX.

Equipment for the stocker cattle includes one mile of electric fence, one water tank, and heater for each 155 head of stocker cattle. Two working chutes, two portable corrals, two portable chutes, and two stock trailers are assumed to be adequate for the seven quarter sections of stocker cattle.

Large Size Firm

The large size firm is representative of an established farmer who has built a large amount of equity in land. He is currently operating

TABLE VIII

MACHINERY COMPLEMENT FOR THE SMALL SIZE FIRM

1st Year Values	Number Of Units	Assumed Age Begins	Description	Width	List Price	Asset Life
13,650	1	3	Tractor #4 115HP	0	$19,500	10 years
6,600	1	4	Tractor #1 55HP	0	$11,000	10 years
4,560	2	4	Drills	13 ft.	$ 7,600	10 years
895	1	5	Springtooth	27 ft.	$ 1,790	10 years
1,175	1	5	Field Cultivator	14 ft.	$ 2,350	10 years
1,625	1	5	M. B. Plow 6-16	8 ft.	$ 3,250	10 years
800	1	6	M. B. Plow 4-16	5.3 ft.	$ 2,000	10 years
800	1	6	Tandom Disk	14 ft.	$ 2,000	10 years
5,625	1	1	Pickup	0	$ 7,500	4 years
240	4 miles	6	Electric fence		$ 600	10 years
960	4	4	Water Tank	0	$ 1,600	10 years
245	1	3	Working Chute	0	$ 350	10 years
1,345	1	4	Portable Corral		$ 575	10 years
1,090	1	4	Portable Chutes		$ 150	10 years
200	4	5	Tank Heaters	0	$ 480	10 years
3,000	1	1	Stock Trailer		$ 3,000	10 years

TABLE IX

MACHINERY COMPLEMENT FOR THE MEDIUM SIZE FIRM

1st Year Values	Number Of Units	Assumed Age Begins	Description	Width	List Price	Asset Life
$22,400	1	3	Tractor #7 175 HP		$32,000	10 years
$ 6,600	1	4	Tractor #1 55 HP		$11,000	10 years
$ 5,100	1	4	Drill	40 ft.	$ 8,500	10 years
$ 2,625	1	5	M. B. Plow	12 ft.	$ 5,050	10 years
$ 1,200	1	5	Springtooth	33 ft.	$ 2,400	10 years
$ 2,660	1	6	Offset Disk	22.5 ft.	$ 6,650	10 years
$11,250	2	1	Pickups		$15,000	4 years
$ 420	7 miles	6	Electric Fence		$ 1,050	10 years
$ 1,680	7	4	Water Tanks		$ 2,800	10 years
$ 490	2	3	Working Chutes		$ 700	10 years
$ 690	2	4	Portable Corrals		$ 1,150	10 years
$ 180	2	4	Portable Chutes		$ 700	10 years
$ 350	7	5	Tank Heaters		$ 700	10 years
$ 6,000	2	1	Stock Trailers		$ 6,000	10 years

640 acres of owned land, 640 acres of leased land, and wants to purchase an additional 160 acres of land. The dollar values of beginning inventory of assets and liabilities for the large firm are presented in the third column of Table VII. The dollar value of machinery inventory is $81,165. This total is the sum of the first year values in Table X.

The equipment complements for stocker cattle includes one mile of electric fence, one water tank, and heater for each 155 head of stocker cattle. Also, three working chutes, three portable corrals, and three stock trailers are assumed adequate for the nine quarter sections of stocker cattle. This represents 1,395 head of stocker cattle for the large size firm.

Required Machinery Purchases

Consideration of the feasibility of capital investment, such as land, should not overlook investments to replace the machinery and equipment necessary to operate the proposed size farm. For the small, medium, and large size firms in this study, machinery complements were designed to accommodate the proposed size units which include the proposed land investment. The machinery complements were presented in Tables VIII, IX, and X and represent the beginning inventory of machinery and equipment for the three firm sizes. The year of replacement for these assets is based on assumed age and asset life. The first item in Table VIII, a 115 horse power tractor, has an assumed age of three years and an asset life of ten years. Given seven years of useful life remaining, that asset is not replaced until the eighth year. Table XI indicates that the new 115 horse power tractor was purchased in year eight. The purchase price of all machinery and equipment is inflated

TABLE X

MACHINERY COMPLEMENT FOR THE LARGE SIZE FIRM

1st Year Valued	Number Of Units	Assumed Age Begins	Description	Width	List Price	Asset Life
$28,000	1	3	Tractor 225HP		$40,000	10 years
$ 6,600	1	4	Tractor 55 HP		$11,000	10 years
$ 5,100	1	4	Drill	40 ft.	$ 8,500	10 years
$ 3,500	1	5	M. B. Plow	16 ft.	$ 7,000	10 years
$ 1,800	1	5	Springtooth	48 ft.	$ 3,600	10 years
$ 5,100	1	6	Offset Disk	28 ft.	$ 8,500	10 years
$16,875	3	1	Pickups		$22,500	4 years
$ 540	9 miles	6	Electric Fence		$ 1,350	10 years
$ 2,160	9	4	Water Tanks		$ 3,600	10 years
$ 735	3	3	Working Chutes		$ 1,050	10 years
$ 1,035	3	4	Portable Corrals		$ 1,725	10 years
$ 270	3	4	Portable Chutes		$ 450	10 years
$ 450	9	5	Tank Heaters		$ 900	10 years
$ 9,000	3	1	Stock Trailers		$ 9,000	10 years

at a four percent annual rate. Likewise, each asset in Tables VIII, IX, and X is replaced when its asset life is exhausted. Tables XI, XII, and XIII represent the actual investment in machinery and equipment for the small, medium, and large size firms, respectively. The purchase price and tax information provided in these tables allow calculation of actual investment costs, depreciation, investment tax credit, and annual capital investment cost for the three size firms.

Labor Requirements

Operator and family labor for the three size firms is fixed at 3,328 hours per year. This number of operator labor hours assumes 60 hours per week for the months October through May and 72 hours per week from June through September. Monthly labor requirements for the wheat and stocker cattle enterprises are listed in Table XIV. The two enterprises compete for labor only in the month of February.

The per acre and per head labor requirements calculated by the budget generator are multiplied by the appropriate number of acres and head for each firm size. Each of these three firm sizes in Table XIV is divided into two groups. The current size represents the number of acres of wheat and head of livestock for each firm size before the land is purchased. The proposed size includes the current size and the acres of wheat and number of stockers associated with the proposed land purchase.

Total labor required and total hired labor increases as the acres of wheat and head of stocker cattle increase. Based on the different size machinery for the three firm sizes, the per head or per acre labor requirement, listed in Table XV, decreases as the firm size increases.

TABLE XI

REQUIRED MACHINERY PURCHASES DURING THE PLANNING HORIZON FOR THE SMALL SIZE FIRM

Description	Purchase Price	Salvage Value	Amount Eligible for Investment Tax Credit	Amount Eligible for 20% Bonus Depreciation	Year of Invest-ment	Loan Life	Asset Life
1. Tractor 115 HP	25660.63	2566.06	25660.63	20000.00	8	10	10.000
2. Tractor 55 HP	13918.30	1391.83	13918.30	13918.30	7	10	10.000
3. 2 Drills 13.3 ft.	9616.28	961.62	9616.28	6016.28	7	10	10.000
4. Springtooth 27 ft.	2177.80	217.78	2177.80	2177.80	6	10	10.000
5. Moldboard Plow 6-16	3893.28	389.32	3893.28	3893.28	6	10	10.000
6. Moldboard Plow 4-16	2339.70	233.97	2339.70	2339.70	5	10	10.000
7. Tandom Disk 14 ft.	2339.70	233.97	2339.70	2339.70	5	10	10.000
8. Pickup	8436.45	843.64	2812.13	8436.45	4	4	4.000
9. Stocker Equipment	4223.84	422.38	4223.84	4223.84	4	10	10.000
10. Tractor 115 HP	36523.11	3652.31	36523.11	20000.00	18	10	10.000
11. Tractor 55 HP	20602.78	2060.27	20602.78	20000.00	17	10	10.000
12. 2 Drills 13.3 ft.	14234.64	1423.46	14234.64	0.00	17	10	10.000
13. Springtooth 27 ft.	3222.00	322.20	3222.00	3222.00	16	10	10.000
14. Moldboard Plow 6-16	5850.00	585.00	5850.00	5850.00	16	10	10.000
15. Moldboard Plow 4-16	3464.00	346.40	3464.00	3464.00	15	10	10.000
16. Tandom Disk 14 ft.	3464.00	346.40	3464.00	3464.00	15	10	10.000
17. Pickup	9869.47	986.94	9869.47	9869.47	8	4	4.000
18. Stocker Equipment	6252.07	625.20	6252.75	6252.75	14	10	10.000
19. Pickup	11545.87	1154.58	3848.62	11545.87	12	4	4.000
20. Pickup	13500.00	1350.00	4500.00	6000.00	16	4	4.000
21. Stock Trailer	3000.00	300.00	3000.00	3000.00	1	10	10.000
22. Stock Trailer	4440.00	444.00	4440.00	4440.00	11	10	10.000

TABLE XII

REQUIRED MACHINERY PURCHASES DURING THE PLANNING HORIZON FOR THE MEDIUM SIZE FIRM

Description	Purchase Price	Salvage Value	Amount Eligible for Investment Tax Credit	Amount Eligible for 20% Bonus Depreciation	Year of Invest-ment	Loan Life	Asset Life
1. Tractor 175 HP	42109.76	4210.97	42109.76	20000.00	8	10	10.000
2. Tractor 55 HP	13918.30	1391.83	13918.30	13918.30	7	10	10.000
3. Drill 40 ft.	10755.05	1075.50	10755.05	0.00	7	10	10.000
4. Moldboard Plow 8-18	6144.08	614.40	6144.08	6144.08	6	10	10.000
5. Springtooth 33 ft.	2919.96	291.99	2919.96	2919.96	6	10	10.000
6. Offset Disk 22.5 ft.	7779.50	777.95	7779.50	7779.50	5	10	10.000
7. Stocker Equipment	7536.73	753.67	7536.73	7536.73	4	10	10.000
8. Tractor 175 HP	62332.76	6233.27	62332.76	20000.00	18	10	10.000
9. Tractor 55 HP	20602.78	2060.27	20602.78	20000.00	17	10	10.000
10. Drill 40 ft.	15920.33	1592.03	15920.33	0.00	17	10	10.000
11. Moldboard Plow 6-18	9090.00	909.00	9090.00	9090.00	16	10	10.000
12. Springtooth 33 ft.	4320.00	432.00	4320.00	4320.00	16	10	10.000
13. Offset Disk 22.5 ft.	11517.80	1151.78	11517.80	11517.80	15	10	10.000
14. Stocker Equipment	11155.50	1115.55	11155.50	11155.50	14	10	10.000
15. 2 Pickups	16872.90	1687.29	5624.30	11350.00	4	4	4.000
16. 2 Pickups	19738.95	1973.89	6579.65	0.00	8	4	4.000
17. 2 Pickups	23091.75	2309.17	7697.75	20000.00	12	4	4.000
18. 2 Pickups	27000.00	2700.00	9000.00	0.00	16	4	4.000
19. Stock Trailers	6000.00	600.00	6000.00	6000.00	1	10	10.000
20. Stock Trailers	8880.00	888.00	8880.00	8880.00	11	10	10.000

TABLE XIII

REQUIRED MACHINERY PURCHASES DURING THE PLANNING HORIZON FOR THE LARGE SIZE FIRM

Description	Purchase Price	Salvage Value	Amount Eligible for Investment Tax Credit	Amount Eligible for 20% Bonus Depreciation	Year of Invest-ment	Loan Life	Asset Life
1. Tractor 225 HP	52637.20	5263.72	52637.20	20000.00	8	10	10.000
2. Tractor 55 HP	13918.30	1391.83	13918.30	13918.30	7	10	10.000
3. Drill 40 ft.	10755.05	1075.50	10755.05	0.00	7	10	10.000
4. Moldboard Plow 8-18	8516.55	851.65	8516.65	8516.65	6	10	10.000
5. Springtooth	4379.94	437.99	4379.94	4379.94	6	10	10.000
6. Offset Disk 28 ft.	9943.72	994.37	9943.72	9943.72	5	10	10.000
7. 3 Pickups	25309.25	2530.92	8436.81	17000.00	4	4	4.000
8. Stocker Equipment	10208.10	1020.81	10208.10	3000.00	4	10	10.000
9. Tractor 225 HP	77915.96	7791.59	77915.96	20000.00	18	10	10.000
10. Tractor 55 HP	20602.78	2060.27	20602.78	20000.00	17	10	10.000
11. Drill 40 ft.	15920.33	1592.03	15920.33	0.00	17	10	10.000
12. Moldboard Plow 8-18	12600.00	1260.00	12600.00	12600.00	16	10	10.000
13. Springtooth	6480.00	680.00	6480.00	6480.00	16	10	10.000
14. Offset Disk 28 ft.	14722.00	1472.20	14722.00	13072.00	15	10	10.000
15. Stocker Equipment	15109.87	1510.98	15109.87	15109.87	14	10	10.000
16. 3 Pickups	29608.42	2960.84	9869.47	0.00	8	4	4.000
17. 3 Pickups	34537.62	3453.76	11545.87	20000.00	12	4	4.000
18. 3 Pickups	40500.00	4050.00	13500.00	0.00	16	4	4.000
19. Stock Trailers	9000.00	900.00	9000.00	9000.00	1	10	10.000
20. Stock Trailers	13320.00	1332.00	13320.00	13320.00	11	10	10.000

TABLE XIV

LABOR REQURIEMENTS FOR THE SMALL, MEDIUM, AND LARGE SIZE FIRM

	Jan.	Feb.	Mar.	June	July	Aug.	Sept.	Nov.	Dec.
<u>Small Size Firm</u>									
Current Size:									
465 Stockers	111.6	111.6	111.6					204.6	111.6
465 A. Wheat		158.1		241.8	297.6	232.5	279.0		
Less Operator Labor	260.0	260.0	260.0	312.0	312.0	312.0	312.0	260.0	260.0
Labor Hired		9.7							
Proposed Size:									
620 Stockers	148.8	148.8	148.8					272.8	148.8
620 A. Wheat		210.8		322.4	396.8	310.0	372.0		
Less Operator Labor	260.0	260.0	260.0	312.0	312.0	312.0	312.0	260.0	260.0
Labor Hired		99.6		10.4	84.8		60.0	12.8	
<u>Medium Size Firm</u>									
Current Size:									
930 Stockers	204.6	204.6	204.6					353.4	204.6
930 A. Wheat		316.2		418.5	418.5	381.3	381.3		
Less Operator Labor	260.0	260.0	260.0	312.0	312.0	312.0	312.0	260.0	260.0
Labor Hired		260.8		106.5	106.5	69.3	69.3	93.4	
Proposed Size:									
1085 Stockers	238.7	238.7	238.7					412.3	238.7
1085 A. Wheat		412.3		488.2	488.2	444.8	444.8		
Less Operator Labor	260.0	260.0	260.0	312.0	312.0	312.0	312.0	260.0	260.0
Labor Hired		391.0		176.2	176.2	132.8	132.8	152.3	

TABLE XIV (Continued)

	Jan.	Feb.	Mar.	June	July	Aug.	Sept.	Nov.	Dec.
<u>Large Size Firm</u>									
Current Size:									
1240 Stockers	248.0	248.0	248.0					396.8	248.0
1240 A. Wheat		421.6		533.2	483.6	458.8	471.2		
Less Operator Labor	260.0	260.0	260.0	312.0	312.0	312.0	312.0	260.0	260.0
Hired Labor		409.6		221.2	171.6	146.8	159.2	136.8	
Proposed Size:									
1395 Stockers	279.0	279.0	279.0					446.4	279.0
1395 A. Wheat		474.3		599.8	544.0	516.1	530.1		
Less Operator Labor	260.0	260.0	260.0	312.0	312.0	312.0	312.0	260.0	260.0
Hired Labor	19.0	493.3	19.0	287.8	232.0	204.1	218.1	186.4	19.0

TABLE XV

MONTHLY LABOR REQUIREMENTS PER HEAD OR PER ACRE

	Jan.	Feb.	Mar.	June	July	Aug.	Sept.	Nov.	Dec.
<u>Small Size Firm</u>									
Wheat		.34		.52	.64	.50	.60		
Stockers	.24	.24	.24					.44	.24
<u>Medium Size Firm</u>									
Wheat		.34		.45	.45	.41	.41		
Stockers	.22	.22	.22					.38	.22
<u>Large Size Firm</u>									
Wheat		.34		.43	.39	.37	.38		
Stockers	.20	.20	.20					.32	.20

The effect of more acres and head of livestock outweighs the effect of a smaller labor requirement per unit. These influences result in an increased hired labor cost per farm acre.

Family and Non-Farm Income and Expense

Family living expenses, Table XVI, are assumed to be $12,000 in the first year and increase at a constant five percent annual inflation rate. This seemingly conservative rate results in family living expenses in the twentieth year of $30,322.98. The family size, three persons, and family living expenses are assumed to be equal for the small, medium, and large size firms.

Labor requirements for the small size firm allow one-half time off-farm employment of $6,000 per year, inflating three percent annually. The medium size firm operator is employed one-quarter time earning $3,000 annually. This figure is also increased at the rate of three percent annually. The large size firm has no off-farm income.

Off-farm employment and hired labor may seem inconsistent. However, Table XIV indicates no labor requirement for April, May, and October. The peak labor demands in the other months require hired labor, while April, May, and October are available for off-farm employment.

Enterprise Cost Per Unit

Enterprise costs per unit were developed using the Oklahoma State University Computerized Crop and Livestock Budget Generator. Specifically two budgets, 13200016, Stocker Steers, and 76200202, Wheat Custom

TABLE XVI

NON-FARM AND FAMILY INCOME AND EXPENSE

Year	Small Firm Size		Medium Firm Size		Large Firm Size	
	Income	Expense	Income	Expense	Income	Expense
1	6000.00	12000.00	3000.00	12000.00	0.0	12000.00
2	6180.00	12599.99	3090.00	12599.99	0.0	12599.99
3	6365.40	13229.98	3182.70	13229.98	0.0	13229.98
4	6556.36	13891.47	3278.18	13891.47	0.0	13891.47
5	6752.05	14586.03	3376.52	14586.03	0.0	14586.03
6	6955.64	15315.32	3477.82	15315.32	0.0	15315.32
7	7164.30	16081.08	3582.15	16081.08	0.0	16081.08
8	7379.23	16885.12	3689.61	16885.12	0.0	16885.12
9	7600.60	17729.36	3800.30	17729.36	0.0	17729.36
10	7828.62	18615.82	3914.31	18615.82	0.0	18615.82
11	8063.48	19546.59	4031.74	19546.59	0.0	19546.59
12	8305.38	20523.91	4152.69	20523.91	0.0	20523.91
13	8554.54	21550.09	4277.27	21550.09	0.0	21550.09
14	8811.17	22627.58	4405.59	22627.58	0.0	22627.58
15	9075.51	23758.94	4537.75	23758.94	0.0	23758.94
16	9347.77	24946.87	4673.88	24946.87	0.0	24946.87
17	9628.20	26194.19	4814.10	26194.19	0.0	26194.19
18	9917.04	27503.88	4958.52	27503.88	0.0	27503.88
19	10214.55	28879.05	5107.28	28879.05	0.0	28879.05
20	10520.98	30322.98	5260.49	30322.98	0.0	30322.98

Harvest, were used as a base.[1] The machinery complements listed in Tables VIII, IX, and X and the basic budgets were utilized to generate the necessary cost data.

Operating input costs vary between firms due to tractor and equipment fuel and lubrication costs per acre. The current and proposed size unit are assumed to use the same machinery complement, thus operating input costs for the current and proposed size unit are the same. Fuel and lubrication costs per acre increase as the firm size increases. As a result, operating input costs for wheat and stocker cattle increase as the firm size increases.

Ownership costs in Table XVII are taxes and insurance. Interest and depreciation, which are also ownership costs, will be calculated by the simulation model based on actual machinery purchases. Since the same machinery complement is used for the current and proposed size firms, total ownership cost is equal for the current and proposed size units. Total ownership cost per head is 15 cents for the small and medium size firms. The large size firm's cost per head is 13 cents. The small and medium size firms total ownership cost per acre of wheat are approximately equal, \$1.96 and \$2.04, respectively. The large size firm shows some economies of size with a total ownership cost per acre of \$1.69.

Labor costs as explained in the next section, and presented in Table XIV, are greater for the proposed size firm. Also, the total hired labor cost increases as the firm size increases because operator labor is fixed and more units require a larger percentage of hired labor. Labor requirements per head and per acre, Table XV, decrease as the firm size increases.

[1]The budgets were developed by Roy Sharkey, Area Farm Management Specialist, Enid, Oklahoma.

TABLE XVII

ENTERPRISE COST PER UNIT

	Current Size		Proposed Size	
	Wheat *	Stockers	Wheat *	Stockers
SMALL SIZE FIRM	(465)	(465)	(620)	(620)
Enterprise Cost:				
Operating Inputs	41.85	28.74	41.85	28.74
Annual Operating Capital	1.61	6.41	1.61	6.41
Taxes	.49	.05	.49	.05
Insurance	1.47	.10	1.47	.10
Hired Labor		.06	.75	.54
Total Costs	45.42	35.36	46.17	35.84
MEDIUM SIZE FIRM	(930)	(930)	(1085)	(1085)
Enterprise Cost:				
Operating Inputs	42.02	28.76	42.02	28.76
Annual Operating Capital	1.35	5.34	1.35	5.34
Taxes	.51	.05	.51	.05
Insurance	1.53	.10	1.53	.10
Hired Labor	1.13	1.14	1.71	1.50
Total Costs	46.54	35.39	47.12	35.75
LARGE SIZE FIRM	(1240)	(1240)	(1395)	(1395)
Enterprise Cost:				
Operating Inputs	42.86	28.49	42.86	28.49
Annual Operating Capital	1.11	4.27	1.11	4.27
Taxes	.42	.04	.42	.04
Insurance	1.27	.09	1.27	.09
Hired Labor	1.69	1.32	2.02	1.46
Total Costs	47.35	34.21	47.68	34.35

*Wheat lease enterprises for each firm have a $25.00 per acre cash rent cost added to the indicated wheat enterprise cost.

This effect slows the rate of increase in total hired labor cost as firm size increases. Table XVII presents the production costs of the current and proposed size operating unit for the small, medium, and large size firm.

Economies of size exist for the three firm sizes in labor requirements, annual operating capital, and investment cost per acre. Only labor required per unit and annual operating capital are reflected in Table XVII. The other costs are calculated by the simulation model based on actual machinery and equipment purchases. Therefore, economies of size are included in the simulation model but are not reflected in Table XVII. The cost specified in Table XVII includes operating inputs, ownership costs, annual operating capital, and labor costs. The principle and interest cost associated with machinery and equipment investment are calculated by the simulation model.

CHAPTER V

RESULTS OF THE SIMULATION EXPERIMENTS AND SENSITIVITY ANALYSIS

Outcomes of major capital investments for the three farm sizes are presented in this chapter. The effects of equity, firm size, machinery size, and off-farm employment on the success of the investment are evaluated. Also, the relative influence of the land inflation rate, product price trends, production cost trends, and loan interest rate on results of land investment is discussed. The chapter is divided into two sections. First, the simulation results are presented for three firm sizes. Second, comparative results are presented for the sensitivity analysis of key parameters.

Success of the proposed capital investment is measured in several ways. The profitability of land investment is represented by the investment's net present value. Net present value is the discounted value of net cash flows associated with the current or proposed size firm. A zero net present value indicates a rate of return equal to the discount rate. Negative net present values indicate a return on investment less than the discount rate while positive net present values imply rates of return on investment greater than the discount rate. Since each experiment is repeated 100 times utilizing stochastic prices and yields, distributions of the key variables can be presented. Variation in variables such as net present value is measured for the different simulation experiments by comparing the minimum, mean, maximum, standard deviation, and coefficient of variation.[1] Also, cumulative probability distributions are used to indicate the probability of obtaining a larger or smaller value of a particular variable, for all probability levels.

Beginning, annual, and ending net worth provide a measure of the solvency of the firm. Real or deflated ending net worth is compared to beginning and ending current net worth to measure real firm growth. Annual cash surpluses and deficits are generated to give an indication of the firm's liquidity and required credit. A measure of firm survival is provided to further evaluate the desirability of land investment. A firm has failed the survival test when the long-term equity ratio is below .20. The firm can no longer borrow funds to meet negative annual cash flow.

Characteristics of the Three Resource Situations

The three size firms currently operate 480, 960, and 1,280 acres respectively. Each firm would like to expand by purchasing an additional 160 acres of land. The three firms are designed to represent realistic farm situations for North Central Oklahoma. Beginning equity ratio is 50 percent for each firm, while the dollar amount increases as firm size increases. Machinery complements for each firm are described in Tables VIII, IX, and X. All input information, the proposed land investment, and related financial information were described in detail in Chapter IV.

---

[1]Coefficient of variation is the ratio of standard deviation to the mean value multiplied by 100.

