THE UNIVERSITY OF MANITOBA

RISK ANALYSIS OF FARMLAND INVESTMENT

BY

RAYMOND E. SNITYNSKY

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS

WINNIPEG, MANITOBA

OCTOBER, 1983

RISK ANALYSIS OF FARMLAND INVESTMENT

by

Raymond E. Snitynsky

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

ABSTRACT

Current economic conditions require careful consideration of a decision to invest in farmland. This study is set in the economic and agronomic environment of the Prairie Provinces and examines the risk taken by a farm business through purchasing additional farmland.

The analytical model is based on a Monte Carlo experimental design. The model evaluates the effects of loan arrangements and debt levels on farm firm survival and growth. The model examines four different loan arrangements. The first scenario simulates a long term loan where the interest rate is fixed for the amortization period. The remaining three scenarios examine loan arrangements where interest rates vary every 1, 3, or 5 years within a long term loan. Within each scenario various debt levels are simulated. Debt levels are represented by six different farmland investments. These investments are compared to a benchmark where the investor has no debt and purchases no additional land. Farm firm survival is expressed in terms of the probability of bankruptcy. Growth is expressed in terms of a probability distribution illustrating annual percent change in equity.

The specific program logic requires investor supplied information to initialize several deterministic relationships and the distributions for the random variables. This information represents the data source which will be used in each ten year trial. Each ten year trial is replicated 300 times.

The major improvement within this model compared to some previous methods applied to evaluate farmland investments is the treatment of crop prices, yields and interest rates. These variables are randomly generated and are essential in risk analysis of farmland investment.

The economic conditions specified have a significant effect on the random variables and subsequently the simulated results. Expected inflation will have a major influence on interest rates and the price of wheat. In addition, the final results are influenced by the initial economic conditions for the price of wheat and interest rate.

The results of an investor purchasing no additional land is an average annual equity increase of 4 percent. The average is simulated to occur a third of the time. When the investor purchases a greater amount of farmland the average annual equity growth increases; however, the probability of obtaining this growth is reduced. If an investor used an annually renewed loan with a debt/equity ratio of 3, there is a probability of 0.07 of obtaining the modal equity growth of 15 percent. If the investor did not purchase any additional land, there would be a probability of 0.31 of having a 4 percent modal equity growth. The remaining loan arrangements illustrate a similar relationship.

Given falling interest rates over the longer term, the annually renewed loan represented the least risk of failure. As the renewable term of the loan increased there was a corresponding increase in the risk of failure. This result was due mainly to the specification of the initial interest rate with respect to the expected inflation rate. If the expected inflation rate is relatively low compared to the interest rate, interest rates can be expected to decline. Although interest rate is a random variable, fixed bounds were incorporated to represent a deterministic relationship between the inflation rate and interest rate. In this study, the inflation rate was assumed to be 7 percent and the interest rate for a 30 year nonrenewable loan was 13.5 percent. Therefore, an investor with an annually renewed loan had the advantage of usually renewing at a lower interest rate compared to an investment with a 30 year fixed interest rate.

Statistically, the percentage change in equity was not influenced by the terms of credit used to acquire farmland until the debt/equity relationship exceeded 0.82. This inplies financial arrangements did not influence farm growth or survival under the specified economic conditions. The simulations indicated the probability of attaining a desired rate of equity growth was not dependent upon how the farmland purchased was financed until debt levels exceed 82 percent of the farm's equity at the time of the investment. At leverage ratios greater than 0.82, a nonrewable loan was significantly different than a loan where the interest rate is renewed annually. An annully renewed loan and a 5 year renewable loan were also significantly different. In both cases the probability distribution of the percent change in equity for a land investment with annually renewed interest rates inferred a greater likelihood of a higher growth rate would be obtained than with a fixed interest rate or when the interest rate changed every five years.

ACKNOWLEDGEMENTS

I wish to thank Dr. Daryl Kraft under whose supervision this research project was undertaken. His generous assistance and guidance throughout this period has been invaluable.