Simulation Results for the Three Resource Situations

The desirability of the investment is measured by comparing the current size firm and the proposed firm which includes the land purchase. The current size firm is simulated to determine measures of investment success. Then, the proposed size firm is simulated to provide comparative measures of profitability, solvency, liquidity, and firm survival. For each size firm the proposed firm operates an additional 155 acres of wheat and stocker cattle, and pays principle and interest on the $138,000 amortized loan.

Profitability of the Proposed Investment

The bottom portion of Table XVIII lists the minimum, mean, and maximum values of ending net present value for the 100 replications of the current and proposed size firms.[2] The standard deviation and coefficient of variation measure the relative variations in net present value. For each size, the current firm's expected net present value is greater than the proposed firm. However, maximum net present value of the large proposed size firm, $691,597 exceeds the large current size firm's net present value, $666,942. For each farm size, ending net worth is greater for the proposed size firm. The large proposed size firm's expected ending net worth is $126,500 greater than the ending net worth of the large current firm. Expected profitability, measured by ending net worth, over the 20 year planning horizon is greater if the land is purchased.

---

[2] Simulation results presented in this chapter were summarized by the support program, AGSTAT, written by James W. Richardson (1978) and modified to generate cumulative probability density functions (Hardin and Walker, 1978).

TABLE XVIII

NET WORTH AND NET PRESENT VALUE FOR THREE RESOURCE SITUATIONS

Simulation Experiment	Min	Mean	Max	Std Dev	Coeff. Variation
Net Worth					
Small Current Firm Size	-251,900	135,960	602,880	187,364	137.8
Small Proposed Firm Size	-196,212	279,331	821,010	225,519	80.73
Medium Current Firm Size	260,944	921,504	1,593,258	295,460	32.02
Medium Proposed Firm Size	275,282	1,013,941	1,758,856	334,452	32.98
Large Current Firm Size	356,629	1,189,289	2,021,388	372,937	31.35
Large Proposed Firm Size	419,231	1,315,789	2,206,397	406,306	30.87
Net Present Value					
Small Current Firm Size	-182,493	13,645	233,883	89,526	656.1
Small Proposed Firm Size	-261,642	-5,497	271,138	113,711	2,068.6
Medium Current Firm Size	-136,993	194,008	538,998	147,082	75.81
Medium Proposed Firm Size	-242,364	154,235	557,345	171,383	111.11
Large Current Firm Size	-198,276	231,732	666,942	187,050	80.71
Large Proposed Firm Size	-289,129	206,419	691,597	208,897	101.20

Figure 7 presents the cumulative probability distributions of net present value for the current firms. For example, a net present value of $333,178, has a 15 percent chance of a worse (less positive net present value) outcome for the small firm. The medium firm's chance of a worse net present value is 32 percent, while the large firm has a 50 percent chance of a lower net present value. At higher levels of probability and net present value, the results are different. For a $341,000 value, the chance of a smaller net present value is 85, 80, and 83 percent, respectively, for the small, medium, and large size current firms. For the proposed firms, the probability of obtaining greater than a zero net present value is about 90 percent. Analysis of net present value alone would indicate that expected return on investment would be less for the proposed size firm. Internal rate of return methods would provide the exact rate of return.

Investment Effects on Firm Net Worth

Net worth is a generally accepted measure of firm solvency. Positive net worth indicates that the firm could be liquidated, creditors paid, and the residual claimed by the owners. Net worth is also used to measure firm growth through time. Ending net worth can be discounted to equal beginning net worth. That discount rate represents the annual firm growth rate which includes inflationary influences.

Potential gain in net worth is one measure of the desirability of a proposed capital investment. Table XVIII lists the minimum, mean, and maximum values of ending net worth for the three firms. For each firm size, the current firm's expected net worth is less than the proposed firm's. Negative minimum net worth for the small current and proposed

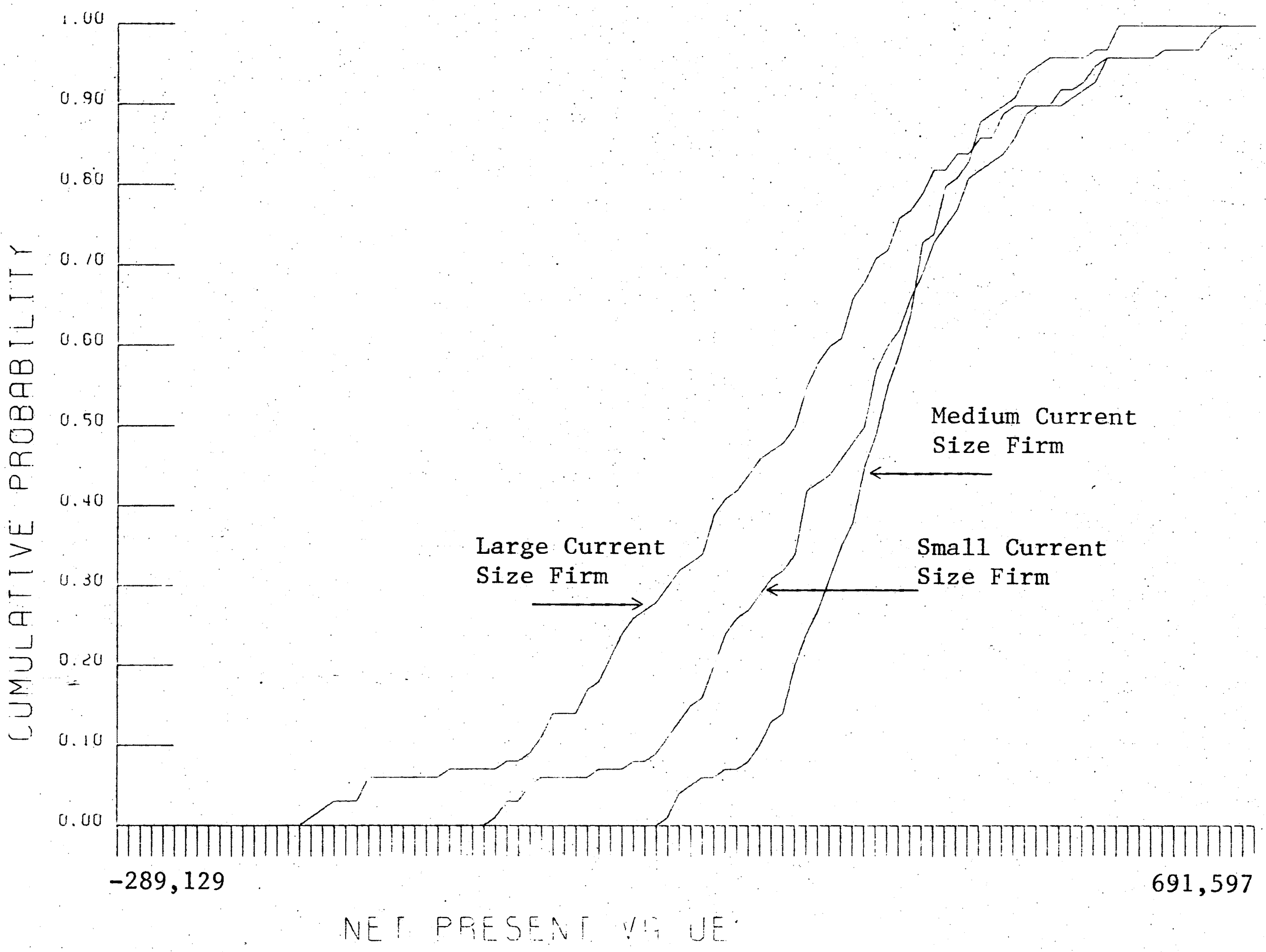

Figure 7. Cumulative Probability Distribution of Net Present Value for the Small, Medium, and Large Current Size Firms

firm results from allowing the analysis to continue after the firm failed the survival test. These results will be explained in more detail in the cash flow and firm survival section of this chapter.

Beginning net worth is $94,405, $242,822, and $326,582, for the small, medium, and large size firms. Even so, the potential gain in expected net worth for the proposed firms is $92,437 to $143,371 greater than the current firms. If the decision maker's goal was to increase ending net worth, this comparison would indicate that the proposed large firm would be preferred.

Cumulative probability distributions of net worth for the large current and proposed size firms are presented in Figure 8. Given a $1,290,000 ending net worth, the proposed firm's chance of a worse outcome is 43 percent, while the current firm's chance is 59 percent. According to the criteria for stochastic statistical dominance described in Chapter II, the proposed firm would be preferred. These criteria assume the decision maker prefers more to less and is risk adverse.

For all replications of the three size firms, net worth of the proposed firm is greater than the current size firm. If the decision maker's goal is to increase net worth, land investment is preferred for all firm sizes. The additional 160 acres of land adds $410,513 to ending net worth. Net present value of the proposed firm exceeds that of the current firm only when price and yield conditions are near the maximum level. When the effects of inflation are considered and net cash flows are discounted to a present value, the current firm's chance of a worse net present value is greater than the proposed firm. The potential gain in net worth from land investment must be weighed against an increased chance of a worse net present value.

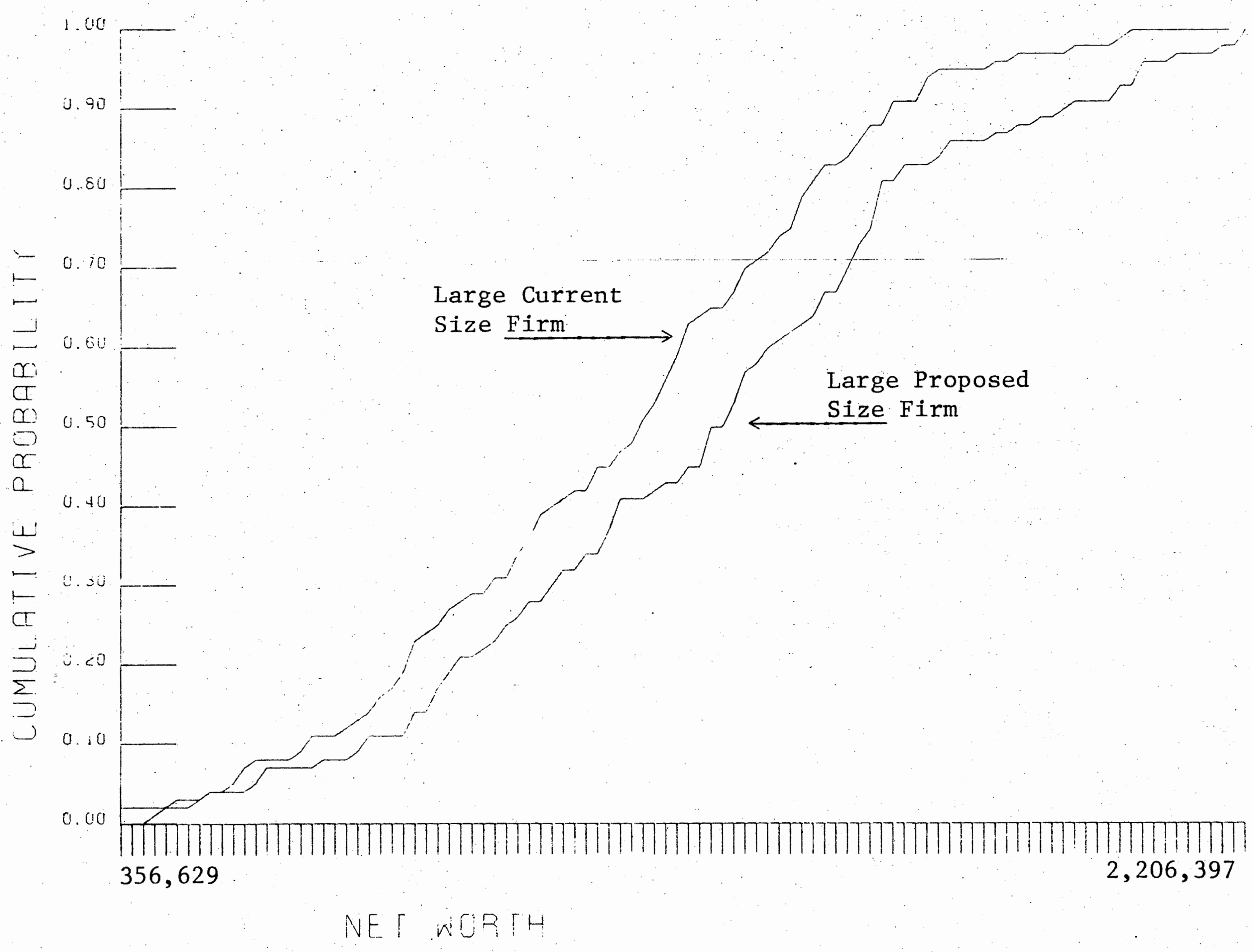

Figure 8. Cumulative Probability Distribution of Net Worth for the Large Current and Proposed Size Firms

Investment Effects on Firm Growth

Firm growth is a combination of firm success and inflation. This influence can be removed by discounting ending net worth to a present value. Discounted ending net worth can be compared to the beginning net worth to determine real firm growth. Table XIX lists beginning, current, ending, and discounted net worth for the current and proposed size firms.

The small current size firm's net worth increased from $94,405 to $135,960 during the 20 year planning horizon. When ending current net worth is discounted for the effects of inflation, net worth decreases in real terms. When land investment is included, the small size proposed firm's net worth also decreases in real terms. Given a six percent inflation rate, the medium current size firm showed a slight increase in real net worth from $242,282 to $287,341. Both the large current and proposed size firms increased real net worth over the 20 year planning horizon.

Discounted net worth can be interpreted another way. The discount rate which reduces ending current net worth to the beginning value of net worth represents the growth rate of the firm. This interpretation assumes no inflationary influences. Land appreciates at an annual rate of six percent for the small, medium, and large size firms. Other depreciable assets increase due to inflation and decrease due to annual depreciation, as explained in Chapter III. Total effects of inflation would be less than six percent annually. Thus, the increase in real net worth for the larger proposed size firm to $410,286 from $326,582 represents a growth rate of more than six percent.

TABLE XIX

CURRENT AND REAL ENDING NET WORTH FOR THE SMALL, MEDIUM, AND LARGE CURRENT AND PROPOSED SIZE FIRMS

Description	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4 Percent Annual Inflation	Real Ending Net Worth 6 Percent Annual Inflation
Small Current Size Firm	94,405	135,960	62,053	42,394
Small Proposed Size Firm	94,405	279,331	127,490	87,100
Medium Current Size Firm	242,822	921,504	420,586	287,341
Medium Proposed Size Firm	242,822	1,013,941	462,775	316,164
Large Current Size Firm	326,582	1,189,289	542,806	370,841
Large Proposed Size Firm	326,582	1,315,789	600,542	410,286

Investment Effects on Cash Flow and Firm Solvency

Expected rate of return on investment, rate of firm growth, and potential gain in net worth are valid indicators of the desirability of a proposed capital investment. However, ability to meet cash flow is a critical factor that must not be ignored. An investment that has good net worth and firm growth potential may be nullified if financial flexibility is not available to meet a series of deficit cash flow years.

Estimates of maximum expected cash flow deficits help the decision maker plan future credit needs and determine if firm equity is sufficient to allow borrowing to meet these deficits. Table XX lists the minimum, mean, and maximum values of annual net cash flow for the current size firms. These net cash flows are the algebraic sum of all variable costs, principle and interest costs for replacement of fixed assets, family living expenses, taxes, and gross income. Expected cash flow is negative for all except year two through four. Year four is the peak of a ten year cattle cycle and the firms are utilizing existing inventories of machinery and equipment. Replacement of these assets begins in year five. Maximum values of net cash flow are positive for all except year 20. Positive net cash flows do exist and help offset borrowing in other years. Increases in net worth as shown in Table XVIII, provide equity and financial flexibility to support deficits.

Standard deviation of annual net cash flow and the coefficient of variation increase as firm size increases. However, the coefficient of variation generally decreases throughout the 20 year planning horizon. This measure which is the raio of standard deviation and the mean cash

TABLE XX

ANNUAL NET CASH FLOW FOR THE SMALL, MEDIUM, AND LARGE CURRENT SIZE FIRMS

Year	Small Current Size Firm					Medium Current Size Firm					Large Current Size Firm				
	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation
1	-41,041	-2,253	31,544	18,310	812.61	-77,902	-2,981	52,242	33,669	1,129.13	-104,473	-5,625	63,292	43,762	777.93
2	-45,920	956	31,283	18,394	1,923.74	-86,877	2,605	51,262	32,383	1,242.96	-116,421	1,193	61,509	41,471	3,474.47
3	-42,040	2,816	40,906	20,804	738.70	-79,199	5,460	65,770	35,685	653.54	-106,446	4,435	78,541	45,356	1,022.68
4	-53,883	5,841	40,415	20,277	347.12	-102,221	11,906	65,925	35,167	295.37	-137,880	12,355	79,157	45,028	365.03
5	-46,915	-5,796	-46,915	19,477	366.00	-86,770	-8,339	65,517	34,581	414.66	-117,132	-13,810	78,193	44,754	324.06
6	-47,912	-2,971	35,034	19,190	645.72	-91,733	-4,475	55,606	34,830	778.34	-124,559	-8,954	66,268	45,460	508.21
7	-54.338	-10,452	30,021	20,949	200.43	-100,542	-16,509	47,457	37,873	229.40	-135,731	-24,923	55,041	48,980	196.52
8	-64,671	-14,983	40,971	24,349	162.51	-120,774	-23,103	63,027	45,453	196.74	-162,431	-33,312	74,269	59,175	177.63
9	-66,848	-19,210	23,252	21,279	110.77	-121,792	-30,109	38,187	39,511	131.23	-163,453	-42,390	44,477	51,795	122.19
10	-70,026	-21,503	30,865	23,569	109.61	-129,510	-33,754	46,706	42,742	126.63	-174,897	-47,343	54,189	56,011	118.31
11	-66,977	-12,704	29,302	23,971	188.68	-123,066	-18,932	50,822	42,924	226.72	-165,964	-27,694	61,491	55,922	201.92
12	-76,326	-11,211	42,298	24,609	219.50	-141,591	-14,748	62,081	43,304	293.62	-190,883	-22,043	72,200	56,291	255.36
13	-71,814	-9,584	37,364	26,099	272.30	-130,684	-13,193	57,111	43,239	327.73	-175,548	-20.527	66,522	55,742	271.55
14	-91,998	-12,630	41,530	26,687	211.29	-166,853	-17,316	60,562	44,834	258.91	-223,316	-25,980	69,660	58,063	223.49
15	-99,931	-16,350	31,433	29,081	177.87	-182,013	-22,573	47,789	49,867	220.91	-243,762	-33,155	54,562	64,617	194.89
16	-87,004	-15,724	35,849	25,945	165.01	-142,176	-8,377	68,766	45,433	542.29	-189,889	-13,078	84,371	59,365	453.93
17	-88,732	-19,528	42,439	32,431	166.07	-151,573	-15,083	76,771	57,044	378.18	-206,066	-23,292	91,971	73,682	316.34
18	-86,309	-29,003	35,899	29,283	100.97	-135,397	-28,604	71,527	53,765	187.96	-180,011	-40,742	85,840	69,943	171.67
19	-103,170	-36,386	42,804	32,669	89.79	-163,313	-40,321	75,653	59,112	146.60	-216.213	-56,312	88,648	77,206	137.10
20	-156,380	-90,967	-16,262	27,906	30.68	-229,322	-110,184	-22.823	47,391	43.01	-290,978	-136,343	-27,947	61,148	44.85
Salvage Value			$519,489.06					$1,294,230.00					$1,843,926.00		

flow value may yield variable results when the negative mean values are possible.[3]

Table XXI lists annual net cash flow for the proposed size firms. Expected cash flow deficits for the proposed firms are greater than the current firms. For the small, medium, and large firms, the land investment causes expected net cash flow to be more negative. Standard deviation and coefficient of variation increases as the size of the proposed firm increases. Standard deviations of the proposed firms are only slightly larger than the current firms. Given estimates of cash flow deficits and relative measures of variation in cash flow, a measure of firm survival and financial flexibility is needed.

Annual net cash flow, equity ratios, and credit availability, are determinants of the financial survival of a firm. If the firm has an acceptable level of equity and a supportive lender, negative cash flows can be financially endured. Financial failure occurred in the simulation model when equity ratios were below a specified minimum level and additional funds were needed to meet an annual cash flow deficit. If the long-term equity ratio is below .20 and the intermediate term equity ratio is below .30, then the firm has failed the survival test for this repetition of the analysis. However, the analysis continues assuming that funds could be borrowed to meet cash flow deficits. This allows the estimate of net worth and net present value for this repetition to be compared with the other repetitions. If only the net worth and net present values of repetitions where the firm survived were compared, the

---

[3]An all positive valued variable may have the same standard deviation as a negative valued variable, and have greatly different coefficients of variation because the negative valued variables mean may be small (close to zero). Net present value for the small proposed size firm and the medium current size firm provide an example.

TABLE XXI

ANNUAL NET CASH FLOW FOR THE SMALL, MEDIUM, AND LARGE PROPOSED SIZE FIRMS

	Small Proposed Size Firm					Medium Proposed Size Firm					Large Proposed Size Firm				
Year	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation
1	-60,083	-8,121	35,888	24,622	303.18	-97,846	-9,616	54,939	39,960	415.55	-123,529	-11,560	65,918	49,833	430.73
2	-66,844	-4,166	35,196	24,550	589.28	-108,806	-3,573	52,823	38,323	1,072.53	-137,361	-4,321	63,059	47,084	1,089.59
3	-61,600	-2,084	46,259	27,458	1,317.26	-99,842	-716	68,880	42,032	5,864.24	-126,100	-1,098	81,324	51,295	4,670.96
4	-77,128	1,987	45,526	26,432	1,329.77	-126,670	6,689	69,302	41,130	614.81	-161,221	7,765	82,283	50,594	651.53
5	-67,927	-13,221	45,460	25,622	193.71	-109,153	-17,113	68,008	40,636	237.46	-138,263	-21,650	80,374	50,479	233.16
6	-70,834	-11,003	38,525	25,496	231.70	-116,030	-13,743	56,101	41,216	299.91	-147,642	-17,224	66,807	51,555	299.32
7	-79,426	-20,797	30,831	27,656	132.98	-127,343	-28,401	46,189	44,609	157.07	-161,026	-35,612	54,090	55,432	155.65
8	-92,988	-26,616	43,532	32,181	120.91	-150,843	-36,323	63,558	53,090	144.96	-191,294	-45,534	75,159	66,497	146.04
9	-95,849	-32,349	21,993	28,209	87.20	-152,868	-45,115	36,484	46,544	103.17	-192,677	-55,905	42,730	58,536	104.71
10	-100,443	-35,640	31,014	31,052	87.13	-162,198	-49,939	45,596	50,382	100.89	-205,717	-61,879	53,187	63,326	102.34
11	-97,755	-25,069	28,643	31,648	126.24	-156,400	-33,428	47,261	50,876	152.20	-198,069	-40,561	58,584	63,425	156.37
12	-110,828	-23,468	43,010	32,216	137.27	-179,059	-29,364	61,616	51,175	174.28	-226,115	-34,857	71,414	63,666	182.65
13	-104,508	-21,551	38,771	34,044	157.92	-165,918	-27,408	56,685	51,631	188.37	-208,825	-33,028	65,975	63,421	192.02
14	-130,892	-25,645	42,169	34,920	136.17	-209,052	-32,959	59,265	53,479	162.26	-262,699	-39,712	68,095	66,033	166.28
15	-141,605	-30,590	29,510	38,107	124.57	-227,212	-39,776	43,312	59,241	148.93	-286,154	-48,237	50,448	73,310	151.98
16	-126,908	-32,520	32,479	33,933	104.34	-186,059	-28,551	63,085	53,801	188.44	-230,183	-30,642	79,465	67,232	219.41
17	-132,743	-38,287	38,946	42,453	110.88	-200,433	-37,491	72,589	67,396	179.76	-251,183	-43,075	87,541	83,234	193.23
18	-125,437	-51,375	32,864	38,574	75.08	-178,731	-55,268	62,512	62,987	113.97	-219,565	-64,199	77,921	78,635	122.49
19	-148,696	-61,520	37,359	42,854	69.66	-213,701	-69,961	67,062	69,746	99.69	-262,255	-82,449	80,574	87,292	105.87
20	-199,382	-152,556	-123,637	14,903	9.77	-276,769	-180,592	-129,397	28,319	15.68	-334,009	-202,329	-135,452	38,972	19.26
Salvage Value			$929,985.06						$1,804,726.00				$2,254,457.00		

estimates of these values would be biased upward. This would omit the variation in these variables which is most critical to the decision maker.

Table XXII lists the frequency of annual financial failure. The total of each column represents the number of financial failures in 100 replications of each analysis. The small current size firm failed the firm survival test in year three in four of the 100 replications. The chance of firm failure for the small proposed size firm is 65 percent while the current small size firm is 32 percent. No financial failures were allowed in years one and two. It was assumed that a lender would loan funds in the first two years to meet unusual cash flow deficits regardless of the equity percentage.