As well, I would like to thank my other committee members, Dr. Robert Aukes and Dr. Terry Johnson for their criticisms and encouragement.

Further thanks are extended to Mr. Neil Longmuir for the computer programming which was essential to this project.

Many thanks are due to fellow colleagues for their discussion on a wide variety of topics, helpful views and friendship throughout the time I spent working on this project.

I would also like to thank my family for their patience and support.

Finally, I would like to thank my wife Betty, for her diligent assistance, patience and understanding throughout this endeavor.

CONTENTS

<u>Appendix</u> <u>page</u>

LIST OF TABLES

LIST OF FIGURES

Chapter I

INTRODUCTION

1.1 PROBLEM STATEMENT

Of all the decisions facing a grain producer, few if any are more critical then purchasing farmland. The difficulty arises because the future is unknown and assumptions are made about future circumstances. There is a certain degree of risk[1] associated with each assumption and the combined risk will have a definite influence on the decision maker. Evaluation of the risk involved with all relevant information is critical in determining whether the investment is economically feasible and financially viable. Normally investment experience is limited for most buyers because the frequency of farmland investment is low. Inexperience may threaten the viability of the farm because of errors in purchasing farmland.

Typically, farmland investments involve large amounts of debt capital. Terms of financing often involve a fixed commitment of funds ranging from 20 to 40 years. For the farmer the fixed commitment must be met by revenue from highly uncertain production, marketing and financing factors.

---

[1] For purposes of this study, the term risk represents the variation in key agricultural variables, based on objective and/or subjective data.

Arrears will occur if fixed contractual commitments can not be met by volitile net cash flows. Table 1.1, compares arrears with realized net farm income. The relatively large number of arrears in the early seventies and eighties represent a symptom of a financial stress with several probable causes. The most likely cause of arrears in any one year is a corresponding low net cash flow in the previous year. In the early seventies, net income was relatively low resulting in a high percentage of arrears. The low percentage of arrears experienced between 1974 and 1980 relates to a higher cash income between 1973 and 1979. However, when income started to decline in 1979 due to falling crop prices and inflating operating costs, there was a corresponding increase in arrears. If the arrears continue, the ultimate result can be a significant increase in voluntary liquidation or bankruptcy.

The fact arrears range from 3.4 to 28.2 percent, implies farmland investors have endured varying degees of risk. Although there is risk involved in any investment, it is important to assess if farmland investors are exposed to greater risk in the seventies and eighties then previous years. If farmland investment risk has increased, a study addressing this topic is more than justified.

The crop price variability has a definite effect on the amount of risk sustained by the investor. Table 1.2, represents the price variability of wheat between 1949 and 1982. In the period between 1949 and 1969, the greatest frequency of price variability between two successive years occurred in the category of 0 to + or -5 percent. Comparing this frequency with that of 1970 to 1982, it is apparent that the latter displays much greater price risk. This increased price risk is supported

TABLE 1.1

Arrears and Net Farm Income in Manitoba

Year	Total Arrears as Percent Due in Previous 12 Months[1]	Realized Net Farm Income[2] (Million Dollars)
1969	N/A	110
1970	14.8	125
1971	25.1	104
1972	28.2	195
1973	17.6	278
1974	6.4	370
1975	3.4	385
1976	3.9	251
1977	4.2	186
1978	4.9	297
1979	5.1	276
1980	6.6	265
1981	11.5	225
1982	16.1	248*

[1] Farm Credit Corporation, Federal Farm Credit Statistics: 1970-1982, Ottawa, annual, Table 17.

[2] Statistics Canada, Farm Net Income: 1981, Ottawa, annual, Table 1.

*preliminary

by the fact there is significant crop price variation. Furthermore, the row representing the least annual price change illustrates the greatest range of observations between the two time intervals. This supports the added price variation between the two time intervals. Thus, land investments in the seventies and early eighties have been subject to greater output price risk then previous years.

TABLE 1.2

Price Variability of Wheat

Change in Price as % of Previous Year (%)	Frequency	
	1949 - 1969	1970 - 1982
25+	0	2
16 - 24	1	3
0 - 5±	11	1
-6 - 15-	3	3
-16 - 24-	2	2
-25-	0	0

SOURCE: Manitoba Department of Agriculture, Manitoba Agriculture: 1981 Yearbook, Winnipeg, annual, pp. 50.

Another factor which can cause arrears is the risk associated with price variability of inputs. Table 1.3, presents four crop inputs and indicates the price variability over two successive decades for these factors of production. In all cases, the early decade displays less price variability and a stronger central tendency then the later decade. In the latter decade, a definite central tendency can be detected only in the price of farm machinery. All the input costs of the latter decade display inflationary conditions. Therefore, in the years between 1970 and 1982, an investor would tend to plan more for cost increases rather then for stability.

The variability of price of output and inflationary tendencies for inputs can be magnified in the difference between total revenues and operating costs. Therefore, when these price risks are taken together the net cash flows could magnify the total risk in excess of the risk associated with total receipts or operating costs. It is this downside risk which the investor is mainly concerned about, since it threatens the viability of the farm. Price variability of both operating costs and crops has increased significantly in the seventies implying a greater chance of a farm being in arrears.

The extent a farmland investor is levered is also a probable cause of arrears. The amount of debt a grain producer holds is based on both the expected net returns from grain production and capital gains from land. In the period between 1970 and 1979, Kraft determined the total annual rate of return of a farmland investment in Western Canada to be 18.4 percent.[2] This rate of return represents an annual return from farmland rent and capital appreciation. Since this return is significantly greater than that experienced in previous decades, investors could generally pay a relatively higher price for additional farmland. The high-

---

[2] D. F. Kraft, Economic Implications of Absentee Ownership of Farmland, Paper prepared for Farm Business Challenges of the 1980's, Department of Agricultural Economics, University of Manitoba, 1981.

TABLE 1.3

Price Variability of Inputs in Western Canada

Change In Price as % Previous Year (%)	Frequency							
	Pesticides		Fertilizer		Farm Machinery		Interest Rates	
	62-71	72-81	62-71	72-81	62-71	72-81	62-71	72-81
25+		2		2				3
16 - 24		1		3		1		2
6 - 15	1	4		3		7	2	2
0 - 5+	8	3	9	1	10	2	7	
-6 - 15-	1		1	1			1	2
-16 - 25-								1

SOURCE: Statistics Canada, Farm Input Price Index, Ottawa, quarterly, Table 3.

er farmland price ultimately rests upon the assumption that the revenue remaining after all costs associated with crop production will continue to increase at the rate land prices are rising. The rate of return is capitalized into the price of land, which has resulted in farm investors paying more for farmland. Since cash returns were high, some investors consequently became levered at a higher level since they believed the additional debt could be serviced.

In the eighties, net income started to decline, farmland prices in most areas declined, and arrears started to increase. The arrears in the eighties are based on land prices which have capitalized the returns encountered throughout the seventies. However, these returns have not been maintained, but the land mortgages based on expected high returns still exist. Therefore, the frequency of arrears in the eighties may continue to increase to a level greater than previously experienced in the early seventies.

Given the increase in price risk experienced throughout the seventies and eighties, it would appear important to analyse the total risk associated with farmland investment. In retrospect, not only has risk increased, but given the underlying supply and demand conditions in grains and oilseed products, the price variability is likely to continue and farmland investmemt risk could be greater in the future.

1.2 OBJECTIVES OF THE STUDY

Financial stress results from fixed contractual commitments not being met by revenue from highly uncertain production, marketing, and financing factors. Within many of these factors, the grain producer has little influence. However, the grain producer does command the amount of land acquired and the price paid. The amount of debt capital which the investor uses will be directly related to the chance of financial failure.