Firm failure for the medium and large current firms is two percent, while the medium and large proposed firms' rate of failure is seven percent. Given negative expected cash flows for almost every year, these firms had sufficient equity to meet cash flow deficits and increase net worth throughout the 20 year planning horizon. Given the same price and yield situations for these firms, expected ending net worth is smaller and the chance of firm failure is smaller for the current size firms.

Interpretation of Simulation Results

Estimates of net worth, net present value, annual net cash flow, and the chance of firm survival for the current firm and the proposed firm provide evaluative information for capital investments. Cumulative probability distributions of these estimates indicate the range of outcomes and chance of obtaining a worse financial outcome. The decision maker can evaluate the proposed investment based on his personal goals and willingness to accept the risk of financial disaster.

TABLE XXII

FREQUENCY OF ANNUAL FIRM FINANCIAL FAILURE FOR THE SMALL, MEDIUM, AND LARGE CURRENT AND PROPOSED SIZE FIRMS

Year	Small Current Size Firm	Small Proposed Size Firm	Medium Current Size Firm	Medium Proposed Size Firm	Large Current Size Firm	Large Proposed Size Firm
1						
2						
3	4	23				
4	1	6				
5	3	6		1		
6	1	7				
7	1	2		2		1
8	1	3		1		3
9	2	4	1		1	
10	4	4				
11	3	2		1		
12	1	1		1		1
13	1	1	1		1	
14						
15		2				
16	1					
17	2	1				
18	3			1		
19	4	3				2
20						
TOTAL	32	65	2	7	2	7

Measures of ending net worth and net present value indicate that the proposed land investment would increase the chance of financial failure and would increase the expected ending net worth of the firm. Price and yield situations are the same for both the current and proposed size firms. The expected potential increase in net worth must be weighed against the increased chance of financial failure and negative net present value. In Chapter VI, a nonlinear optimization technique is used to determine the breakeven price given a more profitable price and yield situation.

Sensitivity Analysis of Key Variables

Sensitivity of investment success to key variables, loan interest rate, product price trends, production cost trends, land appreciation rates, and capital gain tax liabilities are presented in this section. Loan interest rates affect loan cost and investment success. The relationship of product price trends and production cost trends influence investment outcomes. All sensitivity analysis runs are based on the large proposed size firm. Table XXIII lists the different sensitivity experiments and levels of key parameters.

Best and Worst Scenarios for Agriculture

The conditions depicted by Runs 2 and 3 are not predicted or implied, but are presented to provide an estimate of the feasible range of financial outcomes possible for agriculture investment under these situations. The following describes a set of economic conditions which would be favorable to agricultural producers. If land investment continues to provide a hedge against inflation for non-farm investors, and land

TABLE XXIII

DESCRIPTION OF SIMULATION EXPERIMENTS AND PERCENTAGE LEVELS FOR KEY VARIABLES IN THE SENSITIVITY ANALYSIS

Run Number	Description	Land Inflation Rate	Product Price Trends	Production Cost Trends	Land Loan Interest Rate	Other Interest Rates
1	Large Proposed Size Firm[a]	6	2	3	8.5	8.5
2	Best Financial Situation[b]	12	3	3	5.0	5.0
3	Worst Financial Situation[c]	0	0	6	8.5	8.5
4	Low Interest Rates[d]	6	2	3	5.0	5.0
5	High Interest Rates[e]	6	2	3	10.0	10.0
6	Favorable Price-Cost Trends[f]	6	3	1	8.5	8.5
7	Equal Price-Cost Trends[g]	6	3	3	8.5	8.5
8	Low Land Appreciation Rate[h]	0	2	3	8.5	8.5
9	High Land Appreciation Rate[i]	12	2	3	8.5	8.5
10	No Cash Flow Adjustment[j]	6	2	3	8.5	8.5
11	Capital Gain Tax Low Inflation[k]	6	2	3	8.5	8.5
12	One Percent Loan Interest[l]	6	2	3	1.0	8.5
13	Capital Gain Tax High Inflation[m]	12	2	3	8.5	8.5
14	Large Current Size Firm[n]	6	2	3	0.0	8.5

[a]The large proposed size firm is the base situation for most sensitivity analyses. It is used as a benchmark to evaluate the effects of changes in key variables. The land appreciation rate is six percent. Product prices trend upward two percent annually while production costs increase at a three percent annual rate. The investment loan and all other long-term loans are charged 8.5 percent interest. Intermediate-term interest rates are nine percent. The discount rate is 7.5 percent. Other sensitivity experiments are deviations from this base. Unless specifically changed, a variable has the value described in the base situation.

TABLE XXIII (Continued)

[b]Best financial situation: This experiment which was described in detail earlier in this chapter, is assumed to have a 12 percent land appreciation rate. Product prices and production cost trends are equal at three percent. The investment loan and other long-term loans are charged five percent interest. Intermediate-term interest rate is 5.5 percent.

[c]Worst financial situation: Land appreciation trend and product price trend is zero for this experiment. Production costs increase at a six percent annual rate.

[d]Low interest rate: Long-term interest rates for the investment loan and other long-term loans are five percent. Intermediate-term interest rate is 5.5 percent.

[e]High interest rate: Long-term interest rate for the investment and other long-term loans is ten percent. Intermediate-term interest rate is 10.5 percent.

[f]Favorable price-cost trends: This experiment has a three percent growth in annual product prices. Production costs increase one percent per year.

[g]Equal price-cost trends: The trends in product prices and production costs are equal at three percent.

[h]Low land appreciation rate: This experiment is conducted with zero trend in land value.

[i]High land appreciation rate: Land value increases at a 12 percent annual rate.

[j]No cash flow adjustment: This experiment is like the large proposed size firm for all sensitivity parameters in Table XXIII. In this experiment, the interest charged on borrowing to meet annual net cash flow deficits and interest paid on invested annual surplus cash is not included in future cash flow.

[k]Capital gain tax low inflation: This experiment is like the large proposed size firm for all sensitivity parameters in Table XXIII. The capital gain tax liability is not subtracted from cash flow or net worth.

[l]One percent loan interest: The interest rate for the land investment is one percent. All other interest rates are as described for the large proposed size firm.

[m]Capital gain tax high inflation: The annual appreciation rate for land is 12 percent. Also, the capital gain tax liability is not subtracted from cash flow or net worth.

[n]Large current size firm: This experiment represents the current firm before the land investment is made. It has no investment loan.

appreciates in value relative to costs of land ownership, growth in land value will benefit high equity land owners. However, double digit inflation rates in land value make it increasingly difficult for beginning farmers to "get started" in agricultural production. Twelve percent annual growth is comparable with recent experience.

As the number of farm operators decreases, voluntary production control will become a more realistic goal. Farm operators armed with new technology and decision making knowledge may reduce price variability through discriminate production to meet demand and orderly marketing strategies. Historic product price trends of less than one percent could increase three to four times. Cost of production increases have tended to follow the rate of inflation. Historically, the costs have increased much more rapidly than product prices. Technological improvements have allowed agricultural producers to be competitive. Cost of production trends equal to or less than product price trends would be very favorable to agriculture.

The money supply and related fiscal and monetary policies directly influence interest rates. In the last decade, long-term interest rates have ranged from five to ten percent. Interest cost directly affects cost of production and the producers' competitive position.

A favorable situation for a high equity, individual producer might include a 12 percent land appreciation rate, three percent annual increase in product prices coupled with a one percent trend in production cost. The minimum likely interest rate based upon recent experience would be five percent. Changes in the structure of the U. S. agricultural economy would be necessary for this situation to be realistic, but it is possible.

Worse conditions are also possible for agriculture. If recent net returns to land continue, farm and non-farm investors may consider other non-land investment alternatives. Most investors require positive land returns to meet fixed ownership costs. In this situation, stable land prices would be possible.

While advances in technology have allowed the farm operator to be competitive, technology has also contributed to surplus production of many agricultural commodities. These surpluses would tend to stabilize the market at relatively low price levels. Given the nearly perfect competitive structure of agriculture and historic price trends of less than one percent, a zero trend for agricultural prices is assumed for the worst situation. Inflation is at best a mixed blessing for agricultural producers. Inflation in land value increases producers net worth, while it also increases the cost of everything producers purchase. Inflation does not equally influence all segments of the economy. Inflation in costs of agricultural production could more than offset product price increases. In the worst situation, production costs are assumed to increase at a six percent annual rate.

Interest rates depend partially on the supply of money, riskiness of the loan, and costs associated with money lending. In the past, increases in interest rates have been used to reduce inflationary pressures. The sets of conditions described as "bad for agriculture" include an 8.5 percent loan interest rate, zero land appreciation and product price trends, and a six percent trend in annual production costs.

Effects of changes in these variables are compared using measures of net worth, net present value, annual net cash flow, and firm survival. Table XXIV lists the ending net worth and net present value for the base, best, and worst agricultural situations. Expected net worth ranges from 5.6 million to -2.3 million dollars. Expected present value ranges from $1,303,318 for the best situation to -$938,496 for the worst situation. Positive net present value indicates that the investor could pay more than $800 per acre and receive a 7.5 percent return on investment. Standard deviation of the best situation is smallest, $189,123, while the base level is $208,897, and the worst situation is $236,203.

TABLE XXIV

ENDING NET WORTH AND NET PRESENT VALUE FOR THE LARGE PROPOSED SIZE FIRM GIVEN THE BASE, BEST, AND WORST FINANCIAL SITUATIONS

Run	Description	Min	Mean	Max	Std. Dev.	Coeff. Variation
Net Worth						
1	Base	419,231	1,315,789	2,206,397	406,306	30.87
2	Best	4,827,743	5,652,612	6,385,898	365,900	6.47
3	Worst	-3,780,477	-2,344,946	-1,139,017	482,395	20.57
Net Present Value						
1	Base	- 289,129	- 206,419	691,597	208,897	101.20
2	Best	812,461	1,303,318	1,747,489	9,123	14.51
3	Worst	-1,708,971	- 938,496	- 448,402	236,203	25.17

Table XXV lists the annual net cash flow for the base, best, and worst financial conditions. Expected net cash flows are most negative

TABLE XXV

ANNUAL NET CASH FLOW FOR THE LARGE PROPOSED SIZE FIRM GIVEN THE BASE, BEST, AND WORST FINANCIAL SITUATION

	Average Financial Conditions					Best Financial Conditions					Worst Financial Conditions				
Year	Min	Mean	Max	Std Deviation	Coeff Var	Min	Mean	Max	Std Deviation	Coeff Var	Min	Mean	Max	Std Deviation	Coeff Var
1	-123,529	- 11,569	65,918	49,833	430.73	-123,092	- 10,168	66,936	49,838	490.11	-124,327	- 14,300	63,903	49,733	347.78
2	-137,361	- 4,321	63,059	47,084	1,089.59	-135,988	- 1,784	65,110	46,946	2,630.75	-143,587	- 12,538	57,514	48,241	384.75
3	-126,100	- 1,098	81,324	51,295	4,670.96	-123,836	2,911	84,574	50,674	1,740.47	-139,066	- 15,322	70,905	53,908	351.82
4	-161,221	7,765	82,283	50,594	651.53	-158,546	13,259	87,700	50,127	378.03	-179,607	- 14,192	68,388	54,173	381.69
5	-138,263	- 21,650	80,374	50,479	233.16	-132,838	- 13,575	85,910	50,376	371.08	-167,938	- 54,611	58,443	53,236	97.48
6	-147,642	- 17,224	66,807	51,555	299.32	-142,182	- 7,878	73,991	51,061	648.14	-188,985	- 62,834	43,663	53,432	85.04
7	-161,026	- 35,612	54,090	55,432	155.65	-153,999	- 22,326	65,508	54,228	242.89	-213,320	- 87,760	29,090	58,201	66.32
8	-191,294	- 45,534	75,159	66,497	146.04	-173,191	- 29,993	84,347	67,355	224.57	-266,731	- 18,809	116,800	81,731	434.53
9	-192,677	- 55,905	42,730	58,536	104.71	-191,133	- 36,704	54,710	58,269	158.75	-200,077	- 29,242	92,470	79,028	270.25
10	-205,717	- 61,879	53,187	63,326	102.34	-189,581	- 38,369	67,603	62,253	161.11	-267,132	-147,675	- 4,181	60,682	41.09
11	-198,069	- 40,561	58.584	63,425	156.37	-182,495	- 15,109	76,478	60,271	398.91	-283,762	-155,077	- 33,781	61,083	39.39
12	-226,115	- 34,857	71,414	63,666	182.65	-205,596	- 8,122	85,388	59,085	727.41	-339,508	-171,049	4,338	61,420	35.91
13	-208,825	- 33,028	65,975	63,421	192.02	-189.324	- 4,852	85,583	58,182	1,198.95	-356,708	-186,828	- 23,974	68,789	36.82
14	-262,699	- 39,712	68,095	66,033	166.28	-237,860	- 7,389	91,374	60,657	820.90	-403,770	-222,180	- 47,489	66,252	29.82
15	-286,154	- 48,237	50,448	73,310	151.98	-260,439	- 12,302	75,870	67,656	549.92	-468,370	-263,731	-104,257	73,862	29.01
16	-230,183	- 30,642	79,465	67,232	219.41	-193,218	16,581	106,681	60,250	363.35	-446,270	-289,192	-167,717	59,526	20.58
17	-251,279	- 43,075	87,234	83,234	193.23	-210,780	8,288	111,658	75,623	912.39	-498,653	-328,736	-185,498	72,151	21.95
18	-219,565	- 64,199	77,921	78,635	122.49	-175,992	- 874	108,338	71,057	8,123.13	-484,237	-273,738	6,196	117,523	42.93
19	-262,255	- 82,449	80,574	87,292	105.87	-196,260	- 15,966	117,623	80,933	506.90	-538,372	-324,483	23,215	125,778	38.76
20	-334,009	-202,329	-135,452	38,972	19.26	-521,426	-456,215	-386,823	28,446	6.24	-712,403	-565,498	-372,709	60,676	10.73
Salvage Value			$2,254,457.00					$6,375,417.00					$329,977.00		

for the worst situation except in year 20 when the capital gain tax liability associated with the best situation causes net cash flow to be more negative. The worst financial condition simulation experiment failed the firm survival test in all of the 100 replications. Table XXVI presents beginning, ending, and discounted ending net worth for the base, best, and worst situation. As explained previously in this chapter, the base firm growth rate is approximately six percent. Given an adjustment for six percent inflation, real net worth increases five fold over the 20 year planning horizon for the best situation. The ending current net worth of $5,652,612 represents an approximate 15 percent compound annual growth rate for the 20 year analysis. Net worth for the worst situation, if funds could have been borrowed to meet cash flow deficits, would be -$2,344,946. More drastic good and bad assumptions could be realistically imagined for agriculture. This analysis provides an example of the range of financial outcomes for the three combinations of key variables.

TABLE XXVI

CURRENT AND REAL NET WORTH FOR THE LARGE PROPOSED SIZE FIRM GIVEN THE BASE, BEST, AND WORST FINANCIAL SITUATIONS

Run	Description	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4% Annual Inflation	Real Ending Net Worth 6% Annual Inflation
1	Base	326,582	1,315,789	600,542	410,286
2	Best	326,582	5,652,612	2,579,923	1,762,585
3	Worst	326,582	-2,344,946	-1,070,262	- 731,196

Sensitivity of Investment Success to Alternative Loan Interest Rates

Loan interest rates of 5.0, 8.5, and 10 percent are used in this simulation, while other variables are held at the base to determine the effects of loan interest rate on investment success. The investment loan and all borrowing are charged the same interest rates. Long-term interest rates for runs 1, 4, and 5, and 8.5, 5, and 10 percent while intermediate-term rates are one-half percent higher, 9.0, 5.5, and 10.5 percent.

Table XXVII lists the ending net worth and net present value for the three levels of interest rate. Expected net worth for the low interest rate exceed that of the base interest rate by more than $300,000. The high interest rate generated an expected net worth $250,000 less than the base level interest rate. The five percent range in interest rate from five to ten percent caused a range in net worth of more than one-half million dollars over the 20 year planning horizon. Standard deviation and coefficient of variation is smallest for the five percent interest rate and increases as interest rate increases.

Expected net present value is highest for the low interest rate while the base level, 8.5 percent interest, yielded $206,419 net present value, ten percent interest generated a $106,385 expected net present value. Figure 9 illustrates the cumulative distribution of net present value for the three interest rates. The probability of obtaining a negative net present value is greatest for the ten percent interest rate situation, 34 percent. The five and 8.5 percent interest situation

TABLE XXVII

ENDING NET WORTH AND NET PRESENT VALUE WITH 8.5, 5, AND 10 PERCENT LOAN INTEREST RATE

Run	Description	Min	Mean	Max	Std. Dev.	Coeff. Variation
		Net Worth				
1	Large Proposed Size Firm - Base	419,231	1,315,789	2,206,397	406,306	30.87
4	Low Interest Rate	1,071,286	1,678,103	2,348,977	284,428	16.94
5	High Interest Rate	-79,715	1,065,523	2,132,716	505,525	47.44
		Net Present Value				
1	Large Proposed Size Firm - Base	- 289,129	206,419	691,597	208,897	101.20
4	Low Interest Rate	4,567	359,558	754,081	156,489	43.52
5	High Interest Rate	- 473,189	106,385	658,657	247,724	232.85

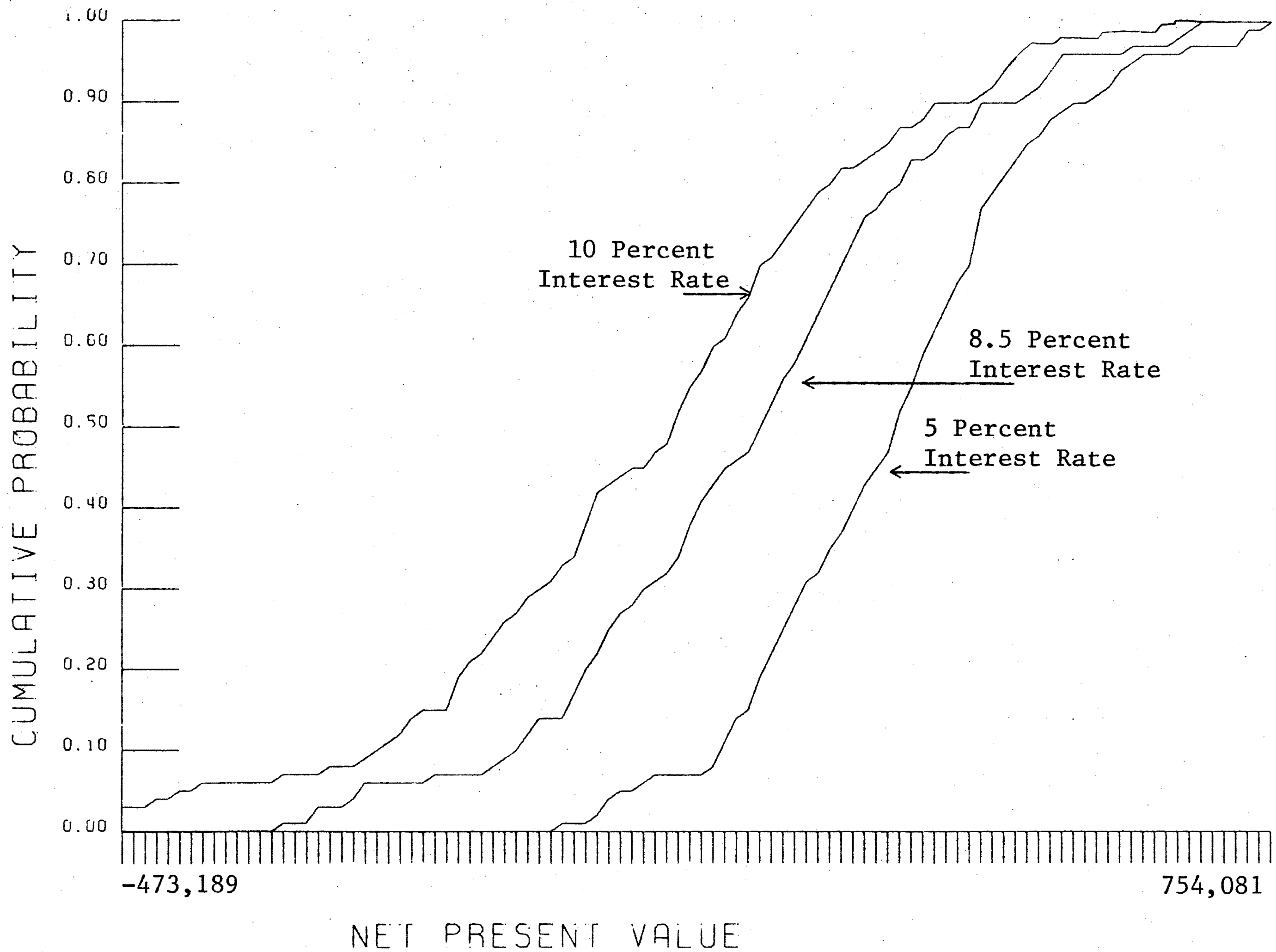

Figure 9. Cumulative Probability Distribution of Net Present Value for the Large Proposed Size Firm Given 5, 8.5, and 10 Percent Interest Rates

have a one percent and 15 percent chance of negative net present value. Assuming that a decision maker cannot accept a net present value less than $133,178, the five percent loan interest rate situation would have .08 probability of a worse outcome while the 8.5 and 10 percent interest rate situations would have .40 and .60 probability of worse than $133,178 net present value.

Interest rates have an effect on annual net cash flow. Table XXVIII indicates that low interest rates yield smaller cash flow deficits. As interest rate increases, net cash flow becomes more negative. Standard deviation also increases as interest rate is adjusted upward. A ten percent interest rate caused firm failure in eight of the 100 replications, while lower interest rates allowed 100 percent firm survival.

Table XXIX presents beginning, current ending, and real ending net worth for the three interest rates. The five percent interest rate generated a real growth in net worth of almost $200,000 given a six percent allowance for inflation. The 8.5 percent interest rate yielded $83,704 growth in real net worth, while the 10 percent interest rate caused real net worth to increase only $5,667.

In summary, interest rate has a significant influence on ending net worth, firm growth, and annual net cash flow. Credit alternatives may not allow the decision maker to 'shop around' for the best interest rate, but the rate paid may determine the outcome of the investment. Planning for credit needs and minimizing borrowing through good management of credit can increase the chance of successful capital investment.

TABLE XXVIII

ANNUAL NET CASH FLOW COMPARISONS OF THE EFFECT OF 5, 8.5, AND 10 PERCENT LOAN INTEREST RATE

	Number 1 Large Proposed Size Firm with 8.5% Loan Interest					Number 4 5% Loan Interest					Number 5 10% Loan Interest				
Year	Min	Mean	Max	Std Deviation	Coeff Var	Min	Mean	Max	Std Deviation	Coeff Var	Min	Mean	Max	Std Deviation	Coeff Var
1	-123,529	- 11,569	65,918	49,833	- 430.73	-112,346	- 4,342	66,571	46,355	-1,067.42	-128,664	- 15,330	65,243	51,174	- 333.82
2	-137,361	- 4,321	63,059	47,084	-1,089.59	-121,893	3,309	63,998	42,698	1,290.80	-144,605	- 8,344	62,225	48,995	- 587.15
3	-126,100	- 1,098	81,324	51,295	-4,670.96	-114,530	6,787	81,958	46,817	689.77	-131,481	- 5,280	80,728	53,351	-1,010.43
4	-161,221	7,765	82,283	50,594	651.53	-148,373	15,278	84,300	46,319	303.17	-167,588	3,452	80,186	52,576	1,522.91
5	-138,263	- 21,650	80,374	50,479	- 233.16	-120,975	- 10,796	81,986	46,193	- 427.85	-147,115	- 27,469	79,452	52,516	- 191.18
6	-147,642	- 17,224	66,807	51,555	- 299.32	-135,459	- 7,092	71,849	47,367	- 667.89	-154,272	- 23,037	65,258	53,491	- 232.19
7	-161,026	- 35,612	54,090	55,432	- 155.65	-139,133	- 22,746	59,078	51,327	- 225.65	-174,111	- 42,832	50,208	57,437	- 134.10
8	-191,294	- 45,534	75,159	66,497	- 146.04	-177.678	- 31,498	75,308	62,521	- 198.49	-198,946	- 53,584	74,077	68,611	- 128.04
9	-192,677	- 55,905	42,730	58,536	- 104.71	-157,663	- 39,415	44,879	54,077	- 137.20	-212,219	- 65,657	39,312	60,826	- 92.64
10	-205,717	- 61,879	53,187	63,326	- 102.34	-181,346	- 42,843	58,008	58,309	- 136.10	-219,827	- 73,621	50,723	65,881	- 89.49
11	-198,069	- 40,561	58,584	63,425	- 156.37	-180,965	- 21,437	70,457	56,801	- 246.96	-210,327	- 52,403	51,058	67,492	- 128.80
12	-226,115	- 34,857	71,414	63,666	- 182.65	-195,926	- 14,993	75,212	56,025	- 373.66	-243,628	- 48,528	71,693	67,763	- 139.64
13	-208,825	- 33,028	65,975	63,421	- 192.02	-189,786	- 11,633	74,768	55,442	- 476.58	-233,781	- 46,993	62,702	63,984	- 146,80
14	-262,699	- 39,712	68,095	66,033	- 166.28	-231,591	- 15,784	77,931	59,454	- 376.66	-283,545	- 55,518	66,582	71,191	- 128.23
15	-286,154	- 48,237	50,448	73,310	- 151.98	-241,543	- 21,751	63,812	65,350	- 300.43	-315,577	- 66,523	44,099	79,012	- 118.77
16	-230,183	- 30,642	79,465	67,232	- 219.41	-196,177	- 6,278	88,588	61,386	- 977.76	-257,220	- 49,898	74,340	71,562	- 143.42
17	-251,279	- 43,075	87,541	83,234	- 193.23	-211,694	- 16,819	92,278	73,128	- 434.78	-277,801	- 63,761	84,234	90,903	- 142.57
18	-219,565	- 64,199	77,921	78,635	- 122.49	-185,875	- 33,647	87,265	69,657	- 207.02	-248,309	- 88,529	69,359	86,027	- 97.17
19	-262,255	- 82,449	80,574	87,292	- 105.87	-217,130	- 48,736	86,325	80.038	- 164.23	-320,003	-109.888	77.670	94,075	- 85.61
20	-334,009	-202,329	-135,452	38,972	- 19.26	-277,267	-180.676	-118,579	30,812	- 17.05	-377,149	-222,978	-144,735	49,594	- 22.24
Salvage Value		$2,254,457.00					$2,254,457.00						$2,254,457.00		

TABLE XXIX

CURRENT AND REAL ENDING NET WORTH FOR 5, 8.5, AND 10 PERCENT INTEREST RATES

Run	Description	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4% Annual Inflation	Real Ending Net Worth 6% Annual Inflation
1	8.5 Percent	326,582	1,315,789	600,542	410,286
4	5.0 Percent	326,582	1,678,103	765,907	523,262
5	10 Percent	326,582	1,065,523	486,318	332,249

Effects of Product Price Trends and Production Cost Trends on Investment Success

Historically, the rate of growth in product prices has lagged behind increases in production costs. Adoption of production increasing and cost saving technology has helped agricultural producers to endure the cost-price squeeze. Runs 6 and 7, from Table XXIII, were simulated and compared to Run 1 to determine the influence of price and cost trends on capital investment success. Run 1 assumed that produce prices increase at two percent annually, while costs increase at three percent. Run 6 represents a favorable price cost relation for agriculture. Product prices increase three percent annually, while production costs increase one percent per year. Run 7 represents equal price and cost trends of three percent.