The objective of the study is to evaluate farm growth and survival associated with farmland investment within the Prairie Provinces. In order to achieve this general objective, three specific objectives are identified:

1. to develop a Monte Carlo simulation model which can be used to determine financial consequences of addition farmland investment within a stochastic environment,
2. to evaluate the effects of debt levels on farm firm survival and growth, and
3. to evaluate the effects of fixed and variable interest rates on farm firm survival and growth.

1.3 OUTLINE OF STUDY

To this point, the problem has been introduced and briefly discussed, and the objectives of the study have been set out. Chapter II presents initial underlying assumptions and methodology used. In addition, Chapter II will contain a review of the related studies associated with the determination and specification of various components within the model.

A complete documentation of the simulation model will be presented in Chapter III. The purpose is to illustrate the components, their interrelationships, and the method in which risk of investing in additional farmland is determined. Chapter IV will specify the conditions of the different scenarios identified for the experiments. Empirical results of increasing leverage and loan arrangements will be analysed. Chapter V summarizies the contents of this study and examines some of the limitations.

Chapter II

RISK EVALUATING METHODS AND RELATED STUDIES

2.1 TECHNIQUES FOR EVALUATING RISK IN CAPITAL BUDGETING

A major component in investment analysis is the estimation of future cash flows. These forecasts are interpreted as a "best estimate" which may in fact vary widely from year to year. There have been several proposed methods in evaluating investment risk. The criteria for evaluating risk involves a trade off between operational simplicity and theoretical validity. Table 2.1 presents a brief overview of risk evaluating criteria ranging from crude rules of thumb to sophisticated, operationally less convenient methods. A complete illustration of the use of different methods are presented in Lusztig and Schwab.[3]

In practice, it is quite common to ignore risk. This implies that an investment will be based upon the best estimates of net cash flow. The disadvantage of this approach is that even though various investments have varying degrees of risk, a "best estimate" will still be used. Thus, an investment with a large expected value and variation of net cash flow will be preferred to an investment with a lessor expected value and variation because variation of the expected value is being ignored. If risk was taken into account the latter investment may be chosen. The one exception where risk can be ignored is in making

---

[3] P. Lusztig and B. Schwab, Managerial Finance in a Canadian Setting, (Toronto: Butterworth and Company Limited, 1977), Chapter 6.

TABLE 2.1

Techniques For Evaluating Risk In Capital Budgeting

A. Simple rules of thumb:

1. Ignoring risk
2. Conservative estimates
3. Payback period

B. More sophisticated rules of thumb:

1. Risk adjusted discount rate
2. Certainty equivalents

C. Other decision making aids:

1. Decision Trees
2. Sentivity Analysis
3. Monte Carlo simulation

SOURCE: P. Lusztig and B. Schwab, Managerial Finance in a Canadian Setting, (Toronto: Butterworth and Company Limited, 1977), pp. 156.

investment decisions where the investment is relatively small in relation to the firm's total resources. In this case, the benefits derived from a sophisticated analysis may not warrant the costs. This particular risk evaluating criteria is not applicable to most grain producers contemplating a land investment.

Conservative estimates are often used to account for risk. In order to limit downside risk, the cash flow estimates are merely scaled down. This method does have limitations since it lacks analytical backing.

Conservative estimates are usually extremely subjective without the investor realizing the consequences on the capital budgeting results. However, conservative estimates are a basis for certainty equivalents to be discussed later.

Payback period is widely used in ranking investments because of it simplicity. The criteria involves choosing the investment which returns the initial investment in the least number of years. The major limitation is that cash flows occuring after the payback period are ignored. This approach receives limited use in land investment due to the low net cash flows and long planning horizon.

A more sophisticated method of dealing with risk is by using risk-adjusted discount rates. This approach relies on increasing the discount rate by a risk premium to reflect the investments degree of risk. The result of increasing the discount rate will be to lower the investment's net present value, thus making it less financially attractive. The greater the risk associated with the investment, the greater the economic undesirability. The limitation that does occur relates to the question of the appropriate risk-adjusted discount rate. In many cases it is merely based on the investor's subjective value. This method also implies a questionable assumption about the risk of a project's cash flow over time. It involves tying time value of money and risk together in the same discount rate, resulting in compounding risk over time. Bierman and Smidt[4] discuss these shortfalls to a much greater extent.

---

[4] H. Bierman and S. Smidt, The Capital Budgeting Decision, (New York: MacMillan Publishing Co., Inc., 1980), Chapter 9.

In order to overcome some of the limitations of risk-adjusted discount rates, a sophisticated method is used involving certainty equivalents. In this approach, risk is accounted for by adjusting the net cash flows. This allows the discount rate to reflect only the time value of money with each net cash flow having an associated probability to account for risk. The greater the risk the smaller the associated expected net cash flows. The result being similar to using conservative estimates. The complexity occurs in a multi-period case where each certainty-equivalent coefficient reflects a decision maker's specific risk preferences. The decision maker's risk preference usually changes depending on the size of the investment as well as the time period involved. To determine his risk preference, utility theory is used to elicit an individuals indifference curve between risk and money income. However, this technique is complex and has several limitations as discussed by Raiffa.[5]

Decision trees are used in investments involving sequential events. They are favored due to their lesser degree of complexity. However, they are limited to a few key variables involving explicit probabilities. In the land investment decision there are too many variables involved to make decision trees a likely alternative.

Sensitivity analysis is used frequently to determine the responsiveness of the outcome with regard to the influencing variables. This added information is intended to enhance the investor's decision making process. This technique allows the investor to concentrate on the vari-

---

[5] H. Raiffa, Decision Analysis: Introductory Lectures on Choices under Uncertainty, (Philippines: Addison-Wesley Publishing Company, 1970), Chapter 4.

ables that have the greatest effect on the acceptance or rejection of a potential investment. Sensitivity analysisis is usually performed on computer-based models making analysis of alternatives manageable. Therefore, under different scenarios the investor can evaluate risk. An example is presented later using this particular technique.

In cases where several variables interact collectively to determine the overall risk, the Monte Carlo simulation technique is superior to sensitivity analysis. This is especially true when one considers net cash flows being made up of several components affecting both costs and revenues. An example is presented by Hertz,[6] illustrating the impact of several interrelated variables resulting in a outcome which may be far from obvious. Another advantage is objective and/or subjective probability distributions can be used to influence the decision outcome. Unlike other methods, the Monte Carol simulation technique results in a derived probability distribution. The investor can then examine the complete range of outcomes which is important to the decision making process based on all associated risk. This technique being computer-based can accommodate varying degrees of complexity without any major comprehension problems.

---

[6] D. B. Hertz, "Risk Analysis in Capital Investment," Harvard Business Review, Vol. 42, 1964, pp. 95-106.

2.2 REVIEW OF RELATED STUDIES

Numerous studies have addressed the question of the price of land. These studies have used a multitude of investment evaluation techniques with varing degrees of complexity. They range between determining the value of an individual acre of land based on its productive value to the investor's ability to pay for land based on all farm and nonfarm revenue streams. It is necessary to review these studies to obtain a proper perspective of risk within a capital budgeting framework.

2.2.1 Income Capitalization Method of Land Valuation

An important feature of income capitalization models is that they incorporate discounted cash flows to allow for the time value of money. Capital budgeting is a widely accepted technique in evaluating various types of investments, and is generally accepted as being among the best available for the evaluation of new investment opportunities. Numerous examples can be sited in Barry, Hopkins and Baker[7] illustrating its potential use.

A traditional method used by real estate appraisers to value farm land is:

$$V = I/r \tag{2.1}$$

where:

V = value of land,

I = annual expected net return to land, and

---

[7] P. J. Barry, J. A. Hopkins and C. B. Baker, Financial Management in Agriculture, (Danville: The Interstate Printers and Publishers, 1979), Chapter 12.

r = discount or capitalization rate.