Table XXX presents minimum, mean, and maximum values of net worth and net present value for the three price-cost simulation experiments. The favorable price-cost simulation generated the largest expected net worth, $2,220,053. Equal price-cost trends produced an ending expected net worth of $1,789,015, while the base situation with product cost increasing faster than product prices generated $1,315,789 expected net worth. These price-cost relationships caused a range of expected net worth of almost one-million dollars. The three interest rates produced only a one-half million dollar range of expected net worth.

Unfavorable or traditional product price and production costs trend relationships increase variation in net worth. The traditional price-cost relationship, Run 1, caused a coefficient of variation of 30.87. This measure of net worth variation is three times the favorable price-cost, simulation, Run 6, and twice as large as the equal price-cost simulation experiment. Net present values exhibit the same relationships as net worth. Coefficient of variation values are influenced by the negative mean values for net present value.

Table XXXI lists annual net cash flow for the three price-cost relationships. Net cash flows are largest for the favorable price-cost simulation. Standard deviations are largest for the unfavorable price-cost relations.

Gains in real net worth over the 20 year planning horizon are indicated by Table XXXII. The unfavorable situation exhibited more than six percent firm growth, the equal price cost situation yielded 8.9 percent annual firm growth, and the favorable price-cost situation generated a 10 percent annual rate of growth.

TABLE XXX

ENDING NET WORTH AND NET PRESENT VALUE FOR THE SENSITIVITY ANALYSIS OF PRODUCT PRICE AND PRODUCTION COST TRENDS

Run	Description	Min	Mean	Max	Std. Dev.	Coeff. Variation
		Net Worth				
1	Large Proposed Size Firm - Base Assumptions	419,231	1,315,789	2,206,397	406,306	30.87
6	Favorable Price-Cost Trends	1,633,663	2,220,531	2,856,878	258,936	11.66
7	Equal Price-Cost Trends	999,402	1,789,015	2,553,322	335,443	18.75
		Net Present Value				
1	Large Proposed Size Firm - Base Assumptions	- 289,129	206,419	691,597	208,897	101.20
6	Favorable Price-Cost Trends	128,834	569,244	943,856	160,307	28.16
7	Equal Price-Cost Trends	96,894	387,100	825,895	187,003	48.30

TABLE XXXI

ANNUAL NET CASH FLOW COMPARISONS OF THE RELATIONSHIP BETWEEN PRODUCT PRICE TRENDS AND PRODUCTION COST TRENDS

	Number 1 Large Proposed Size Firm with Product Price Trends less than Production Cost Trends					Number 6 Product Price Trends Greater than Production Cost Trends					Number 7 Product Price Trends Equal to Production Cost Trends				
Year	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation
1	-123,529	-11,569	65,918	49,833	430.73	-123,092	-10,841	65,028	49,222	454.01	-123,092	-10,841	65,028	49,222	454.01
2	-137,361	-4,321	63,059	47,084	1,089.59	-133,390	-794	64,006	45,597	5,967.83	-135,099	-2,641	63,123	46,221	1,749.71
3	-126,100	-1,098	81,324	51,295	4,670.96	-118,658	5,593	84,030	48,466	866.45	-124,024	1,914	82,423	49,910	2,606.44
4	-161,221	7,765	82,283	50,594	651.53	-150,329	17,265	88,027	47,268	273.78	-158,778	12,024	85,627	49,409	410.91
5	-138,263	-21,650	80,374	50,479	233.16	-121,044	-5,849	87,214	46,897	801.70	-132,949	-14,505	83,701	49,723	342.80
6	-147,642	-17,224	66,807	51,555	299.32	-127,454	1,391	76,844	46,712	3,346.30	-142,569	-9,032	71,867	50,420	558.19
7	-161,026	-35,612	54,090	55,432	155.65	-134,592	-8,865	68,098	49,037	553.13	-154,363	-23,298	63,480	53,659	230.11
8	-191,294	-45,534	75,159	66,497	146.04	-150,508	-12,116	88,970	61,357	506.38	-173,874	-30,949	82,086	66,827	215.92
9	-192,677	-55,905	42,730	58,536	104.71	-160,351	-15,441	61,884	51,056	330.65	-191,349	-37,784	52,037	57,730	152.79
10	-205,717	-61,879	53,187	63,326	102.34	-155,159	-14,902	74,964	52,783	354.20	-190,369	-39,843	65,276	61,708	154.88
11	-198,069	-40,561	58,584	63,425	156.37	-143,820	8,636	88,444	49,383	568.49	-183,685	-15,797	76,356	60,388	382.26
12	-226,115	-34,857	71,414	63,666	182.65	-156,168	18,980	99,288	47,375	249.61	-206,817	-8,759	85,094	59,257	676.47
13	-208,825	-33,028	65,975	63,421	192.02	-141,154	21,574	99,713	45,321	210.07	-190,508	-5,453	85,372	58,419	1,071.25
14	-262,699	-39,712	68,095	66,033	166.28	-182,089	22,597	108,582	47,047	208.20	-239,043	-8,057	90,905	60,966	756.68
15	-286,154	-48,237	50,448	73,310	151.98	-195,434	20,755	94,490	52,164	251.32	-260,890	-12,955	75,511	67,895	524.06
16	-230,183	-30,642	79,465	67,232	219.41	-120,463	55,430	128,331	42,765	77.28	-194,198	15,817	106,464	60,524	382.65
17	-251,279	-43,075	87,541	83,234	193.23	-123,413	51,665	131,798	54,181	104.87	-212,862	7,499	111,574	75,883	1,011.88
18	-219,565	-64,199	77,921	78,635	122.49	-93,587	53,105	132,553	46,327	87.24	-176,780	-1,817	107,681	71,348	3,924.88
19	-262,255	-82,449	80,574	87,292	105.87	-98,156	40,285	137,254	53,131	131.89	-198,140	-16,919	117,765	81,314	480.60
20	-334,009	-202,452	-135,452	38,972	19.26	-205,242	-138,965	-68,102	28,216	20.30	-260,659	-169,933	-98,944	31,601	18.60
Salvage Value			$2,254,457.00					$2,254,457.00					$2,254.457.00		

TABLE XXXII

CURRENT AND REAL ENDING NET WORTH FOR THE SENSITIVITY ANALYSIS OF PRODUCT PRICE AND PRODUCTION COST TRENDS

Run	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4% Annual Inflation	Real Ending Net Worth 6% Annual Inflation
1	326,582	1,315,789	600,542	410,286
6	326,582	2,220,053	1,013,260	692,252
7	326,582	1,789,015	816,528	557,846

Ending net worth, net present value, and annual net cash flows for the three price-cost relationships were predictable. As product price trends increase relative to production costs, measures of financial success should improve. However, the standard deviation and coefficient of variation increased as the price-cost relationship deteriorated. Traditional product price trends and production cost trends are one source of variation in measures of investment success.

Sensitivity of Investment Success to Alternative Land Appreciation Rates

The land appreciation rate is very important to agricultural producers. Appreciation increases net worth and financial flexibility. However, it also increases the price that producers must pay for additional land. The analysis in this section is comprised of three simulations of the large proposed firm using zero, six, and 12 percent annual rates of land appreciation (Runs 8, 1, and 9).

Table XXXIII presents the ending net worth and net present value for the alternative land appreciation rates. Expected ending net worth given no trend in land value is -$56,150. The minimum or most negative net worth is -$985,111, disregarding the survival test. Of the 100 replications of the zero land trend situation, the firm failed the survival test 65 times. Six percent land inflation rate generates a $1,315,789 ending net worth, while 12 percent land growth rate yields $5,146,159 ending net worth. Coefficient of variation decreases from 30.87 to 8.06 as land appreciation is increased from six to 12 percent.

Expected net present value for the zero and six percent inflation situations are -$117,903 and $206,419, respectively. The 12 percent land inflation experiment has the largest net present value, $1,115,607.

Increasing land appreciation rates have no effect on annual cash flow. However, in the last year, capital gain tax liability is calculated and the salvage value of land is added (after taxes) to cash flow. Annual net cash flows are listed in Table XXXIV. Zero land inflation would generate no capital gain to be taxed. Thus, expected annual net cash flow in the 20th year, -$161,008, is due to prices, yields, and other financial commitments. Land appreciation equal to six percent generates -$202,329, net cash flow in the last year, while 12 percent land inflation yields -$480,217 expected annual net cash flow. Differences in year 20 cash flow are due to difference in capital gain tax liability.

TABLE XXXIII

ENDING NET WORTH AND NET PRESENT VALUE FOR THE SENSITIVITY ANALYSIS OF LAND APPRECIATION RATES

Run	Description	Min	Mean	Max	Std. Dev.	Coeff. Variation
		Net Worth				
1	Large Proposed Size Firm - Base Appreciation Rate	419,231	1,315,789	2,206,397	406,306	30.87
8	Low Land Appreciation Rate	- 985,111	-56,150	871,969	419,748	747.54
9	High Land Appreciation Rate	4,250,427	5,146,159	6,173,600	415,069	8.06
		Net Present Value				
1	Large Proposed Size Firm - Base Appreciation Rate	- 289,129	206,419	691,597	208,897	101.20
8	Low Land Appreciation Rate	- 604,949	- 117,903	375,936	211,835	179.67
9	High Land Appreciation Rate	617,632	1,115,607	1,598,470	208,063	18.65

TABLE XXXIV

ANNUAL NET CASH FLOW COMPARISONS OF THE EFFECTS OF ZERO, SIX, AND TWELVE PERCENT LAND APPRECIATION RATES

Year	Minimum	Mean	Maximum	Std. Dev.	Coeff. Variation
	No. 1 Large Proposed Size Firm with 6% Land Appreciation Rate				
1	-123,529	-11,569	65,918	49,833	430.73
2	-137,361	-4,321	63,059	47,084	1,089.59
3	-126,100	-1,098	81,324	51,295	4,670.96
4	-161,221	7,765	82,283	50,594	651.53
5	-138,263	-21,650	80,374	50,479	233.16
6	-147,642	-17,224	66,807	51,555	299.32
7	-161.026	-35,612	54,090	55,432	155.65
8	-191,294	-45,534	75,159	66,497	146.04
9	-192,677	-55,905	42,730	58,536	104.71
10	-205,717	-61,879	53,187	63,326	102.34
11	-198,069	-40,561	58,583	63,425	156.37
12	-226,115	-34,857	71,414	63,666	182.65
13	-208,825	-33,028	65,975	63,421	192.02
14	-262,699	-39,712	68,095	66,033	166.28
15	-286,154	-48,237	50,448	73,310	151.98
16	-230,183	-30,642	79,465	67,232	219.41
17	-251,279	-43,075	87,541	83,234	193.23
18	-219.565	-64,199	77,921	78,635	122.49
19	-262,255	-82,449	80,574	87,292	105.87
20	-334,009	-202,329	-135,452	38,972	19.26
Sal. Value			$2,254,457.00		
	Zero Land Appreciation Rate				
20	-334,009	-161,008	-37,136	69,453	43.13
Sal. Value			$329,977.00		
	12% Land Appreciation Rate				
20	-530,101	-480,217	-423,920	24,540	5.11
Sal. Value			$6,375,417.00		

Ending current and real net worth for the zero land inflation rate situation are both negative. Table XXXV indicates about $80,000 real growth in net worth given six percent general and land inflation rates. Twelve percent land appreciation generated growth in real net worth from $326,582 to $1,609,884. The annual compound growth rate of the firm not considering the influence of general inflation is approximately 15 percent.

TABLE XXXV

CURRENT AND REAL ENDING NET WORTH FOR THE SENSITIVITY ANALYSIS OF LAND APPRECIATION RATES

Run	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4% Annual Inflation	Real Ending Net Worth 6% Annual Inflation
1	326,582	1,315,789	600,542	410,286
8	326,582	- 56,150	- 25,627	- 17,508
9	326,582	5,162,771	2,356,353	1,609,844

Effect of Interest Charged and Interest Paid on Investment Success

In a study by Lee and Rask (1971), net returns per acre and growth rate of net returns had the greatest influence on maximum breakeven bid price of variables evaluated. Thus, accurate estimates of cash income and expenses are very important. The analysis in this section compares investment results for simulation experiments in which interest on negative annual cash flows is and is not charged. This approach is a deviation from usual net present value analysis as explained in following paragraphs. Annual current net cash flow is discounted by the model. The base simulation model charges interest on negative cash flows and pays interest on positive cash flows. If annual net cash flow is negative, the firm equity ratio is calculated to determine if funds can be borrowed to meet the cash flow deficit. If the firm equity ratio is above the specified minimum level, funds are borrowed and interest on the unpaid balance of these borrowed funds is added to future cash flow until the loan is repaid. If current annual net cash flow is positive these funds can be invested in a savings account earning six percent interest. This interest paid is added to future cash flow. If a positive cash flow year is followed by a negative annual cash flow, positive cash from the previous years would be exhausted before borrowing would be allowed to meet the cash flow deficit. Since most net present value models do not simultaneously analyze cash flow, net worth, and net present value, these components of cash flow are usually not available for inclusion in the analysis if deemed appropriate.

Estimates of actual cash flows, which include interest charged to meet annual cash flow deficits and interest earned on surplus cash balances, are essential to measure the investment's feasibility. Inclusion of this interest charged and paid in the discounted cash flows, which determine net present value, changes the theoretical interpretation of net present value. Equation 5.1 illustrates a three year net present value calculation.

$$\text{Net Present Value} = \frac{+100}{(1 + 10)^{1}} + \frac{-100}{(1 + 10)^{2}} + \frac{-11.05}{(1 + 10)^{3}} \qquad (5.1)$$

$$\text{Net Present Value} = 90.90 - 82.60 - 8.30 = 0 \qquad (5.2)$$

The zero net present value is interpreted as a rate of return on investment equal to the discount rate, ten percent. If the interest charge option of the simulation model is used, year two cash flow would be credited with six dollars interest paid, and the $100 excess from year one would be used to meet the year two deficit. In determining present value of an investment, an investor pays for a positive cash flow value and is compensated for a negative one. Presumably, if all flows are negative, he receives current money (equity capital) based on the discount rate to meet future flows as they occur. Thus, traditional net present value analysis assumes that negative annual cash flows are met by utilizing equity capital.

The simulation program used in the study, assumes that equity capital is not available. An alternative assumption is the the owner of the equity capital requires additional interest on his money from the time he pays it out. The debt is not repaid in the net present value analysis but, of course, is added to liabilities in the net worth analysis. Inclusion of these cash flows in the determination of net present value is an option of the capital investment simulation model. The large proposed size firm with base assumptions is used to illustrate the net effects of this option.

Run 10 in Table XXIII, has the same values of sensitivity variables as number 1, the base situation. However, results of run 10 do not include the interest charged on borrowed funds or interest paid on annual cash surpluses. Expected ending net worth for run 10 is \$1,576,870, while the base situation expected ending net worth is \$1,315,789. The maximum values of ending net worth are approximately equal, but minimum ending net worth for situation 10 is \$1,100,926, compared to \$419,231 for the base situation. Replications which yield low ending net worth due to unfavorable price and yield combinations must borrow large amounts of funds to meet cash flow deficits. The replication that generated the minimum net worth, \$419,231, borrowed \$1,775,119 during the 20 year planning horizon to meet deficit annual cash flow. Excluding interest paid and received from annual cash flow increased the expected net present value from \$231,732 to \$300,191.

Figure 10 illustrates the cumulative probability of net present value. For a \$133,000 present value, the probability of a worse net present value is eight percent when cash flows are not adjusted. Inclusion of those cash flows indicates a 35 percent chance of a worse net present value. Omission of these cash flows, given other conditions unchanged, will underestimate extremely good and bad financial outcomes.

Annual net cash flow of the base and no cash flow adjustment situations are presented in Table XXXVII. Given no cash flow adjustment, expected cash flow is less negative than the base situation. Standard deviation and coefficient of variation are slightly larger for the no cash flow adjustment situation. Table XXXVIII lists current and real ending net worth. No cash flow adjustment increases expected real ending net worth from \$329,444 to \$491,696.

TABLE XXXVI

ENDING NET WORTH AND NET PRESENT VALUE FOR SENSITIVITY ANALYSIS OF INTEREST CHARGED AND PAID

Run	Description	Min	Mean	Max	Std. Dev.	Coeff. Variation
				Net Worth		
1	Base	419,231	1,315,789	2,206,397	406,306	30.87
10	No Cash Flow Adjustment	1,100,926	1,576,870	2,220,530	224,364	14.22
				Net Present Value		
1	Base	- 289,129	206,419	691,597	208,897	101.20
10	No Cash Flow Adjustment	38,946	300,191	598,592	117,505	39.14

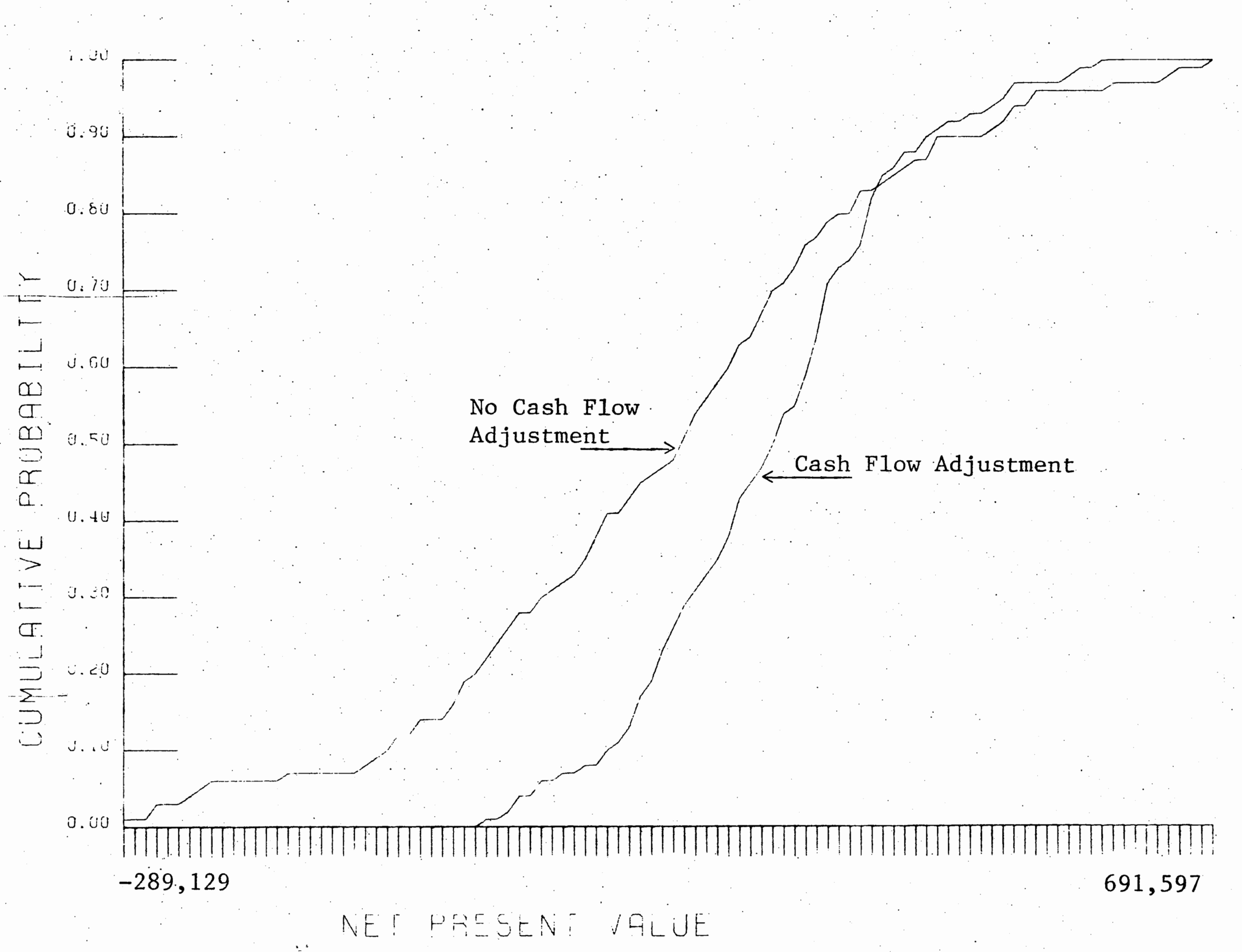

Figure 10. Cumulative Probability Distribution of Net Present Value for the Simulation Experiments With and Without Cash Flow Adjustment

TABLE XXXVII

ANNUAL NET CASH FLOW COMPARISONS OF THE EFFECTS OF CHARGING INTEREST ON FUNDS BORROWED TO MEET CASH FLOW DEFICITS AND INTEREST PAID ON ANNUAL CASH SURPLUSES

	Large Proposed Size Firm					Large Size Proposed Firm, No Cash Flow Adjustment				
Year	Min	Mean	Max	Std Deviation	Coeff Var	Min	Mean	Max	Std Deviation	Coeff Var
1	-123,529	- 11,569	65,918	49,833	- 430.73	-123,529	- 11,569	65,918	49,833	- 430.73
2	-137,361	- 4,321	63,059	47,084	-1,089.59	-128,349	- 3,140	63,914	46,302	- 1,474.26
3	-126,100	- 1,098	81,324	51,295	-4,670.96	-129,887	256	79,659	51,146	19,976.29
4	-161,221	7,765	82,283	50,594	651.53	-161,795	9,166	87,137	50,240	548.29
5	-138,263	- 21,650	80,374	50,479	- 233.16	-131,488	- 20,333	78,155	69,714	- 244.49
6	-147,642	- 17,224	66,807	51,555	- 299.32	-151,931	- 14,828	73,209	50,569	- 341.03
7	-161,026	- 35,612	54,090	55,432	- 155.65	-155,237	- 32,167	59,564	54,089	- 168.15
8	-191,294	- 45,534	75,159	66,497	- 146.04	-187,758	- 39,515	75,114	64,891	- 164.22
9	-192,677	- 55,905	42,730	58,536	- 104.71	-170,401	- 46,729	45,238	55,552	- 118.88
10	-205,717	- 61,879	53,187	63,326	- 102.34	-183,185	- 49,532	51,593	59,344	- 119.81
11	-198,069	- 40,561	58,584	63,425	- 156.37	-190,917	- 25,777	72,051	57,914	- 224.67
12	-226,115	- 34,857	71,414	63,666	- 182,65	-191,250	- 18,521	73,803	56,549	- 305.32
13	-208,825	- 33,028	65,975	63,421	- 192.02	-202,495	- 16,160	68,510	55,903	- 345.93
14	-262,699	- 39,712	68,095	66,033	- 166.28	-236,018	- 21,462	74,002	60,760	- 283.10
15	-286,154	- 48,237	50,448	73,310	- 151.98	-236,939	- 27,743	60,618	65,855	- 327.38
16	-230,183	- 30,642	79,465	67,232	- 219.41	-187,896	- 5,493	91,530	61,503	- 1,119.50
17	-251,279	- 43,075	87,541	83,234	- 193.23	-195,839	- 15,445	91,734	70,047	- 453.51
18	-219,565	- 64,199	77,921	78,635	- 122.49	-184,516	- 30,735	87,675	67,361	- 219.17
19	-262,255	- 82,449	80,574	87,292	- 105.87	-218,469	- 45,685	80,150	78,140	- 171.04
20	-334,009	-202,329	-135,452	38,972	- 19.26	-268,321	-186,008	-122,969	30,342	- 16.31
Salvage Value			$2,254,457.00					$2,254,457.00		

TABLE XXXVIII

CURRENT AND REAL ENDING NET WORTH FOR THE SENSITIVITY ANALYSIS OF INTEREST CHARGED AND PAID

Run	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4% Annual Inflation	Real Ending Net Worth 6% Annual Inflation
1	326,582	1,315,789	600,542	410,286
10	326,582	1,576,870	719,703	491,696

Sensitivity of Investment Success to Capital Gain Taxes

Capital gain tax is a tax liability that must be paid when a capital asset is sold for an amount greater than its cost basis. If certain requirements are met, this liability can be postponed or passed to the next generation. However, if the decision maker is considering alternative investments or comparing the net worth or net value of an estate based on an investment decision, then capital gain tax liability should be considered.