If the expected net income is $50 per acre, (gross income minus all costs except interest on land investment) and the discount rate is 10 percent per year, the value of land would be $500 per acre. However, this formula provides accurate estimates only if the three following conditions are met:

1. annual net returns are constant over time,
2. the discount rate remains constant, and
3. an infinite or very long planning horizon.

Research by Crowley[8] indicates that these three conditions are rarely met and that the discount rate is generally underestimated given Equation 2.1. This is mainly the result of many economic variables that would affect the capitalization formula are assumed constant.

Willet and Wirth[9] illustrate a method to determine the value of additional land to the farm investor, and the maximum price he can pay for the additional land. By expanding the traditional income capitalization formula to include more variables affecting net income expectations, a more realistic land price is derived. The purpose of determing land value first is to assess the likihood of acquiring the land as well as allowing the farmer to more effectively bargain with the seller.

Willet and Wirth consider several additional variables in analysing land value. This allows the conditions of the traditional income capitalization method to be relaxed. These variables include:

---

[8] D. W. Crowley, "Actual Versus Apparent Rate of Return of Farmland Investment," Agricultural Finance Review, Vol. 35, 1974, pp. 52-57.

[9] G. S. Willet and M. E. Wirth, "How to Analyze an Investment in Farmland," Western Regional Extension Publication, April, 1980.

1. annual return to land and projected annual rate of change in the return,
2. annual rate of change in land value,
3. annual rate of change in the general price level,
4. number of years in the farmers planning horizon,
5. income tax paid on annual land returns and on capital gains when land is sold,
6. income tax deductions of interest paid on debt capital, and
7. required after-tax real rate of return on land investment.

Several improvements are apparent in this model. All the additional variables accommodate additional important information in assessing land value. It allows for net returns, land price and general price level to trend upwards. The tax effect on net returns, capital gains and tax saving from interest expense are considered. A further breakdown of the land value method is presented in Appendix A.

The second part of Willet and Wirth's analysis involves calculating the farm operater's maximum bid price according to his cash flows. They determine whether a farm operator's available equity capital reserves and unused borrowing capacity are sufficient to finance the land purchase at the market price. Next, they determine if there is sufficient cash flow to meet potential loan commitments. An important aspect of their approach is that they consider the financial feasibility of the total land base (current plus added land). If the current market price exceeds the maximum bid price, cash flow difficulties will likely occur. Otherwise, the investment may appear desirable with the supporting analysis.

The method used in determining the maximum bid price is basically a cash flow analysis. All relevant annual cash inflows and outflows are considered on the total land base. This includes farm and non-farm inflows and outflows. The objective being to determine the annual residual cash flow to service the loan. The size of the loan will be directly reflected in the maximum bid price. The loan is also affected by the available cash assets required for the downpayment, the interest rate and the loan repayment period. The specific analysis can be examined in Appendix A. The use of their analysis will assist the decision maker in comparing land value based on the net returns and land appreciation against the investor's ability to pay for land.

Some of limitations which exist in the analysis are:

1. income tax benefits from investment credit and depreciation are not considered,
2. relevant recapture of depreciation is ignored, and
3. net returns, land values and general price level are assumed constant or increasing at a constant rate.

A more sophisticated capital budgeting model has been developed by Lee[10] for evaluating farm real estate investments. It is based on using eleven economic variables similar to the previous model. These variables are:

P - the average price per acre of recent sales of comparable parcels in the area,

CC - the after-tax opportunity cost of capital,

---

[10] W. F. Lee, "A Capital Budgeting Model for Evaluating Farm Real Estate Purchases," Canadian Farm Economics, Vol. 11, 1976, pp. 1-10.

n - the buyer's planning period in years,

ANI - the expected annual net cash income per acre befor taxes,

GNI - the expected annual rate of growth in annual net cash income per acre,

MTR - the buyer's marginal income tax rate,

DP - the proportion of the purchase price paid down,

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 gains income in year n when the parcel is sold, and

P* - the maximum bid price, given values for the preceeding eleven variables.