Simulation experiments designed to illustrate the effect of capital gain tax liability are listed in Table XVIII, run 1 and 11. Number 1 is the base situation, land appreciation rate is six percent and capital gain taxes are paid. Simulation experiment number 11 does not have capital gain tax liability subtracted from cash flow and net worth. Table XXXIX lists ending net worth and net present value for these two situations. Minimum, mean, and maximum net worth for the no capital gain tax situation exceeds base net worth values by $8,025, $40,531, and $78,114, respectively. Standard deviation and coefficient of variation are approximately equal. Net present values are larger (less negative) for the no capital gain tax situation.

Figure 11 presents the cumulative probability distribution for net present value. The net present value is overestimated throughout the range of financial outcomes when capital gain tax is not considered. Table XL presents annual net cash flow for the base and no capital gain tax situations. Annual net cash flows are exactly equal except in the 20th year. For the minimum cash flow replication, other cash flow was sufficiently negative to offset capital gain income and thus no tax liability exists. Capital gain tax increased the expected cash flow deficit from -$161,013 to -$202,329. The maximum value of cash flow deficit increased from -$37,136 to -$135,452. Table XLI indicates that failing to consider capital gain tax would increase estimated real net worth from $410,286 to $422,924. Given a six percent land appreciation rate, average or expected capital gain tax liability is $40,000.

Simulation experiments number 9 and 13, Table XXIII, can be used to compare the effects of capital gain taxes assuming a 12 percent land appreciation rate. Table XLII presents ending net worth and net present value for the capital gain tax simulations with 12 percent land inflation. Payment of capital gain tax liability reduces ending expected net worth to $5,162,771 from $5,477,364. Expected net present value increased $314,593 by not considering capital gain tax. Table XLIII indicates

TABLE XXXIX

ENDING NET WORTH AND NET PRESENT VALUE OF THE SENSITIVITY ANALYSIS OF CAPITAL GAIN TAXES WITH 6 PERCENT LAND APPRECIATION RATE

Run	Description	Min	Mean	Max	Std. Dev.	Coeff. Variation
		Net Worth				
1	Large Proposed Size Firm - Base	419,231	1,315,789	2,206,397	406,306	30.87
11	Capital Gain Tax Low Inflation	427,436	1,356,320	2,284,516	419,771	30.94
		Net Present Value				
1	Large Proposed Size Firm - Base	- 289,129	206,419	691,597	208,897	101.20
11	Capital Gain Tax Low Inflation	- 270,898	216,146	709,987	211,837	97.98

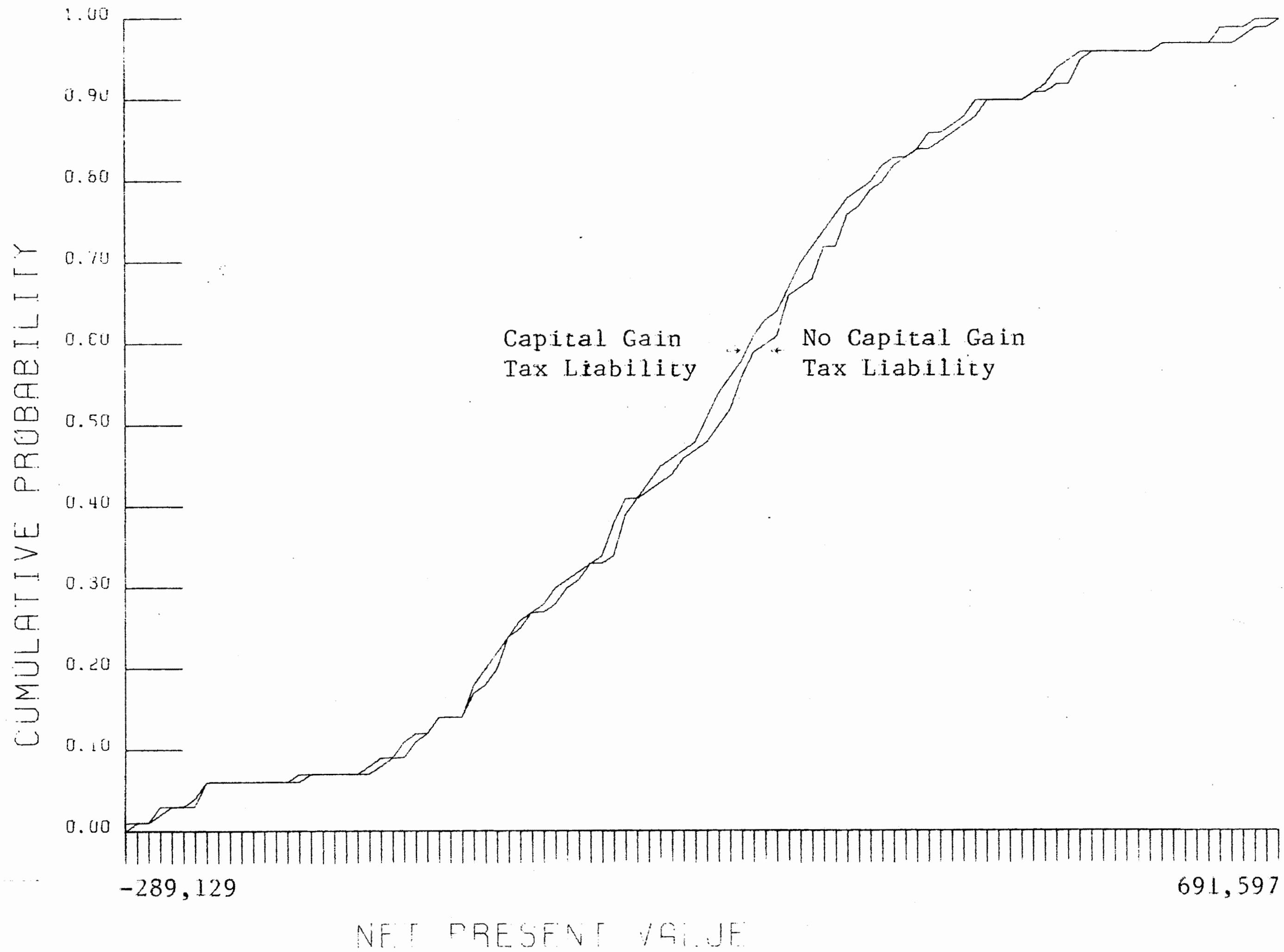

Figure 11. Cumulative Probability Distributions of Net Present Value of Simulation Experiments With and Without Capital Gain Tax and 6% Land Appreciation

TABLE XL

ANNUAL NET CASH FLOW COMPARISONS OF THE EFFECTS OF CAPITAL GAIN TAX WITH 6 PERCENT LAND APPRECIATION RATE

Year	Number 1 Large Proposed Size Firm With Capital Gain Tax					Number 11 Large Proposed Size Firm, No Capital Gain				
	Minimum	Mean	Maximum	Std Deviation	Coeff Var	Minimum	Mean	Maximum	Std Deviation	Coeff Var
1	-123,529	- 11,569	65,918	49,833	430.73	-123,529	- 11,569	65,918	49,833	430.73
2	-137,361	- 4,321	63,059	47,084	1,089.59	-137,361	- 4,321	63,059	47,084	1,089.59
3	-126,100	- 1,098	81,324	51,295	4,670.96	-126,100	- 1,098	81,324	51,295	4,670.96
4	-161,221	7,765	82,283	50,594	651.53	-161,221	7,765	82,283	50,594	651.53
5	-138,263	- 21,650	80,374	50,479	233.16	-138,263	- 21,650	80,374	50,479	233.16
6	-147,642	- 17,224	66,807	51,555	299.32	-147,642	- 17,224	66,807	51,555	299.32
7	-161,026	- 35,612	54,090	55,432	155.65	-161,026	- 35,612	54,090	55,432	155.65
8	-191,294	- 45,534	75,159	66,497	146,04	-191,294	- 45,534	75,159	66,497	146.04
9	-192,677	- 55,905	42,730	58,536	104.71	-192,677	- 55,905	42,730	58,536	104.71
10	-205,717	- 61,879	53,187	63,326	102.34	-204,717	- 61,879	53,187	63,326	102.34
11	-198,069	- 40,561	58,584	63,425	156.37	-198,069	- 40,561	58,584	63,425	156.37
12	-226,115	- 34,857	71,414	63,666	182.65	-226,115	- 34,857	71,414	63,666	182.65
13	-208,825	- 33,028	65,975	65,975	192.02	-208,825	- 33,028	65,975	63,421	192.02
14	-262,699	- 39,712	68,095	66,033	166.28	-262,699	- 39,712	68,095	66,033	166.28
15	-286,154	- 48,237	50,448	73,310	151.98	-286,154	- 48,237	50,448	73,310	151.98
16	-230,183	- 30,642	79,465	67,232	219.41	-230,183	- 30,642	79,465	67,232	219.41
17	-251,279	- 43,075	87,541	83,234	193.23	-251,279	- 43,075	87,541	83,234	193.23
18	-219,565	- 64,199	77,921	78,635	122.49	-219,565	- 64,199	77,921	78,635	122.49
19	-262,255	- 82,449	80,574	87,292	105.87	-262,255	- 82,499	80,574	87,292	105.87
20	-334,009	-202,329	-135,452	38,972	19.26	-334,009	-161,013	-37,136	69,554	43.14
Salvage Value			$2,254,457.00					$2,254,457.00		

the difference in annual net cash flow in the last year due to capital gain tax. Cash flow increases for the minimum, mean, and maximum value of net cash flow are $169,092, $319,204, and $386,790, respectively. Doubling the rate of land appreciation more than tripled the capital gain tax liability. Real growth in expected net worth increased from $1,609,884 to $1,707,940, Table XLIV.

TABLE XLI

CURRENT AND REAL NET WORTH FOR THE SENSITIVITY ANALYSIS OF CAPITAL GAIN TAXES WITH 6 PERCENT LAND APPRECIATION RATE

Run	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4% Annual Inflation	Real Ending Net Worth 6% Annual Inflation
1	326,582	1,315,789	600,542	410,286
11	326,582	1,356,320	619,041	422,924

Effects of One Percent Land Loan Interest on Investment Success

A previous section of this chapter illustrated the effects of interest rate on investment success. The sensitivity analysis in this section demonstrates the effect of alternative interest rates for only

TABLE XLII

ENDING NET WORTH AND NET PRESENT VALUE OF THE SENSITIVITY ANALYSIS OF CAPITAL GAIN TAXES WITH 12 PERCENT LAND APPRECIATION RATE

Run	Description	Min	Mean	Max	Std. Dev.	Coeff. Variation
		Net Worth				
9	High Land Appreciation Rate	4,255,129	5,162,771	6,173,600	418,733	8.11
13	Capital Gain Tax High Inflation	4,548,480	5,477,364	6,405,561	419,771	7.66
		Net Present Value				
9	High Land Appreciation Rate	617,632	1,115,607	1,598,470	208,063	18.65
13	Capital Gain Tax High Inflation	703,709	1,190,753	1,684,594	211,837	17.79

TABLE XLIII

ANNUAL NET CASH FLOW COMPARISONS OF THE INFLUENCE OF CAPITAL GAIN TAXES WITH 12 PERCENT LAND APPRECIATION RATE

	Number 9 High Land Appreciation Rate with Capital Gain Tax					Number 13 No Capital Gain Tax, High Inflation				
Year	Mimimum	Mean	Maximum	Std Deviation	Coeff Var	Minimum	Mean	Maximum	Std Deviation	Coeff Var
1	-123,529	- 11,569	65,918	49,833	430.73	-123,529	- 11,569	65,918	49,833	430.73
2	-137,361	- 4,321	63,059	47,084	1,089.59	-137,361	- 4,321	63,059	47,084	1,089.59
3	-126,100	- 1,098	81,324	51,295	4,670.96	-126,100	- 1,098	81,324	51,295	4,670.96
4	-161,221	7,765	82,283	50,594	651.53	-161,221	7,765	82,283	50,594	651.53
5	-138,263	- 21,650	80,374	50,479	233.16	-138,263	- 21,650	80,374	50,479	233.15
6	-147,642	- 17,224	66,807	51,555	299.32	-147,642	- 17,224	66,807	51,555	299.32
7	-161,026	- 35,612	54,090	55,432	155.65	-161,026	- 35,612	54,090	55,432	155.65
8	-191,294	- 45,534	75,159	66,497	146.04	-191,294	- 45,534	75,159	66,497	146.03
9	-192,677	- 55,905	42,730	58,536	104.71	-192,677	- 55,905	42,730	58,536	104.70
10	-205,717	- 61,879	53,187	63,326	102.34	-205,717	- 61,879	53,187	63,326	102.33
11	-198,069	- 40,561	58,584	63,425	156.37	-198,069	- 40,561	58,584	63,425	156.37
12	-226,115	- 34,857	71,414	63,666	182.65	-226,115	- 34,857	71,414	63,666	182.64
13	-208,825	- 33,028	65,975	63,421	192.02	-208,825	- 33,028	65,975	63,421	192.01
14	-262,699	- 39,712	68,095	66,033	166.28	-262,699	- 39,712	68,095	66,033	166.28
15	-286,154	- 48,237	50,448	73,310	151.98	-286,154	- 48,237	50,448	73,310	151.97
16	-230,183	- 30,642	79,465	67,232	219.41	-230,183	- 30,642	79,465	67,232	219.41
17	-251,279	- 43,075	87,541	83,234	193.23	-251,279	- 43,075	87,541	83,234	193.22
18	-219,565	- 64,199	77,921	78,635	122.49	-219,565	- 64,199	77,921	78,635	122.45
19	-262,255	- 82,449	80,574	87,292	105.87	-262,255	- 82,449	80,574	87,292	105.87
20	-530,101	-480,217	-423,926	24,540	5.11	-334,009	-161,013	- 37,136	69,454	43.13
Salvage Value			$6,375,417.00					$6,375,417.00		

the land loan. One percent interest rates for the land loan are not realistic, but may reflect equity or downpayment ability. Sensitivity experiment numbers 1, 12, and 14, Table XXIII, representing the large proposed size firm, the large proposed size firm with one percent loan interest rate, and the large current size firm which has no land loan are used in the analysis.

TABLE XLIV

CURRENT AND REAL ENDING NET WORTH FOR THE SENSITIVITY ANALYSIS OF CAPITAL GAIN TAXES WITH 12 PERCENT LAND APPRECIATION RATE

Run	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4% Annual Inflation	Real Ending Net Worth 6% Annual Inflation
9	326,582	5,162,771	2,356,353	1,609,844
13	326,582	5,477,364	2,499,937	1,707,940

Table XLV lists a comparison of ending net worth and net present value for 8.5 and one percent loan interest rates. A loan interest rate of one percent increases expected ending net worth from $1,315,789 to $1,491,136.

Annual net cash flows for these simulation experiments are listed in Table XLVI. As expected, one percent loan interest yields less

TABLE XLV

ENDING NET WORTH AND NET PRESENT VALUE FOR THE SENSITIVITY ANALYSIS OF ONE PERCENT LOAN INTEREST RATE

Run	Description	Min	Mean	Max	Std. Dev.	Coeff. Variation
		Net Worth				
14	Large Current Size Firm	356,629	1,189,289	2,021,388	372,937	31.35
1	Large Proposed Size Firm	419,231	1,315,789	2,206,397	406,306	30.87
12	One Percent Loan Interest	640,639	1,491,136	2,314,713	380,764	25.53
		Net Present Value				
14	Large Current Size Firm	-198,276	231,732	666,942	187,050	80.71
1	Large Proposed Size Firm	-289,129	206,419	691,597	208,897	101.20
12	One Percent Loan Interest	-185,235	287,608	736,182	194,868	67.75

TABLE XLVI

ANNUAL NET CASH FLOW COMPARISONS OF THE LARGE CURRENT SIZE FIRM AND LARGE PROPOSED SIZE FIRM WITH 8.5 AND ONE PERCENT LOAN INTEREST RATES

	NUMBER 1 LARGE PROPOSED SIZE FIRM 8.5% LOAN INTEREST RATE					NUMBER 14 LARGE CURRENT SIZE FIRM					NUMBER 12 12% LAND APPRECIATION RATE AND 1% LOAN INTEREST RATE				
Year	Min	Mean	Max	Std Deviation	Coeff Var	Min	Mean	Max	Std Deviation	Coeff Var	Min	Mean	Max	Std Deviation	Coeff Var
1	-123,529	- 11,569	65,918	49,833	430.73	-104,473	- 5,625	63,292	43,762	777.93	-116,595	- 7,030	66,223	47,671	678.04
2	-137,361	- 4,321	63,059	47,084	1,089.59	-116,421	1,193	61,509	41,471	3,474.47	-129,838	50.57	63,403	44,498	87,984
3	-126,100	- 1,098	81,324	51,295	4,670.96	-106,446	4,435	78,541	45,356	1,022.68	-118,956	3,280	81,321	48,494	1,478
4	-161,221	7,765	82,283	50,594	651.53	-137,880	12,355	79,157	45,028	365.03	-153,411	11,937	82,638	47,870	400.99
5	-138,263	- 21,650	80,374	50,479	233.16	-117,132	- 13,810	78,193	44,754	324.06	-129,360	- 15,742	80,886	47,937	304.50
6	-147,642	- 17,224	66,807	51,555	299.32	-124,559	- 8,954	66,268	45,460	508.21	-139,406	- 11,508	68,338	49,052	426.23
7	-161,026	- 35,612	54,090	55,432	155.65	-135,731	- 24,923	55,041	48,980	196.52	-150,993	- 28,443	56,532	53,104	186.69
8	-191,294	- 45,534	75,159	66,497	146.04	-162,431	- 33,312	74,269	59,175	177.63	-181,140	- 37,331	74,898	64,313	172.27
9	-192,677	- 55,905	42,730	58,536	104.71	-163,453	- 42,390	44,477	51,795	122.19	-180,498	- 46,827	43,421	56,482	120.61
10	-205,717	- 61,879	53,187	63,326	102.34	-174,343	- 47,343	54,189	56,011	118.31	-194,423	- 52,148	55,783	61,095	117.14
11	-198,069	- 40,561	58,584	63,425	156.37	-165,964	- 27,694	61,491	55,922	201.92	-186,097	- 31,110	63,206	60,472	193.69
12	-226,115	- 34,857	71,414	63,666	182.65	-190,883	- 22,043	72,200	56,291	255.36	-212,726	- 25,224	71,214	60,356	239.28
13	-208,825	- 33,028	65,975	63,421	192.02	-175,548	- 20,527	66,522	55,742	271.55	-195,455	- 23,337	69,520	59,783	256.16
14	-262,699	- 39,712	68,095	66,033	166.28	-223,316	- 25,980	69,660	58,063	223.49	-247,011	- 29,008	71,131	62,584	215.74
15	-286,154	- 48,237	50,443	73,310	151.98	-243,762	- 33,155	54,562	64,617	194.89	-269,644	- 36,725	56,172	69,833	190.15
16	-230,183	- 30,642	79,465	67,232	219.41	-189,889	- 13,078	84,371	59,365	453.93	-212,883	- 16,885	84,932	64,307	380.83
17	-251,279	- 43,075	87,541	83,234	193.23	-206,066	- 23,292	91,971	73,682	316.34	-232,597	- 28,466	93,024	79,824	280.41
18	-219,565	- 64,199	77,921	78,635	122.49	-180,011	- 40,742	85,840	69,943	171.67	-200,758	- 47,185	86,830	76,306	161.71
19	-262,255	- 82,449	80,574	87,292	105.87	-216,213	- 56,312	88,648	77,206	137.10	-239,017	- 64,601	88,671	84,709	131.53
20	-334,009	-202,329	-135,452	38,972	19.26	-290,978	-136,343	-27,947	61,148	44.85	-311,713	-190,773	-126,885	35,547	18.63
Salvage Value		$2,254,457.00					$1,843,961.00					$2,254,457.00			

negative mean cash flow than 8.5 percent loan interest. Lower interest rate improves cash flow, however, marginal land investment does not generate positive cash flow. When compared to the current firm, investment even with one percent loan interest generates more negative annual net cash flow. Table XLVII presents current and real ending net worth. One percent loan interest increases expected real ending net worth from \$410,286 to \$464,962. Expected real ending net worth for the current size firm is \$370,841.

TABLE XLVII

CURRENT AND REAL ENDING NET WORTH FOR THE SENSITIVITY ANALYSIS OF ONE PERCENT LOAN INTEREST RATE

Run	Beginning Net Worth	Ending Current Net Worth	Real Ending Net Worth 4% Annual Inflation	Real Ending Net Worth 6% Annual Inflation
14	326,582	1,189,289	542,806	370,841
1	326,582	1,315,789	600,542	410,286
12	326,582	1,491,136	680,513	464,962

Summary

Measures of profitability, solvency, liquidity, and firm survival for the sensitivity experiments provide estimates of the net effects of selected variables on firm success. Reducing interest rate or increasing product price trends relative to production cost trends have a positive influence on ending net worth and net present value. The land appreciation rate directly influenced annual net worth and greatly effected net present value. Land appreciation influenced annual net cash flow only in the last year. As land inflation rate increased, capital gain tax liability increased in the last year. Zero land appreciation resulted in firm financial failure 65 of the 100 replications.

Adjustment of annual cash flow for interest on operating capital and interest paid on surplus annual cash flow decreases expected net worth and net present value but increases the standard deviation and coefficient of variation of each. Consideration of capital gain tax liability reduced expected ending net worth less than $30,000 when the land appreciation rate was six percent. However, a 12 percent growth in in land values caused an expected capital gain tax liability of more than $300,000.

A one percent loan interest generated an expected net worth which was greater for the land purchase alternative than the current size firm. In general, any change in interest rate or the relationship of product price trends and production cost trends that increases the profitability of the firm also reduces the variation in net present value, net worth, and annual cash flow. Increasing the profitability of the firm increases financial reserves and flexibility.

CHAPTER VI

SIMULATION RESULTS--BREAKEVEN ANALYSIS

How much can I pay for this land? Agricultural decision makers ask this question every day. How much a decision maker can pay for land depends on the land purchase price, projected income and expenses, net worth, financial flexibility, repayment capacity, and willingness of the buyer to accept risk. The decision maker's current financial situation is known and this information should be utilized to help determine maximum possible bid price. Future income and expense are difficult to accurately predict, thus most investment decision models assume future cash flows to be fixed or increase at a constant annual percent. The decision maker needs to know what he can pay for land given his financial situation and his estimates of future yield and price variation in a probabilistic framework.

Analytical Method

Results presented in this chapter are based on a modification of the internal rate of return method of evaluating capital investments. In the process used here, the bid or purchase price of the investment is iteratively adjusted until the additional discounted cash benefits and costs are equal, net present value of the added investments is zero. The resulting purchase price is the price a decision maker can pay and expect a rate of return on investment equal to the discount rate. However, this price may not be feasible based on cash flow and debt capacity. The internal rate of return method, explained in detail in Chapter II, iteratively adjusts the discount rate until the discounted cash benefits and costs equal zero. Given a fixed bid price, the discount rate represents expected return on an initial investment.

Given certain restrictive assumptions, the bid price that yields a zero net present value can be obtained by algebraically adding the net present value obtained in the conventional net present value analysis to the existing bid price. If the purchase price were $10,000 and the annual income $7,000 and the annual expense $5,000 for a five year investment, the resulting net present value is $3,791.13. The bid price which yields zero net present value would be $13,791.13. This procedure is valid only if the after tax interest rate on the investment equals the discount rate, and, if the addition to bid price is not financed, but is down payment. If the investment price were raised to $13,791.13, the down payment were $3,791.13, and, the salvage value were assumed constant, net present value would be zero. In this example, the marginal tax rate is constant at 25 percent, the loan interest rate is eight percent, and the discount rate is six percent.

Lee (1976) presents a mathematical equation which can be solved for the maximum possible bid price given the discount rate and deterministic net returns per acre. This method avoids the previously described restrictive assumptions of equal after-tax interest rate and discount rate. The basic disadvantages of this procedure include a fixed marginal tax rate, and net returns that are constant or increased by a constant annual percentage.

Results presented here assume stochastic prices and yields based on the subjective parameter estimates of prices and yields in Table V. Also, the actual tax rate is determined by total taxable income. Thus, the maximum bid prices based on these assumptions will not be equal to the calculated net present value plus the original bid price.

In the previous chapter, desirability of a proposed land purchase was evaluated based on ending net worth, net present value, annual cash flow, and measures of firm survival. These measures are based on repeated Monte Carlo trials (in this case, 100) which allow variation in cash benefits and costs through random sampling of subjective probability distributions of product prices and yields. Assuming a 20 year planning horizon for the decision maker, one Monte Carlo trial has associated with it 20 years of random product prices and yields. To reduce the number of breakeven analyses, net present values for all 100 trials were ranked from smallest to largest. A breakeven bid price was estimated for the Best, 10th Best, Middle, 10th Worst, and Worst trials.

A solution procedure suited to the nonlinear, stochastic nature of the problem is needed to adjust the bid or purchase price until the discounted cash benefits equal discounted cash costs. Kuester and Mize (1973) provide, among others, the Fibonacci algorithm which minimizes nonlinear, single variable objective functions. This algorithm is an interval elimination search method that when given initial boundaries for the independent variable, bid price, will reduce the interval which contains the optimal value of net present value, to a desired level of accuracy. Optimum net present value represents the net present value of the current firm. The proposed investment which includes the additional land purchase may yield a higher or lower net present value than that of the current operating unit. When additional land is added, the decision maker may want to know the bid price which yields a zero net present value for the new investment. This bid price can be determined by iteratively adjusting bid price for the proposed size firm until the net present value is equal to that of the current size firm. If the net present value of the proposed firm is greater than the current size firm, the decision maker can pay more than the $800 bid price used in the simulation and be in a financial position equal to his current situation. Specific details of the Fibonacci procedure were explained in Chapter II.

Breakeven Bid Prices

Simulation results from the large proposed size firm are used in the breakeven analysis. The largest net present value of the 100 repetitions of that simulation experiment was $691,597. The stochastic prices and yields associated with that replication, Table XLVIII, were used with a modified version of the simulation model, explained in Chapter III, to solve for the desired net present value. The Fibonacci main program iteratively calls the modified simulation model as a subroutine. Bid price is passed from the main program to the subroutine and the subroutine passes the net present value back to the main program for comparison. Column one of Table IL, lists the values of bid price and net present value for the current firm, the proposed size firm, and the breakeven analysis. The original bid price of $138,000 generated a $691,597 net present value under the best price and yield situation. Breakeven bid price for this best price and yield situation is $156,772 to leave a net present value of $666,942, the net present value of the current firm. This bid price indicates that the decision maker could pay $975 per acre

TABLE XLVIII

PRICES AND YIELDS FOR THE BEST AND WORST INCOME AND EXPENSE SITUATION

Year	Stocker Cattle Gain Rate	Wheat Yield	November Stocker Cattle Purchase Price	March Stocker Cattle Sales Price	Wheat Sales Price
Best Income and Expense Situation					
1	1.88	51.89	51.02	44.15	2.73
2	1.74	47.58	64.06	53.09	2.66
3	2.08	42.36	63.76	58.51	2.51
4	2.88	52.53	68.82	57.63	2.63
5	1.29	51.82	64.02	55.65	2.32
6	2.09	25.55	62.59	53.33	2.84
7	2.24	19.65	50.36	42.97	2.62
8	2.02	28.84	47.85	41.36	3.02
9	1.59	51.27	56.60	45.95	3.01
10	2.16	41.43	59.35	52.62	3.06
11	1.25	19.61	67.93	60.21	3.34
12	1.69	40.49	71.95	58.86	3.65
13	1.76	25.66	71.89	62.51	2.88
14	2.59	17.62	75.97	68.23	2.90
15	2.35	49.99	72.44	64.68	3.05
16	2.32	36.97	67.54	62.02	3.45
17	2.05	25.34	62.13	55.43	3.29
18	1.35	47.96	70.40	56.26	4.05
19	1.97	36.52	63.56	53.49	3.91
20	1.38	39.74	70.18	63.02	2.94
Worst Income and Expense Situation					
1	1.81	24.24	51.28	44.43	2.71
2	1.86	10.94	57.94	50.87	2.69
3	1.54	24.28	62.11	55.24	2.89
4	2.03	52.34	66.24	59.56	2.46
5	1.40	8.37	63.61	54.71	2.78
6	1.27	19.42	62.08	52.85	2.79
7	1.42	37.17	55.29	48.25	2.64
8	0.75	24.13	51.10	45.12	2.52
9	1.64	7.81	53.82	45.95	2.90
10	1.70	19.29	58.46	50.11	2.72
11	1.17	27.27	63.80	56.70	2.64
12	2.63	37.36	76.71	67.42	3.10
13	1.37	16.02	74.49	65.43	3.40
14	2.61	52.46	79.11	67.55	3.41
15	2.58	34.37	76.90	71.88	2.97
16	2.48	25.36	72.19	64.21	3.48
17	1.85	35.22	67.22	55.05	3.73
18	1.44	37.07	67.26	54.64	4.00
19	1.97	28.20	68.86	58.09	4.05
20	2.53	49.81	65.08	55.79	3.71

TABLE IL

BREAKEVEN LAND BID PRICES FOR SPECIFIED PRICE AND YIELD COMBINATIONS, LARGE PROPOSED SIZE FIRM

	Best Net Present Value		90% Chance of Worse Net Present Value		50% Chance of Worse Net Present Value		10% Chance of Worse Net Present Value		Worst Net Present Value	
Description	Bid Price Per Acre	Net Present Value	Bid Price Per Acre	Net Present Value	Bid Price Per Acre	Net Present Value	Bid Price Per Acre	Net Present Value	Bid Price Per Acre	Net Present Value
Current Size Firm	0.0	666,942	0.0	445,590	0.0	257,500	0.0	72,631	0.0	-198,276
Proposed Size Firm	800.0	691,597	800.0	449,778	800.0	229,208	800.0	27,099	800.0	-289,129
Breakeven Analysis	975.0	666,942	883.1	445,590	764.5	257,500	692,7	72,631	558.6	-198,276

and yield a return on investment equal to his return if he had not purchased the land. He could only pay that price under the best set of events, a one in 100 chance. Solution of this problem required 32 seconds of computer time.

Breakeven bid prices were also obtained for the stochastic price and yield combinations which generated the tenth highest, the median, and worst or most negative net present values. These results are presented in Table IL, columns 2, 3, and 4, respectively. Prices and yields that generated the worst net present value, -$289,129, are listed in Table XLVIII. The breakeven land value of land bid price is $558 per acre. Since the current firm generated a less negative, -$198,129, net present value, the decision maker must pay less than $800 per acre to be financially equivalent to his current no land purchase situation. However, this most negative net present value situation is infeasible based on cash flow and debt capacity.

The median net present value is $257,500, given the original $138,000 bid price. When bid price is iteratively reduced to $122,325, the resulting net present value is $229,208. The tenth highest net present value is $449,778. For the 100 replications of this simulation experiment, ten were higher and 90 were lower. Thus, there is a 90 percent chance of a worse net present value. Results in Column 2 of Table IL, indicate the decision maker could pay $141,296 or $883 per acre for the land and have a ten percent chance of a net present value as great as his current situation. Given the price and yield parameters in Table V, the decision maker has a 90 percent chance of a worse net present value. A safety first type decision rule would be to bid so that there is a 90 percent chance of a positive net present value. One run was analyzed under a possible bright future for agriculture. The following breakeven price analysis shows the results as a prospective land bidder might analyze it.

Breakeven Analysis Under Favorable Prospects for Agriculture

Using the largest net present value, breakeven bid price was calculated for the small and medium proposed size firms. The operator of the small size firm could pay $995 per acre while the medium size firm could support a $1,384 per acre bid price. The large size firm could bid $1,547 per acre. These differences are due to the machinery complement size, firm equity, and off-farm employment for the three firms. In each case net present value is zero. In general, if decision makers are willing to utilize the profitability of their current firm to subsidize the proposed investment, larger firms can feasibly pay more for land due to higher levels of equity and financial reserves.

Breakeven Analysis--Large Farm and Most Favorable Future

The final simulation breakeven experiment is based on the large proposed size firm, described in Chapter IV, with the following changes. Product price and production cost trends are both three percent. Annual stochastic wheat yield inflates two percent per year and stocker cattle gain rate increases one-half percent per year. Expected value of wheat yield increases from 33 bushels to 50.15 bushels per acre during the 20 year planning horizon. Average gain rate increases from 1.77 pounds per day to 2.07 pounds of gain per day.

One hundred repetitions of this simulation experiment generated an expected net present value of $644,187. The minimum value, $229,836, and maximum value, $1,030,251, indicated the range of possible outcomes. Table L presents the bid price and net present value for specified price and yield combinations.

The best net present value, $1,030,251, was generated by a unique set of prices and yields. Bid price is iteratively increased until net present value is approximately equal to the net present value of the current size operating unit, $973,765. The decision maker in this best situation could pay $1,196 per acre and receive a return on investment equal to his current rate of return. However, there is only one chance in 100 of this best result.

The worst net present value, $229,836, is presented in column 5 of Table L. A $717 bid price for land results in $276,128 net present value, given the worst price and yield combination. Like the best situation, there is only a one percent chance of the worst financial outcome.

The price and yield combination which generated the 90th net present value, produced a breakeven bid price of $789 per acre. The decision maker could pay this price and have only a ten percent chance of a net present value less than his current operation. The breakeven bid price, given a 90 percent chance of negative net present value, is $1,053 per acre. If the decision maker is willing to accept a 50 percent chance of negative net present value, he can pay $920 per acre. Given this range of financial outcomes, the decision maker can bid for land based on his willingness to accept risk of a negative net present value.

Similar results could be obtained for each of the 100 sets of prices and yields. However, cost may prohibit such an extensive analysis. By

TABLE L

BREAKEVEN LAND BID PRICES FOR SPECIFIED PRICE AND YIELD COMBINATIONS GIVEN A PROFITABLE SITUATION IN AGRICULTURE

	Best Net Present Value		90% Chance of Worse Net Present Value		50% Chance of Worse Net Present Value		10% Chance of Worse Net Present Value		Worst Net Present Value	
Description	Bid Price Per Acre	Net Present Value	Bid Price Per Acre	Net Present Value	Bid Price Per Acre	Net Present Value	Bid Price Per Acre	Net Present Value	Bid Price Per Acre	Net Present Value
Current Size Firm	0.0	973,766	0.0	796,427	0.0	633,440	0.0	452,836	0.0	267,128
Proposed Size Firm	800.0	1,030,251	800.0	832,868	800.0	645,643	800.00	440,744	800.0	229,836
Breakeven Analysis	1,196.9	973,766	1,053.1	796,427	920.4	633,440	789.4	452,836	717.7	267,128

analyzing the best, worst, and selected price and yield situations, decision makers can be given additional information to help make investment decisions. The variation in prices and yields is based on the subjective estimates of the minimum, most likely, and maximum expected values for prices and yields. Based on these estimates of price and yield variation, analysis of the best, worst, and the median or average situation provides a rough outline of the breakeven bid price distribution.

CHAPTER VII

MODEL APPLICATIONS IN AN EXTENSION SETTING

Previous chapters have discussed the theoretical concepts, the simulation model, the required input data, and the simulation results. The results reflect current and prospective land investment opportunities, given the data assumptions of the study. This chapter's purpose is to outline applications of the model in a research or extension setting. How can the simulation model be employed to aid farmers and bankers in real world decision? The model's flexibility in solving extension related problems will be examined.

At one extreme, the model can be executed as a marginal capital investment analysis tool using deterministic cash flows and a minimum of data. As illustrated in Chapters V and VI, the model can compare the results of the current firm size and the proposed firm size, utilizing stochastic prices and yields. Studies of the effects of alternative credit terms, government programs, and different enterprise combinations on stability and profitability of land investments are empirical research areas which will be proposed.

Current Extension Utilization of Investment Analysis Tools

Tools available to extension personnel which assist decision makers in evaluating proposed capital investments can be classified into three general categories:

1) Estimation of market value through capitalization of per unit net returns and analysis of comparable sales by hand methods.

2) Determination of the feasibility of investment using amortization schedules and cash flow analysis based on average returns and costs by hand methods.

3) Estimation of market value or ability to repay using discounted cash flow, net present value, or internal rate of return. Several computer routines are available.

Capitalization of Per Unit Net Returns

As explained in Chapter I, the most frequently used method of land valuation involves capitalization of a fixed annual net return using a predetermined discount or capitalization rate. This method assumes that net returns and the capitalization rate are constant throughout the planning horizon. It is also important to realize which costs are considered in determining net return. Usually the net return is not adjusted for land related principle and interest. Omission of this cost implies that the capitalized price could be paid only if the decision maker paid for the land with equity capital.

Cash Flow or Feasibility Analysis

Cash flow analysis is a practical method of evaluating feasibility of investments. Expected bid price can be amortized to determine required annual principle and interest payments. Enterprise cost and return budgets are available to estimate annual net returns. If net returns are sufficient to meet required cash flows, the investment is feasible. The analysis is based on a critical assumption of fixed product prices and yields throughout the planning horizon.

Comparative Investment Evaluation Based on Discounted Cash Flows

Two commonly used approaches are the net present value and internal rate of return methods. The Willett and Worth (1976) worksheet, explained in Chapter I, is representative of these methods. Effects of depreciable investments such as investment credit, 20 percent first year bonus depreciation and tax deductible depreciation are incorporated in a computer program developed by Nelson (1976). The Nelson program allows specification of income and expense for each year of the investment. Even recent procedures which reflect more of the factors that influence the desirability of a capital investment do not incorporate stochastic variation in net returns. The assumption of certain knowledge with respect to prices and yields for both the capitalization and discounted cash flow method has become less acceptable given recent variation in gross agricultural income.

Model Advantages for Extension Use

The simulation model described in Chapter III relaxes the limiting assumption of perfect knowledge of future prices and yields. Variation in these values can be specified by the decision makers. As a result of the accounting built into the model, the potential investor has a more accurate estimate of cash flow and credit needs because interest charged on annual operating capital or interest paid on surplus capital is considered. Breakeven analysis illustrated in the previous chapter answers the question: "How much can I pay for this land?" These estimates provide a range of bid prices and associated probability of a worse financial outcome.

Traditional net present value and internal rate of return methods of evaluating capital investments utilize only the cash benefits and costs associated with the proposed investment. These methods generate an estimate of the investment's profitability, based on net present value. The simulation model estimates the net worth, cash flow, and rate of firm survival utilizing input data from the current firm and proposed size firm. Whole firm analysis compares solvency, liquidity, and firm survival for the current firm before investment and the proposed size firm after the investment. This comparative analysis provides net effects of the investment based on the farmers financial situation and marginal tax rates over time.

The model can be used to determine the relative desirability of alternative capital investments. Different parcels of land, lease or purchase decisions, and additional investments such as irrigation can be analyzed to determine the profitability and chance of financial failure.

Model Disadvantages for Extension Use

To obtain results similar to those presented in Chapters V and VI, a large amount of input data is required. Beginning net worth, operating and fixed cost, gross income, and additional capital investments required to operate the proposed investment must be provided by the decision maker. The user must also estimate the minimum, most likely, and maximum expected value for each of his enterprise product prices and yields. If the decision maker is unable to specify this price and yield information, a normal distribution can be generated based on historic levels, trends, and variance-covariance of prices and yields.

The simulation model assumes that the capital gain tax must be paid at the end of the planning horizon. If the asset has increased in value, the capital gain tax liability is calculated and included as an expense in the 20th year. Income eligible for capital gains treatment is taxed at one-half the ordinary taxable income rate. Given the alternatives of income averaging and installment sales, the model overestimates the capital gain tax liability.

Extension Applications

The time and effort a decision maker will contribute to evaluating a capital investment ranges from demand for a complex analysis such as presented in Chapter V to the decision maker who requests approval of the investment decision he made yesterday. A good extension program should have the capability to provide complete investment information utilizing all available data. This same program must also have the flexibility to provide investment analysis information to the decision maker who has little data and time.

Extension personnel can utilize the simulation model described in Chapter III, if the decision maker is willing to estimate input data for cards 1 through 5 of Table LI. Cards 1 and 2 contain investment loan information and the depreciable portion of the investment. Card 3 lists the expected land appreciation rate and parameters that determine required computer capacity. Card 4 requires personal tax information and credit availability data and determines if capital gain tax liability should be included. Card 5 contains enterprise cost and the expected rate of increase in those costs. This input data, when combined with price estimates, will provide a deterministic marginal analysis of the

TABLE LI

CAPITAL INVESTMENT DECISION ANALYSIS SIMULATION MODEL INPUT FORMS

	cc	
Card 1		
Purchase Price	17	_ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Down Payment	29	_ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Salvage Value	41	_ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Amount Eligible for Investment Credit	53	_ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Amount Eligible for 20% First Year Depreciation	65	_ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Card 2		
Land Value	5	_ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Planning Horizon	17	_ _ _
Loan Life	20	_ _ _
Depreciation Life	23	_ _ _
Loan Code A = Amortized, C = Constant Principle, E = Earnings Applied	26	_
Depreciation Method 'SL' = Straight Line, 'DB' = Double Declining Balance	27	_ _
Discount Rate	36	_ _ . _ _ _ _
Loan Interest Rate	43	_ _ . _ _ _ _
Card 3		
Land Appreciation Rate	1	_ _ _ . _ _ _
Number of Enterprises	8	_ _ _ _
Number of Other Loans	28	_ _ _ _
Number of Other Investments	32	_ _ _ _

TABLE LI (Continued)

<u>Card 4</u>		
Number of Personal Tax Exemptions	1	_ _ _ . _ _ _
Long-Term Equity Ratio Minimum	8	_ _ _ . _ _ _
Intermediate-Term Equity Ratio Minimum	15	_ _ _ . _ _ _
Intermediate-Term Interest Rate	22	_ _ _ . _ _ _
Long-Term Interest Rate	29	_ _ _ _ _ _ _
Wish to Sell Asset at End of Planning Horizon Punch '1' if yes Punch '0' if no	36	_ _ _ _
Determine if Borrowing Allowed to Meet Cash Flow Deficits Punch '1' if yes Punch '0' if no	40	_ _ _ _
Determine if Interest Charged on Borrowing and Paid on Savings Punch '1' if yes Punch '0' if no	44	_ _ _ _
<u>Card 5</u>		
Enterprise I.D. Number	1	_ _
Enterprise Name	3	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Enterprise Cost	15	_ _ _ _ _ . _ _ _
Enterprise Cost Inflation Rate	24	_ _ _ . _ _ _
Number of Enterprise Units	30	_ _ _ _ _ _ _ . _ _ _
Buy Weight for Livestock	40	_ _ _ _ _ . _ _ _
Normal or Triangle Punch 'NORM' if normal Punch 'TRIA' if triangle	52	_ _ _ _

TABLE LI (Continued)

Number of Years Actual Machinery Purchases are Specified	56	_ _ _ _
Average Machinery Cost to be Added After that Year	60	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Card 6		
I.D. Number for Prices and Yields	1	_ _
Enterprise Price or Yield Name	3	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Minimum Expected Value of Price or Yield	15	_ _ _ _ _ _ _ _ _ _ . _ _ _
Most Likely Value of Price or Yield	25	_ _ _ _ _ _ _ _ _ _ . _ _ _
Maximum Expected Value of Price or Yield	35	_ _ _ _ _ _ _ _ _ _ . _ _ _
Card 7		
Minimum Expected Calving Percentage	1	_ _ _ _ _ _ _ _ _ _ . _ _ _
Most Likely Calving Percentage	11	_ _ _ _ _ _ _ _ _ _ . _ _ _
Maximum Expected Calving Percentage	21	_ _ _ _ _ _ _ _ _ _ . _ _ _
Card 8		
Minimum Expected Weaning Weight	1	_ _ _ _ _ _ _ _ _ _ . _ _ _
Most Likely Weaning Weight	11	_ _ _ _ _ _ _ _ _ _ . _ _ _
Maximum Expected Weaning Weight	21	_ _ _ _ _ _ _ _ _ _ . _ _ _
Card 9 and 10		
Price Trend Values for the Enterprise Prices	Format (5F14.8)	_ _ _ _ _ _ _ _ _ _ _ . _ _ _ _ _ _ _

TABLE LI (Continued)

Card 11

Yield Trend Values for the Enterprise Yields	Format (5F14.8)	_ _ _ _ _ _ _ _ _ _ . _ _ _ _ _ _

Card 12

Other Investment Amount	5	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Salvage Value	17	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Amount Eligible for Investment Credit	29	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Amount Eligible for 20% Bonus Depreciation	41	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Year of the Investment	53	_ _ _
Useful Life of the Asset	56	_ _ _
Depreciation Method Punch 'SL' for straight line Punch 'DB' for declining balance	59	_ _
Loan Interest Rate	61	_ _ _ . _ _ _
Loan Life	68	_ _ . _ _

Card 13

Amount of Liabilities Due to Non-Depreciable Assets	5	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Principle Payment Amount if Known	17	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Annual Interest Amount if Known	29	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Year that Liability Payments Start	44	_ _ _
Interest Rate to Amortize Loan if Annual Interest is not Known	47	_ _ . _ _ _ _

TABLE LI (Continued)

Card 14		
Amount of Non-Farm Other Income	5	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Amount of Tax Deductible Expenses	17	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
If Non-Farm Income is Constant, Punch '0001' If Non-Farm Income Increases at a Constant Percent Punch '0002' If Non-Farm Income is Specified for Each Year Punch '0003'	29	_ _ _ _
If Deductible Non-Farm Expense is Constant Punch '0001' If Deductible Non-Farm Expense Increases at a Constant Percent Punch '0002' If Deductible Non-Farm Expense is Specified for Each Year Punch '0003'	33	_ _ _ _
Number of Years of Income and Expense Flows	37	_ _ _ _
Percentage Annual Increase in Income	41	_ _ _ . _ _ _ _ _
Percentage Annual Increase in Expense	49	_ _ _ . _ _ _ _ _
Card 15		
Amount of Family Income	5	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Amount of Tax Deductible Expenses	17	_ _ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
If Family Income is Constant Punch '0001' If Family Income Increases at a Constant Percent Punch '0002' If Family Income is Specified for Each Year Punch '0003'	29	_ _ _ _

TABLE LI (Continued)

If Family Expenses is Constant, Punch '0001' If Family Expense Increases at a Constant Percent Punch '0002' If Family Expense is Specified for Each Year, Punch '0003'	33	_ _ _ _
Number of Years of Income and Expense Flows	37	_ _ _
Percentage Annual Increase in Income	41	_ _ _ _ . _ _ _ _ _
Percentage Annual Increase in Expense	49	_ _ _ _ . _ _ _ _ _
<u>Card 16</u>		
Market Value of Machinery Inventory	1	_ _ _ _ _ _ _ . _ _
Average Age of Machinery	11	_ _ _ _ _ _ _
Inflation Rate Per Year for Machinery Value	16	_ _ _ _ _ _ _ . _ _
Market Value of Farm Buildings	26	_ _ _ _ _ _ _ . _ _
Average Age of Farm Buildings	36	_ _ _ _ _ _ _
Inflation Rate Per Year for Farm Building Value	41	_ _ _ _ _ _ _ . _ _
Market Value of Owned Land (Do Not Include the Proposed Purchase)	51	_ _ _ _ _ _ _ _ _ _ _ _ _ . _ _
Depreciable Basis of Machinery as a Proportion of Market Value of Machinery Inventory	66	_ _ . _ _ _ _ _ _
Depreciable Basis of Farm Building As a Proportion of Market Value of Farm Building Inventory	72	_ _ . _ _ _ _ _ _

proposed capital investment. Deterministic marginal analysis considers only costs and returns that are associated with the new investment. The decision maker receives estimates of net present value, annual net cash flow, and estimates of firm survival. If the marginal analysis utilizes stochastic variation in prices and yields, then expected value, standard deviation, and coefficient of variation for these variables can be estimated. Also, cumulative probability distributions are generated to provide an estimate of the probability of a worse financial outcome. For the marginal analysis, product price data can be reported three ways:

1) For a stochastic analysis, based on historic price levels and correlation among product prices, code "norm" in column 52 of input card 5.

2) A deterministic analysis can be generated by specifying annual income and expense on input cards 14 and 15.

3) A stochastic analysis based on subjective estimates by the decision maker of minimum, most likely, and maximum expected prices and yields. This input data should be reported on card 6 for each enterprise.

If the decision maker is willing to report additional input data listed on cards 6 through 16, extension personnel can provide an estimate of the investment's net effects on the current firm. A whole-firm analysis insures utilization of the correct marginal tax rate and provides comparative estimates of the firm's net worth, net present value, annual net cash flow and probability of firm survival for the current firm before and after the proposed land purchase. Results presented in Chapters V and VI, illustrate the capabilities of the simulation model given the input data required in Table LI.

It would be possible to provide default values for price and per unit enterprise costs to reduce the data required for a stochastic analysis. Correlation coefficients and variance-covariance matrices used in this study are based on price and yield series for North Central Oklahoma. Similar data could be estimated for other areas to provide default values for estimation of stochastic prices and yields. Per unit enterprise cost and return estimates for different enterprises and areas of the state are generated by the Oklahoma State University Crop and Livestock Enterprise Budget Generator. These budgets, or budgets modified by the decision maker, could provide default values for the per unit enterprise cost section of the input form.

Machinery requirements are also estimated by the budget generator. However, these estimates are based on an assumed number of acres, machinery size, timeliness, and daily labor hours. Machinery requirements could be included by specifying an average annual cost based on short-term machinery investment intentions of the decision maker.

Simulation analysis could be used to determine the sensitivity of investment success to errors in estimates of machinery cost, firm equity, operating costs, and prices and yields of agricultural prices. Stochastic evaluation of capital investments provides estimates of the effects of variation in returns on investment success. These advantages may outweigh the loss of accuracy due to relying on default values. Prediction of financial results 20 years into the future is not without error. But these estimates provide more investment analysis information than has been previously available. Minimizing data and time requirements of an extension model will increase decision maker utilization of that program.

Cost for Simulation Runs

Total computer cost for a simulation of the current and proposed size large firm described in Chapter IV would be less than $50. This amount includes 100 repetitions of the current and proposed firm size, and statistical analysis of each replication to determine the minimum, mean, maximum, standard deviation, and coefficient of variation for net present value, annual net worth, cash flow, and firm survival. Breakeven analysis like that presented in Chapter VI could be obtained for $20 of computer cost. These costs may be prohititive to small resource decision makers. However, a marginal deterministic analysis could be performed for $5 computer cost. Stochastic analysis of a marginal investment could be performed for approximately $20 of computer time. Computer charges vary depending on the computer hardware and institution. The IBM 370 Model 158 Computer, charges $340 per hour of control processor unit or CPU time. Additional charges are added for the amount of computer capacity used, and 25 cents for each 1000 disk accesses. A disk access represents the reading from or writing of one data record on disk.

Research Applications

Flexibility of the simulation model allows application to extension type problem situations and empirical research problems. Repeatable stochastic variation in prices and yields provides a vehicle for sensitivity analysis or comparative analysis of alternative credit policies, enterprise combinations, or alternative financial futures. This type of application cannot be clearly identified as research or extension. Specific problem areas which can utilize this simulation model are presented in following sections.

Evaluation of Alternative Credit Policies

Among other considerations, credit agencies are interested in the repayment capacity of their borrowers. The borrower must have a minimum level of financial resources and earning capacity to carry out his production plans. Bankrupt borrowers have little future repayment capacities. Lenders and borrowers alike desire credit policies that allow the decision maker to reach his goals and minimize the probability of financial disaster.

For a given set of stochastic prices and yields, the model's estimates of firm survival, annual cash flows, equity ratios, and frequency of financial disaster provide a means of evaluating the effects of alternative credit policies on firm survival. Results in Chapter V, Table XXII, indicate that financial failure of the small size resource situation occurred most frequently in the initial years of the investment due to low levels of equity. They also indicated that if unusually low income years did not occur in the first five years, increasing equity due to increases in value of the land allowed the firm to meet minimum equity requirements throughout the planning horizon.

The simulation model can be used to determine the comparative effects of down payment percentages, equity percentage, loan interest rate, and repayment methods on the profitability, solvency, liquidity, and rate of firm survival. Also the influences of borrower characteristics such as age, family size, and non-farm expenditures on firm survival could be analyzed. The results are directly influenced by future land prices, product prices, production costs, and general levels of price inflation. Results in Chapter V provide a few examples of the types of analysis for which the model can be used.

Evaluation of Income Variation Resulting From Alternative Enterprise Combinations

Much research has been conducted to determine the riskiness or variation in income generated by alternative enterprise combinations. A study by Aanderud, Plaxico, and Lagrone (1966), based on deflated annual prices from 1942 to 1957, calculated the expected income and variation in income for alternative farm plans and resource situations. The simulation model provides the same kind of results, for example, as presented in Chapter V. Expected levels and variation in those levels were calculated, not only for annual income, but also for annual net worth, annual cash flow, and net present value. Other enterprise combinations could be analyzed with alternative price and yield assumptions.

Evaluation of the Influence of Government Programs on Capital Investment Success

Tweeten and Nelson (1966) found that government allotment programs had a significant influence on land values for the 1930 to 1963 period. More recently, Boehlje and Griffin (1977) used simulation to determine the effects on land prices of alternative government crop price guarantees based on cost of production. They concluded that the excess returns to land, due to price support, are built into future land prices.

A study with great current interest would determine the effects of parity product prices on future net worth, net present value, firm survival, and future land prices. Government programs in the past have tended to reduce the variation in product prices and, thus, whole-firm income. The stabilizing influence of government programs could be measured by variation in annual income or frequency of firm non-survival. This simulation model with repeatable stochastic variation in prices and yields can be used to evaluate the influence of alternative government programs on capital investment success and firm survival. New insurance programs could be incorporated.

CHAPTER VIII

SUMMARY

The Problem

Capital investment decisions are among the most important decisions made by agricultural producers and are made for a variety of reasons. Producers may wish to increase their gross income or they may be adopting new technology which will lower their cost of production. Investment in new assets may allow the producer to utilize his excess machinery or labor. Whatever the reason, investment requires a fixed commitment of funds many years into the future. Land investments, which are repaid in 20 to 40 years, use the firm's liquidity and financial reserves, thus limiting the producer's future investment opportunities. An unprofitable investment decision may be reversed only by partial or complete liquidation of the firm. Capital investment decisions are critical because a constant future commitment of funds must be met by highly variable future cash incomes.

Product price variability has increased in the last decade due to increased foreign demand, devaluation of the U. S. dollar, and increased export activity. The combination of these events first eliminated the large grain surplus that had accumulated since World War II, then led to a new buildup. During the 1973-1976 period, prices of most agricultural commodities were well above support levels and the income generated by these unusually high prices was invested in land, machinery, and other operating inputs. Beginning farmers and others used these funds and borrowed funds to purchase additional production inputs. As a result of this competitive bidding and the effects of inflation, product input prices reached record levels.

More recently, net farm incomes have dropped due to surpluses and low commodity prices. However, the fixed commitment to machinery and land made when incomes were high still must be paid. This very recent agricultural experience illustrates the high degree of variation in net farm income, due to factors over which the agricultural producer has very little control. The viability of an entire farm unit could depend on the success of capital investment decisions. Investment in production technology is a large part of the fixed cost associated with agricultural production.

Many procedures exist which will accurately calculate the success of long-term capital investments, if cash benefits and cost associated with these investments are known with certainty. A method of realistically incorporating risks associated with agricultural production into the analysis of capital investments is needed.

The major purpose of the study is to analyze potential farm investments in the uncertain farm business environment. It is intended to provide knowledge concerning investment risks and feasibility under stochastic conditions. Thus, it goes beyond contributions of studies which assume perfect knowledge.

Specific objectives are:

1) To estimate the potential gain and risk associated with capital investments under uncertainty.

2) To estimate breakeven bid prices for capital investments under selected levels of key economic variables.

3) To evaluate effects of alternative futures with respect to rates of land appreciation, cost inflation, cost of borrowing, opportunity cost of capital, and product price and yield trends on the level and distribution of farm returns.

4) To suggest extension and research programs which can serve farmers and ranchers by improving information on which investments are made.

Until recently, most of the attempts to include risk in capital investment decisions have been made to corporate operations research staffs. The major application is portfolio management and corporate capital investment planning. Methods used include stochastic linear programming, linear programming under uncertainty, and chance constraint programming. More recently, simulation has been used to incorporate variation in capital investment decision models. Simulation provides more information to the decision maker than a single-valued estimate of returns. Simulation also offers some flexibility in specifying the decision maker's goals. Profit maximization assumptions can be relaxed, while Monte Carlo replication of simulation experiments provides probability distributions of key output parameters. Procedures which allow correlation of variation among variables and probability distributions that include the decision maker's subjective evaluations provide a realistic method for relaxing the assumption of perfect knowledge of future incomes and expenses.

Conceptual Framework

Many alternative methods for evaluating capital investments exist given the assumption of certain knowledge. The payback period and simple rate of return methods are most commonly used because they are relatively easy for the decision maker to understand. The net present value method incorporates the time value of money and the decision maker's discount rate to yield a method of analysis superior to the payback or rate of return methods. The internal rate of return method involves setting discounted net cash flows to zero and solving for the discount rate. The net present value method and internal rate of return method provide single-valued estimates of the rate of return a decision maker can expect from a proposed investment given certain assumptions for estimating cash benefits and costs.

The adjustment of discount rate method and certainty-equivalent method are two ways of incorporating risk in capital investment decisions. The discount rate adjustment method involves specifying a higher discount rate to reflect the investment's degree of risk. The certainty-equivalent method allows the discount rate to reflect only the time value of money, and incorporates risk according to a risk adjustment factor which can be different for each year of the investment. Using these methods, measures of investment success for certainty and varying degrees of risk can be compared, but they represent single-valued estimates adjusted for risk.

Monte Carlo simulation techniques offer another method for incorporating risk into capital investment decision models. These methods involve specification of an objective or subjective probability distribution for the parameters that most influence investment success. Random values drawn for these key parameters are used to calculate measures of investment success. By repeating the analysis a specified number of times, a probability distribution for these measures of investment success can be developed. Using these methods, risk can be measured by the range in net present value or the percent chance that net present value will be greater than a specified level. More importantly, the measure of risk is a probability distribution of outcomes rather than a single-valued estimate which has been adjusted for risk.

Traditional methods of evaluating capital investments are based on marginal analysis of only those cash flows associated with the proposed capital investment. These procedures provide a measure of the profitability of the additional investment. However, these methods generally do not consider the farm firms solvency, liquidity, or firm survival.

To obtain more complete information about the effect of a proposed investment on the current operating unit, a detailed before and after analysis of the firm was developed. This approach required an estimate of the cash benefits and costs, financial situation and transactions, and cash flows associated with the current operating unit. This method allows direct comparison of the measures of investment success for the current operating unit and the proposed operating unit which is composed of the current firm and the proposed investment. An obvious disadvantage of this method is the requirement of relatively large amounts of input data. By evaluating the entire firm, values of resources associated with the current operation may be capitalized into the bid price for the proposed investment. This allows the investor to determine the maximum bid price that his net worth and cash flow situation will support.

A decision maker considering capital investment wants to know how much he can pay for capital investments. The internal rate of return method iteratively adjusts discount rate until the net present value is zero. In the same way, purchase price can be adjusted until the net present value of the investment is zero. This resulting bid price is the amount a decision maker can pay and receive a discount rate of return on investment. If a stochastic analysis is performed, this breakeven bid price can be calculated for the highest, lowest, or other net present value. This provides an estimate of the breakeven bid price for the range of financial outcomes. It also provides the probability of obtaining a worse financial outcome given the respective bid price.

Given the extreme variation in product prices and yields over the last decade, the assumption of certain knowledge of future cash flows becomes less acceptable. The simulation model utilizes either deterministic incomes and expenses or stochastic yields and prices that exhibit either a normal distribution or triangular distribution. Normally distributed prices and yields are based on historic price series and are composed of an intercept, cycle, and trend value. These values are also influenced by a normally distributed random shock which is correlated based on the variance and covariance of historic price and yield series. Triangularly distributed prices and yields are based upon the decision maker's subjective estimate of the minimum, most likely, and maximum value of price and yield. The random influence is triangularly distributed and correlated based on the correlation coefficient matrix of historic price and yield series.

General Model Description

The major purpose of the model developed in the study is to analyze capital investments in an intertemporal and stochastic environment. It is specifically designed to determine the profitability, solvency, liquidity, and the chance of firm survival for alternative capital investments. Direct comparison of the current operating unit and proposed operating unit provides an estimate of the investment's net effect on the current firm.

The main program reads all input data and calculates values which do not change in each replication of the analysis. The amortized cost of existing liabilities, market values of present assets, off-farm income, and the cost associated with asset replacement, affect all replications of the analysis equally and do not change with stochastic variables. They are "deterministic" and may have trends and cyclic variations. To efficiently utilize computer time, these values are calculated and stored in arrays, one time, and then added each time the analysis is repeated. For each replication, prices and yields and the number of units of each enterprise are combined to generate gross enterprise income and enterprise cost. Net cash flows are determined and discounted for each year in the planning horizon. Family living expenses are paid and income taxes are deducted. If net cash flow is positive, it is accumulated for future use. If net cash flow is negative, equity levels are calculated to determine whether funds can be borrowed to meet the cash flow deficits. If the firm equity levels are below a specified minimum, the firm fails the survival test. If surplus funds are available from previous years or if funds can be borrowed to meet the cash flow deficit, the annual analysis continues with the calculation of net worth and present value, and net cash flow for each year in the planning horizon. This analysis is repeated a specified number of times to provide data necessary for probability distributions of key measures of investment success. All data is stored for future statistical analysis.

The main program now reads bid price, loan interest rate, repayment period, discount rate, and additional machinery or other capital purchases necessary to operate the proposed capital investment. The procedure described above is repeated for the proposed size firm ending with calculation of the measures of investment success, net worth, net present value, annual net cash flow, and the chance of firm survival. These two sets of results are compared to determine the net effects of the proposed capital investment on the current size firm.

Required Input Data and Simulation Experiments Conducted

The purpose of simulation experiments in this study is to demonstrate the model's ability to provide evaluative financial information about the expected success of a capital investment. Three resource situations classified as small, medium, and large were developed. Basic differences in the situations are total number of acres, machinery complement size, beginning equity levels, and off-farm employment. Each resource situation experiment is composed of two parts. First, a simulation run is made for the current size operating unit with the total resources currently managed by the decision maker. Then, the simulation is repeated for the proposed size operating unit which is comprised of the current firm and the proposed capital investment. Simulation results for each resource situation experiment are compared to determine the investment's net effect on the current firm. Each of the three firms wants to expand its operating unit by purchasing 160 acres of additional land. Total purchase price is $138,000, to be repaid in 20 years. One hundred percent financing was obtained with amortized repayment at 8.5 percent interest.

Enterprise costs per unit were developed using the Oklahoma State University Computerized Crop and Livestock Budget Generator. Wheat custom harvest and November to March stocker steer enterprises were chosen.

Machinery complements were designed for each firm to provide adequate machinery and equipment for the total acres operated by each firm. These basic input costs and the costs associated with each machinery complement size comprise a segment of the per unit cost.

Operator labor for the three firms is fixed at 3,328 hours per year. As the size of firm increases, the proportion of hired labor increases because operator labor is fixed. This increasing proportion of hired labor causes the hired labor cost and total cost per unit to increase as firm size increases. The per acre and per head labor requirements calculated by the budget generator indicate some economies of size which offset this increasing labor cost.

The capital cost for machinery and equipment calculated by the budget generator is not included in per unit costs. These costs are calculated in the model based on the actual replacement cost for machinery and equipment. Depreciation and investment credit for these capital purchases is calculated based on actual purchase price.

Simulation Results for Alternative Resource Situations

The desirability of land investment was measured by comparing the current size firm and the proposed firm which included the land purchase. Comparative measures of profitability, solvency, liquidity, and firm survival were presented. For each size firm, the proposed firm operates an additional 155 acres of wheat and stocker cattle, and pays principle and interest on the \$138,000 amortized loan.

Measures of ending net worth and net present value for the large proposed size firm indicate that the proposed land investment would increase the chance of financial failure and increase the expected ending net worth of the firm. The potential gain in net worth and net present value must be weighed against the probability of financial failure. Price and yield situations were the same for both the current and the proposed size firms. However, as firm size increased, net present value and net worth increased.

Results of Sensitivity Analysis

Sensitivity of investment outcomes to the loan interest rate, product price trend, production cost trend, land appreciation rate, and capital gain tax liability was evaluated. Reducing interest rates and increasing product price trends relative to production cost trends have a very positive influence on ending net worth and net present value. The land appreciation rate directly influenced annual net worth, and greatly affected present value. Land appreciation influenced annual net cash flow only in the last year. As land inflation rate increased, capital gain tax liability increased the last year. Zero land appreciation resulted in firm financial failure in 65 of the 100 replications.

Adjustment of annual cash flow, for interest on operating capital and interest paid on surplus annual cash flow, decreased expected net worth and net present value but increased standard deviation and coefficient of variation. Consideration of capital gain tax liability reduced expected ending net worth less than $30,000, when the land appreciation rate was six percent. However, 12 percent growth in land values caused expected capital gain tax liability of more than $300,000. A one percent loan interest reflecting high equity financing generated an expected net worth which was greater for the land purchase alternative than the current size firm. In general, any change in interest rate or the relationship of product price trends and production cost trends that increases the profitability of the firm also reduces the variation in net present value, net worth, and annual cash flow. Increasing the profitability of the firm increases financial reserves and flexibility.

Simulation Results--Breakeven Analysis

Determination of breakeven bid prices for capital investments in a stochastic environment was a stated objective of this study. Breakeven prices were determined by iteratively adjusting the bid price until the net present value of the investment was zero. The Fibonacci algorithm was used to calculate breakeven bid prices using the best price and yield combination for the small, medium, and large proposed size firms. The operator of the small size firm could afford to pay $995 per acre while the medium size firm would support a $1,384 bid price per acre. The large size firm could pay $1,547 per acre. These differences are due to the machinery complement size, firm equity levels, and off-farm employment for the three size firms. In general, if the decision maker is willing to utilize the profitability of the current firm to subsidize the proposed investment, larger firms can feasibly pay more for land based on high levels of equity and financial reserves.

One simulation experiment was conducted with very profitable price and yield expectations for agriculture. Given the price and yield situation for the best net present value of $1,030,251, the breakeven bid price was $1,196. With the price and yield situation that generated the worst net present value, the breakeven bid price is $717. If the decision maker is willing to accept a 50 percent chance of negative net present value he can pay $920 per acre. Given this range of financial outcomes, the decision maker can bid for land based on his willingness to accept risk of the negative net present value. A decision rule might be to bid so that there is a 90 percent chance of a positive net present value.

Model Applications in an Extension Setting

Possible tools available to extension personnel which assist decision makers in evaluating proposed capital investments can be classified into three general categories:

1) Estimation of market value through capitalization of per unit net returns and analysis of comparable sales.

2) Determination of the feasibility of investment using amortization schedules and cash flow analysis based on average costs and returns.

3) Estimation of market value or ability to repay through discounted cash flows, net present value, or internal rate of return.

The simulation model described in Chapter III, is designed to relax the limiting assumption of perfect knowledge of future prices and yields. Variation in these values can be specified by the decision maker. A pontential investor has a more accurate estimate of cash flow and credit needs because interest charged on annual operating capital or interest paid on surplus capital is considered. Breakeven analysis answers the question "How much can I pay for land?" These estimates provide a range of bid prices and associated probability of a worse financial outcome. However, the relatively large amount of input data required to obtain these results is a disadvantage for extension use of the model. Beginning net worth, operating and fixed cost, gross income and additional capital investment must be provided by the decision maker.

The time and effort a decision maker will contribute to evaluating a capital investment ranges from the complete analysis presented in Chapter V, to the decision maker who requests approval of the investment decision he made yesterday. A good extension program should have the capability to provide complete investment information utilizing all available data. This same program must also have the flexibility to provide investment analysis information to the decision maker who has little data and time. The simulation model can be run as a marginal analysis utilizing deterministic income and expenses or it can be run as a stochastic analysis of a current size firm compared to the proposed firm after the investment is included. The model can also be used to determine the relative desirability of alternative capital investments. Different parcels of land, lease or purchase decisions, and additional investments such as irrigation, can be analyzed to determine the profitability and chance of financial failure. Input forms and data requirements for both types of run are provided in Chapter VII.

The simulation model described in Chapter III, was designed with the flexibility to apply to other extension and research problems. Repeatable stochastic variation in prices and yields provides a method for analyzing the sensitivity of key parameters, or a comparative analysis of alternative policy variables. Lenders and borrowers alike desire credit policies that allow the decision maker to reach his goals and minimize the probability of financial disaster. The simulation model can be used to determine the comparative effects of downpayment percentages, loan interest rates, and repayment methods, on the profitability, solvency, liquidity, and rate of firm survival.

SELECTED BIBLIOGRAPHY

Aanderud, Wallace G., Plaxico, James S., and Lagrone, William F. "Income Variability of Alternative Plans, Selected Farm and Ranch Situations, Rolling Plains of Northwest Oklahoma," Okla. Agr. Exp. Sta. Bulletin B-646, March 1966.

Alpin, Richard D. and Casler, George L. Capital Investment Analysis, 1973, Grid, Inc., Columbus, Ohio.

Alpin, Richard D., Casler, George L., and Francis, Cheryl P. Capital Investment Analysis Using Discounted Cash Flows, 1977, Grid, Inc., Columbus, Ohio.

Anderson, Jock R., Dillion, John L., and Hardaker, Brian. Agricultural Decision Analysis, The Iowa State University Press, Ames, Iowa, 1977.

Boehlje, Michael and Griffin, Steven. "Financial Impacts of Government Support Price Programs," Presented at an Organized Symposium on "Returns to Land in the Corn Belt, Government Crop Price Guarantees Based on Cost of Production, and Land Values." Paper presented at the Annual Meeting of the American Agricultural Economics Association, San Diego, California, July 31-August 3, 1977.

Byrne, R., Charnes, A., Cooper, W. W., and Kortanek, K. "Some New Approaches to Risk," Accounting Review, Vol. 43, No. 1, January, 1968, pp. 18-37.

Carter, Eugene E. "A Simulation Approach to Investment Decision," California Management Review, Vol. XIII, Summer, 1971, No. 4, pp. 18-26.

Cassidy, P. A., Rogers, J. L., and McCarthy, W. O. "A Simulation Approach to Risk Assessment in Investment Analysis," Review of Marketing and Agricultural Economics, Vol. 38, No. 1, March, 1970, pp. 3-24.

Chamberlain, R. L., and Jowett, D. "The Omnitab Programming System: A Guide for Users," Statistical Laboratory, University Bookstore, Iowa State University, Ames, Iowa.

Charnes, A., and Cooper, W. W. "Chance Constrained Programming." Management Science, Vol. Y, No. 1, October, 1959, pp. 73-79.

Clements, Alvin M., Mapp, Harry P., Jr., and Eidman, Vernon R. A Procedure for Correlating Events in Farm Firm Simulation Models, Okla. Agr. Exp. Sta. Technical Bulletin T-131, August, 1971.

Cohen, Kalman J. and Elton, Edwin J. "Intertemporal Portfolio Analysis Based on Simulation of Joint Returns." Management Science, Vol. 14, No. 1, September, 1967, pp. 5-18.

Conover, W. J. Practical Nonparametric Statistics. John Wiley and Sons, Inc., New York, London, Sydney, Toronto, 1971.

Dantzig, G. P. "Linear Programming Under Uncertainty." Management Science, Vol. 1, No. 3 and 4, April-July, 1955, pp. 179-206.

Denholm, John A. "Investment By Simulation." Journal of Management Studies, May, 1969, pp. 167-180.

Halter, A. N., and Dean, G. W. Decisions Under Uncertainty. Southwestern Publishing Co., Cincinnati, Ohio, 1971.

Halter, A. N., and Dean, G. W. "Use of Simulation in Evaluating Management Policies Under Uncertainty, Application to a Large-Scale Range." Journal of Farm Economics, Vol. 47, 1965, pp. 557-573.

Hardin, Mike L., and Walker, Odell L. User's Manual for Stochastic Capital Investment Decision Model. Okla. Agr. Exp. Sta. Bulletin, forthcoming.

Hatch, Roy E. "Growth Potential and Survival Capability of Southern Plains Dryland Farms: A Simulation Analysis Incorporating Multiple-Goal Decision Making." Unpublished Ph.D. dissertation, Oklahoma State University, July, 1973.

Hertz, David B. "Investment Policies that Pay Off." Harvard Business Review, Vol. 46, No. 1, January-February, 1968, pp. 96-108.

Hess, Sidney W., and Quigley, Harry A. "Analysis of Risk in Investments Using Monte Carlo Techniques." Chemical Engineering Progress Symposium Series, Vol. 59, No. 42, 1963, pp. 55-63.

Hillier, Fredrick S. "Derivation of Probablistic Information for the Evaluation of Risky Investments." Management Science, Vol. 9, No. 3, April, 1963, pp. 443-457.

Hinman, H. R., and Hutton, R. F. "A General Simulation Model for Farm Firms." Agricultural Economics Research, Vol. 22, No. 3, July, 1970, pp. 69-76.

Hopkin, John A., Barry, Peter J., and Baker, C. B. Financial Management in Agriculture. The Interstate Printers and Publishers, Danville, Illinois, 1973.

IBM System 370 Fortran IV Language Manual GC28-6515-10, 1974, International Business Machines, White Plains, New York.

Johnson, S. R., Tefertiller, K. R., and Moore, E. S. "Stochastic Linear Programming and Feasibility Problems in Farm Growth Analysis." Journal of Farm Economics, Vol. 49, 1967, pp. 908-919.

Jones, G. T. Simulation and Business Decisions, Penguin Books, Ltd., Harmondsworth, England, 1972.

Kennedy, Miles. "Risk in Capital Budgeting: An Interactive Approach." Industrial Management Review, Spring, 1968, Vol. IX, No. 3, pp. 121-140.

Kletke, Darrel D. Operations Manual for the Oklahoma State University Enterprise Budget Generator, Okla. Agr. Exp. Sta. Research Report P-719, June, 1975.

Kuester, James L., and Mize, Joe H. Optimization Techniques with Fortran. McGraw-Hill Book Company, New York, 1973.

Lee, W. F. "A Capital Budgeting Decision Model for Evaluating Farm Real Estate Purchases." Canadian Farm Economics, Vol. 11, No. 3, June, 1976.

Lee, Warren F., and Rask, Norman. "Inflation and Crop Profitability: How Much Can Farmers Pay for Land?" American Journal of Agricultural Economics, Vol. 58, No. 5, December, 1976, p. 984.

McGee, J. "Decision Trees for Decision Making." Harvard Business Review, Vol. 42, No. 4, July-August, 1964, pp. 126-138.

Nelson, Ted R. "Present Value Method of Evaluation of Capital Investments." Department of Agricultural Economics Extension Farm Management Form FMPV76.

Officer, R. R., and Anderson, J. R. "Risk, Uncertainty, and Farm Management Decisions." Review of Marketing and Agricultural Economics, Vol. 36, No. 1, March, 1968, pp. 3-19.

Officer, R. R., and Halter, A. N. "Utility Analysis in a Practical Setting." American Journal of Agricultural Economics, Vol. 56, No. 3, 1974.

Poliquen, Louis Y. Risk Analysis in Project Appraisal. World Bank Staff Occasional Paper, No. 11, The Johns Hopkins University Press, Baltimore, 1970.

Rae, Alan N. "Capital Budgeting Intertemporal Programming Models with Particular Reference to Agriculture." Australian Journal of Agricultural Economics, June, 1970, Vol. 14, No. 1, pp. 39-49.

Ray, Daryll E., and Richardson, James W. "Detailed Description of POLYSIM." Forthcoming Technical Bulletin, Okla. Agr. Exp. Sta.

Reutlinger, Shlomo. Techniques for Project Appraisal Under Conditions of Uncertainty. World Bank Staff Occasional Paper, No. 10, The Johns Hopkins University Press, Baltimore, 1970.

Richardson, James W. "Generation of Correlated Triangularly Distributed Stochastic Variables." Unpublished mimeograph, Texas A & M University, College Station, Texas.

Richardson, James W., and Mapp, Harry P., Jr. "Use of Probablistic Cash Flows in Analyzing Investments Under Conditions of Risk and Uncertainty." Southern Journal of Agricultural Economics, December, 1976.

Salzar, Rodolfo C., and Subrata, Sen K. "A Simulation Model of Capital Budgeting Under Uncertainty." Management Science, Vol. 15, No. 4, December, 1968.

Sengupta, J. K., Tintner, G., and Millham, C. "Some Theorems of Stochastic Linear Programming with Applications." Management Science, Vol. 10, No. 1, October, 1963, pp. 143-159.

Sprow, Frank B. "Evaluation of Research Expenditures Using Triangular Distribution Functions and Monte Carlo Methods." Journal of Engineering Chemistry, Vol. 59, No. 7, July, 1967.

Sundem, Gary L. "Evaluating Capital Budgeting Models in Simulated Environments." The Journal of Finance, Vol. XXX, No. 4, September, 1975, pp. 978-992.

Swirles, John, and Lusztig, Peter A. "Capital Expenditure Decisions Under Uncertainty." Cost and Management, September, 1968, pp. 13-19.

Tweeten, Luther G., and Nelson, Ted R. "Sources and Repercussions of Changing U. S. Farm Real Estate Values." Okla. Agr. Exp. Sta. Technical Bulletin T-120, April, 1966.

U. S. 1978 Master Tax Guide, Commerce Clearing House, Inc., Chicago, Illinois.

U. S. Department of Agriculture. Agricultural Finance Outlook, AFO-18, November, 1977, Economic Research Service, p. 7.

____________. Agricultural Prices. Crop Reporting Board Economics, Statistics, and Cooperative Services.

____________. State Farm Income Statistics, Supplement to Statistical Bulletin No. 576, September, 1977, Economics Research Service, p. 29.

U. S. Department of Labor. News. Bureau of Labor Statistics, 1973.

Wagner, John, and Pryor, Leroy J. "Simulation and the Budget: An Integrated Model." Sloan Management Review, Winter, 1971, pp. 45-58.

Walker, Odell L., and Nelson, A. Gene. "Agricultural Research and Education Related to Decision Making Under Uncertainty: An Interpretative Review of Literature." Okla. Agr. Exp. Sta. Research Report P-747, March, 1977.

Willett, Gayle S., and Wirth, Myron E. The Financial Analysis of Farm Land Investments. Working Paper, Western Extension Farm Management Committee Regional Publication.

Zusman, P., and Amiad, A. "Simulation: A Tool for Farm Planning Under Conditions of Weather Uncertainty." Journal of Farm Economics, Vol. 47, pp. 574-594, 1965.

APPENDICES

APPENDIX A

ALTERNATIVE LOAN PAYMENT METHODS

The proposed capital investment can be paid by any of three methods, 1) amortization, 2) earnings applied, and 3) constant principle. The following equations describe the three methods.

Amortization

$$PAYMT = (PRIC - DNPAY) \times LNINTR \times (1 + LNINTR)^{ILNLF} / (1 + LNINTR)^{ILNLF - 1} + .0005 \quad (3.29)$$

where PAYMT = the annual amortized payment of principle and interest,

PRPRIC = total purchase price of the proposed capital investment,

DNPAY = the down payment made on the capital investment,

LNINTR = the loan interest rate on the capital investment, and

ILNLF = the life or length of the loan in years.

$$LOAN = LOAN - LOANPY \quad (3.30)$$

$$INTST = INTRATE \times LOAN \quad (3.31)$$

$$LOANPY = PAYMT - INTST \quad (3.32)$$

where LOANPY = the annual amortized amount of payment less the annual interest due,

LOAN = unpaid principle balance of the loan,

INTRATE = the loan interest rate, and

INTST = the annual interest on unpaid principle.

Earnings Applied

$$LOANPY = TINCOM - DEXPEN - INTST + TXSV \quad (3.33)$$

where all variables have been previously defined.

Constant Principle

$$LOANPY = (PRPRIC - DNPAY) / ILNLF \qquad (3.34)$$

where PRPRIC = total purchase price of the capital investment,

DNPAY = down payment on the capital investment, and

ILNLF = the loan life in years on the capital investment.

APPENDIX B

HISTORIC PRICE AND YIELD SERIES AND PREDICTIVE EQUATIONS USED IN THE SIMULATION MODEL

TABLE LII

HISTORIC PRICE SERIES, NORTH CENTRAL OKLAHOMA

Year	Wheat	Grain Sorghum	Nov. Stockers	March Stockers	May Stockers	Slaughter Cows	Weaning Calves	Alfalfa Hay	Forage Sorghum
1938	0.56	0.79	7.4	8.12	8.00	5.7	7.2	9.74	6.90
1939	0.65	1.12	7.9	8.26	8.78	6.3	7.8	12.07	4.50
1940	0.62	0.91	8.6	9.28	10.02	6.6	8.2	11.12	5.19
1941	0.93	1.04	9.6	10.86	11.52	8.1	9.6	10.96	5.96
1942	1.11	1.55	12.1	12.95	13.75	9.5	11.8	13.97	5.14
1943	1.38	2.20	11.6	12.06	11.90	9.9	12.4	25.98	7.67
1944	1.39	1.66	12.1	11.86	12.71	8.9	11.9	21.97	13.35
1945	1.45	2.14	11.8	13.85	14.57	10.5	12.3	21.35	13.06
1946	1.80	2.41	15.6	17.95	18.60	12.2	14.7	29.35	16.68
1947	2.17	3.43	19.6	23.48	25.37	16.2	19.7	28.06	16.30
1948	1.98	2.14	22.2	22.60	22.88	20.7	23.6	24.35	13.37
1949	1.87	1.96	19.6	23.87	26.50	18.3	20.8	19.93	11.16
1950	2.02	1.88	26.0	33.82	31.74	22.0	25.3	22.72	11.85
1951	2.20	2.30	30.0	31.19	31.25	26.7	30.6	33.11	18.19
1952	2.12	2.86	19.2	20.06	18.65	21.7	23.4	29.42	25.43
1953	2.13	2.20	13.6	16.91	19.52	13.9	15.2	27.13	17.79
1954	2.18	2.20	15.2	19.59	18.79	13.8	15.8	28.56	19.77
1955	2.05	1.64	15.0	17.45	16.74	14.1	16.6	24.49	16.19
1956	1.97	2.18	15.0	19.00	19.75	13.3	15.6	32.73	22.42
1957	1.93	1.64	18.6	25.31	25.35	15.9	17.9	23.63	16.22
1958	1.75	1.66	26.8	26.94	27.65	21.5	25.5	18.69	12.97
1959	1.77	1.52	24.2	25.15	23.50	22.2	26.9	23.47	14.38
1960	1.75	1.43	21.5	23.20	23.06	18.6	22.1	24.32	15.79
1961	1.80	1.77	23.9	24.35	24.30	19.3	23.5	23.42	15.29
1962	2.04	1.79	25.3	23.88	23.45	20.7	25.3	24.33	17.04
1963	1.90	1.79	23.1	20.50	18.75	19.8	24.1	29.92	23.22
1964	1.46	1.93	19.6	18.94	21.56	17.2	19.8	26.71	18.83

TABLE LII (Continued)

Year	Wheat	Grain Sorghum	Nov. Stockers	March Stockers	May Stockers	Slaughter Cows	Weaning Calves	Alfalfa Hay	Forage Sorghum
1965	1.36	1.82	23.0	26.03	24.75	19.3	22.5	23.83	17.00
1966	1.66	1.93	25.4	24.20	23.53	22.1	26.5	28.75	19.54
1967	1.47	1.79	25.2	24.75	25.24	22.2	26.3	26.79	18.29
1968	1.25	1.70	26.8	26.72	28.85	23.0	27.3	26.67	17.46
1969	1.23	1.95	30.5	31.46	29.80	26.1	31.3	29.12	19.25
1970	1.33	2.05	34.0	30.42	39.58	27.3	34.4	34.62	22.88
1971	1.42	1.89	39.2	33.39	33.75	29.3	37.2	33.21	22.67
1972	1.70	2.62	46.5	47.72	46.02	34.5	43.9	49.67	28.50
1973	3.56	4.09	57.3	37.68	33.53	44.7	58.9	45.54	31.83
1974	3.95	5.11	25.9	22.60	29.12	33.5	38.1	60.38	42.46
1975	3.30	4.21	30.4	33.94	38.52	30.0	27.9	56.17	39.88

Source: U. S. Department of Agriculture, Agricultural Prices, Crop Reporting Board, Economics, Statistics, and Cooperative Services.

TABLE LIII

HISTORIC YIELD SERIES, NORTH CENTRAL OKLAHOMA

Year	County Grain Sorghum Yield A	County Alfalfa B	County Wheat C	Stocker Gain Rates D	Forage Sorghum E
1960	32.9	2.42	27.4	2.389	5.4
1961	27.4	2.34	25.9	2.274	4.8
1962	28.6	2.37	22.4	2.896	4.1
1963	29.6	2.03	21.8	2.684	4.8
1964	20.6	1.93	26.5	2.519	5.2
1965	32.0	2.12	31.7	2.263	4.1
1966	31.2	1.82	23.8	2.589	5.9
1967	27.9	2.32	16.8	2.348	4.4
1968	33.7	2.14	26.2	2.397	3.9
1969	41.8	2.58	30.6	2.086	5.9
1970	29.8	2.06	29.5	2.497	4.8
1971	29.0	2.34	23.7	2.329	6.1
1972	32.0	2.38	25.5	2.147	4.6
1973	37.4	2.82	33.3	2.497	6.3
1974	36.7	3.06	24.7	2.046	7.2
1975	33.1	2.85	26.8	2.467	5.8

Source: U. S. Department of Agriculture, Oklahoma Crop and Livestock Reporting Service, A = Oklahoma Sorghum Production County Estimates, B = Oklahoma Hay: Acreage and Production, C = Oklahoma Wheat Acreage Yield and Production, D = U. S. Southern Great Plains Field Station, Woodward, Oklahoma, continuous, moderate, yearling grazing native pasture and tame pasture 1961-1976, E = Performance Test of Hybrid Forage Sorghum in Oklahoma 1960-1976.

TABLE LIV

PREDICTIVE PRICE AND YIELD EQUATIONS USED IN THE SIMULATION MODEL

Yields:

1. Stocker Gain Rate = 2.37 + 0.0 X[a]
2. County Grain Sorghum = 27.385 + .47823529 X
3. County Wheat Yield = 26.03 + 0.0 X
4. Experimental Forage Sorghum = 4.345 + .10132353 X
5. County Alfalfa = 1.9915 + .04202941 X

Prices:

1. Wheat = 1.40356 + .01154815 X
2. Grain Sorghum = 1.68579 + .01797580 X
3. November Stockers = 9.27 + .59955187 X
   (400-500# good)
4. March Stockers = 10.08526 + .58030317 X
   (600-700# good)
5. May Stockers = 10.423827 + .58542862 X
   (600-700# good)
6. Cull Cows = 6.307337 + .61828634 X
7. Weaning Calves = 9.12489 + .64284158 X
8. Alfalfa Hay = 13.658 + .69937521 X
9. Forage Sorghum = 5.63128 + .60786957 X

---

[a]X denotes time.

APPENDIX C

DESCRIPTION OF MODEL INPUT

The card column, program variable name, and description of each input item is discussed in this section.

Row	Card Column	Variable Name	Description
		Card 1	
1	17-28	PRPRIC	Purchase price is the estimated total purchase cost of the new investment which includes land value, and depreciated improvements.
2	29-40	DNPAY	Down payment amount.
3	41-52	SALVAL	Salvage value of the depreciable portion of investment.
4	53-64	TXCRED	Amount of investment eligible for 10% investment tax credit.
5	65-76	FSTYRT	Amount of investment eligible for 20% first year bonus depreciation.
		Card 2	
6	5-16	LANDV	Portion of the purchase cost attributible to land value.
7	17-19	IPLNYR	Planning horizon of the decision maker.
8	20-22	ILNLF	Life of loan in years.
9	23-25	IDEPLF	Number of years that the asset is to be depreciated.
10	26	ALNCD	Loan repayment method. Punch "A" for amortized loan, "C" for constant principle, or "E" for earnings applied.
11	27-28	DEPMTH	Method of depreciation. Punch "SL" for straight line, or "DB" for declining balance.
12	29-35	DISRAT	Discount rate.
13	36-42	LNINTR	Loan interest rate.
		Card 3	
14	1-7	LDMULT	Inflation rate for land.
15	8-11	NOENTS	Number of crop and livestock enterprises.

Row	Card Column	Variable Name	Description
16	12-15	NOIT	Number of iterations to be simulated.
17	16-19	NODIST	Number of crop and livestock prices and yields used in the model.
18	20-23	NOPRIC	Number of livestock and crop prices.
19	24-27	NOYLD	Number of livestock and crop yields.
20	28-31	NOL	Number of other liabilities.
21	32-35	NOI	Number of other capital investments.
22	36-39	IDIST	Determines if a normal or triangle or both types of price and yield distributions are used for this simulation. Punch "1" for normal distributions, "2" for triangular distributions, and "3" for both normal and triangular distributions.
		Card 4	
23	1-7	PRTXEX	Number of personal "$750" tax exemptions.
24	8-14	LTEQMN	Minimum equity ratio allowed for long term fixed assets.
25	15-21	ITEQMN	Minimum equity ratio allowed for intermediate term assets.
26	22-28	ITRATE	Interest rate charged on intermediate term loans.
27	29-35	LTRATE	Interest rate charged on long term loans.
28	36-39	ISELL	Determines if the capital investment is sold at the end of the planning horizon. Punch "1" for sale of asset, or "0" if no sale.
29	40-43	ILEND	Determines if the decision maker wishes to allow additional borrowing based on minimum acceptable equity ratios. Punch "1" is borrowing is allowed, or "0" if no borrowing is allowed.
30	44-47	NPVADJ	Determines if interest from excess cash or interest charged on funds borrowed to meet negative cash flow are included in the net present value analysis. Punch "1" if included, or "0" if not included.

Row	Card Column	Variable Name	Description
		Card 5	
31	1-2	ENTNO(I)	A vector of enterprise ID numbers where I is equal to the number of enterprises used in this simulation.
32	3-6	ENTS1(I)	A vector of the first four letters of the enterprise names.
33	7-10	ENTS2(I)	A vector of the second four letters of the enterprise names.
34	11-14	ENTS3(I)	A vector of the last four letters of the enterprise names.
35	15-23	ENTCST(I)	A vector of the enterprise costs per unit.
36	24-29	CINFLT(I)	A vector of the enterprise cost inflation rates.
37	30-39	NOUNIT(I)	A vector of the number of units of each enterprise to be produced.
38	40-47	BUYWHT(I)	A vector of the buy weights for stocker enterprises.
39	52-55	TRORNM	Determines the price and yield distributions to be used. Punch "NORM" for normal distributions, or "TRIA" for triangular distributions. See Card 3, 36-39.
40	56-59	IDEPYR(I)	A vector of the number of years into the future that actual investment in depreciable assets can be specified.
41	60-71	ADDEP(I)	A vector of the amount of average depreciation costs that should be added to enterprise cost per unit in the years after actual depreciation values are specified.
		Card 6	
42	1-2	NORMNO(I)	A vector of the identification number for prices and yields.
43	3-6	AN1(I)	A vector of the first four letters of enterprice prices and yields names.

Row	Card Column	Variable Name	Description
44	7-10	AN2(I)	A vector of the second four letters of the enterprise prices and yields names.
45	11-14	AN3(I)	A vector of the last four letters of the enterprise prices and yields names.
46	15-24	AMIN(I)	A vector of the minimum expected values of enterprise prices and yields.
47	25-34	AMODE(I)	A vector of the most likely value of enterprise prices and yields.
48	35-44	AMAX(I)	A vector of the maximum expected value of enterprise prices and yields.
		Card 7	
49	1-10	AMIN1	The minimum expected value for calving percentage for cow-calf enterprise.
50	11-20	AMAX1	The maximum expected value for calving percentage.
51	21-30	AMODE1	The most likely value for calving percentage.
		Card 8	
52	1-10	AMIN2	The minimum expected value for weaning weight for cow-calf enterprises.
53	11-20	AMAX2	The maximum expected value for weaning weight.
54	21-30	AMODE2	The most likely value for weaning weight.
		Card 9 and 10	
55	FORMAT (5F14.8)	PRSLOP(I)	A vector of the trend values for the enterprise prices where I is the number of enterprise prices.
		Card 11	
56	FORMAT (5F14.8)	YDSLOP(I)	A vector of the trend values for the enterprise yields where I is the number of enterprise yields.

Row	Card Column	Variable Name	Description
		Card 12	
57	5-16	OIVAMT(I)	A vector of other investment amounts where I is the number of other investments.
58	17-28	OISALV(I)	A vector of the salvage value for other depreciable investments.
59	29-40	OITXCD(I)	A vector of the amount of the investment eligible for 10% investment tax credit.
60	41-52	OIFSTY(I)	A vector of the amount of depreciable investment eligible for 20% first year bonus depreciation.
61	53-55	OIYR(I)	A vector of the year in which the other investment begins or is invested.
62	56-58	OILIFE(I)	A vector of the life of the other investment.
63	59-60	OIDPMH(I)	A vector of determining which depreciation method is used. Punch "SL" for straight line depreciation, or "DB" for declining balance depreciation.
64	61-67	OIRATE(I)	A vector of the interest rate which is charged on the other investment if assumed that investments are financed using borrowed funds.
65	68-72	OIASLF(I)	A vector of the asset's useful life.
		Card 13	
66	5-16	OLAMT(I)	A vector of other loan amounts where I equals the number of other loans.
67	17-28	OLPRIN(I)	A vector of the principle payment for other loans if it is known, if it is not known, punch "0", in this column and card column 29-40. If both these card columns are blank or zero, the loan is amortized automatically within the program.
68	29-40	OLITST(I)	A vector of the amount of interest payable each year on the other loan.

Row	Card Column	Variable Name	Description
69	44-46	OLSTYR(I)	A vector of the year of the planning horizon in which the other liabilities or other loans are made.
70	47-53	OLRATE(I)	A vector of the interest rate at which to amortize the loan if the principle and interest amount is not specified above.
		Card 14	
71		PERMIN	Amount of Non-Farm Other Income.
72		PERMEXP	Amount of Tax Deductable Expenses.
73		IDINC	If Non-Farm Income is constant, punch '0001'. If Non-Farm Income increases at a constant percent, punch '0002'. If Non-Farm Income is specified for each year, punch '0003'.
74		IDEXP	If Deductable Non-Farm Expense is constant, punch '0001'. If Deductable Non-Farm Expense increases at a constant percent, punch '0002'. If Deductable Non-Farm Expense is specified for each year, punch '0003'.
75		IYEARS	Number of years of income and expense flows.
76		RTINC	Percentage annual increase in income.
77		RTEXP	Percentage annual increase in expense.
		Card 15	
78		FINCOM	Amount of Family Income.
79		FEXPEN	Amount of Family Expenses.
80		IDINC	If Family Income is constant, punch '0001'. If Family Income increases at a constant percent, punch '0002'. If Family Income is specified for each year, punch '0003'.
81		IDEXP	If Family Expenses is constant, punch '0001'. If Family Expenses increase at a constant percent, punch '0002'. If Family Expenses is specified for each year, punch '0003'.
82		IYEARS	Number of years of income and expense flows.

Row	Card Column	Variable Name	Description
83		RTINC	Percentage annual increase in income.
84		RTEXP	Percentage annual increase in expense.
		Card 16	
85	1-10	MVMACH	The market value of the beginning machinery inventory.
86	11-15	AAGEMH	The average age of the beginning inventory of machinery.
87	16-25	RTINFM	The inflation rate per year for machinery.
88	26-35	MVBLD	Market value of beginning building inventory.
89	36-40	AAGEBD	The average age of the beginning inventory of buildings.
90	41-50	RTINFB	The inflation rate per year for buildings.
91	51-65	MVLAND	The market value of the owned land.
92	66-71	DEPBLM	Percent of beginning inventory of machinery that is depreciable.
93	72-77	DEPBLB	Percent of beginning inventory of buildings that is depreciable.
		Card 17	
94	FORMAT (9F8.0)	NEWAPR(I,J)	An upper triangular matrix of factored variance and co-variances of enterprise prices, where I + J = the number of enterprise prices.
		Card 18	
95	FORMAT (5F10.0)	NYLDAA(I,J)	An upper triangular matrix of factored variance and co-variances of enterprise yields, where I + J = the number of enterprise yields.
		Card 19	
96	FORMAT (5F14.8)	PRITCP(I)	A vector of intercept values for the enterprise prices, where I = the number of enterprise prices.

Row	Card Column	Variable Name	Description
		Card 20	
97	FORMAT (5F14.8)	YDITCP(I)	A vector of intercept values for enterprise yields where I = number of enterprise yields.
		Card 21	
98	FORMAT (5F8.0)	YIELDX(L,K)	An upper triangular matrix of factored correlation coefficients of enterprise yields where L and K = the number of enterprise yields.
		Card 22	
99	FORMAT (9F8.0)	PRICET(L,K)	An upper triangular matrix of factored correlation coefficients of enterprise prices where L and K = the number of enterprise prices.

VITA

Michael Leroy Hardin

Candidate for the Degree of

Doctor of Philosophy

Thesis: A SIMULATION MODEL FOR ANALYZING FARM CAPITAL INVESTMENT ALTERNATIVES

Major Field: Agricultural Economics

Biographical:

Personal Data: Born at Muskogee, Oklahoma, July 14, 1949, son of Talmage and Maureen Hardin.

Education: Graduated from Wagoner High School, Wagoner, Oklahoma, in May, 1967; received the Bachelor of Science degree from Oklahoma State University with a major in Agricultural Economics in May, 1971; received the Master of Science degree from Oklahoma State University with a major in Agricultural Economics in May, 1973; completed requirements for the Doctor of Philosophy degree from Oklahoma State University with a major in Agricultural Economics in July, 1978.

Professional Experience: Assistant Data Processing, Department of Agricultural Economics, Extension Farm Management, Oklahoma State University, September to May of 1968-1970; Student Trainee, Oklahoma Farmer's Home Administration, May, 1970 to August, 1970; Programmer, Costfinder Farm Record System, Extension Farm Management, Oklahoma State University, September, 1970 to August, 1971; Research Assistant, Department of Agricultural Economics, Oklahoma State University, September, 1971 to December, 1972; Extension Farm Mangement Associate, Department of Agricultural Economics, Oklahoma State University, January, 1973 to present.