In Lee's model, land purchase is considered acceptable if the present value of all cash inflows are equal to or greater than the present value of all cash outflows. Or simply, the investment is acceptable if net present value is equal to or greater than zero.

The model is a computer-based program which allows sensitivity analysis of all relevant variables. The results of such an analysis are illustrated in Table 2.2. It can be seen that of the ten variables, four have a major effect on the maximum bid price. These variables include: annual net income, growth in annual net income, inflation in land values and the cost of capital. The responsiveness of the maximum bid price to these variables does cast doubt on the reliability of Lee's Model. As illustrated previously, greater fluctuations and price risk exist in the seventies then previous decades. Therefore, the probability of these variables fluctuating is correspondingly greater.

The purpose of sensitivity analysis is to provide the investor with insights of the main variables of risk. However, when the outcome is extremely sensitive to four of the eleven variables the investor may become overwhelmed with the range of outcomes in evaluating risk. An additional limitation is the farm investor is usually not interested in testing the impact of any one variable, rather he is concerned about the overall impact of all the variables. In periods of relatively high risk, as is presently being experienced, sensitivity analysis has limited applications. Thus, sensitivity analysis is useful in conjuction with other investment models, if the investor is concerned with the sensitivity of each variable.

In Lee's maximum bid price model there is no question of the importance of the eleven economic variables used. However, criticism is raised regarding the technique used to account for risk. Superior results can be derived using a Monte Carlo land investment model. The farmland investor will have the advantage of being able to evaluate a specific generated probability distribution of possible outcomes, rather then a single-valued estimate which has been adjusted for risk. As described by Jones,[11] simulation has the advantage of a "look before you leap" approach.

---

[11] G. T. Jones, Simulation and Business Decisions, (Harmondsworth: Penquin Book, Ltd., 1972), pp. 28.

[12] Hertz, op. cit.

TABLE 2.2

Sensitivity Of Maximum Bid Price (P*) To Input Variables

Input Variables	Range of Values of Input Variable	Corresponding Range in Maximum Bid Price
A. Terms of mortgage financing		
Interest rate (IR)	.06 - .14 per year	824 - 590
Down payment (DP)	0 - 1.0	724 - 584
B. Opportunity cost of Capital (CC)	.06 - .14 per year	941 - 536
C. Land prices and inflation		
Average price of comparable parcels (P)	\$400 - \$800 per acre	606 - 783
Expected rate of inflation in land values (INF)	0 - .15 per year	512 - 1782
D. Income and tax variables		
Income per acre (ANI)	\$20 - \$100 per acre	437 - 1124
Growth in net income per acre (GNI)	0 - 6%	633 - 865
Marginal tax rate (MTR)	0 - 5%	739 - 655
Capital gains tax (T*)	0 - 25%	749 - 695
E. Time horizon and loan amortization period (n, t)	5 - 35 years	653 - 678

Source: Lee, W. F., "A Capital Budgeting Model for Evaluating Farm Real Estate Purchases." Canadian Farm Economics, Vol. 11, 1976, pp. 1-10.

Note: Solutions were obtained by holding all variables constant except the one of interest.

Base Values: P = \$600 per acre, CC = 10%, N = 20 years, ANI = \$50 per acre per year, GNI = 2% per year, MTR = 30%, DP = 25%, IR = 10% per year, t = 20 years, INF = 6% per year, T* = 25%.

Hertz[12] demonstrated the application of probabilities in yielding entirely different and better decisions. Given the knowledge of the risk which exists, investors can maximize the value of information for decision making. This allows the investor to maximize the value of the existing information. The probability distribution of the range of financial outcomes are generated by repeated sampling of the individual distributions. In Hertz's example, the individual distributions involved: market size, selling price, market growth rate, share of market, investment required, residual value of investment, operating costs, fixed costs and useful life of facilities. These distributions involve subjective and/or objective probabilities. The formulation of these subjective probabilities should not be a problem to the decision maker. As Officer and Anderson[13] suggest, the decision maker will never be in a complete state of ignorance concerning an investment proposal. Even when there is limited knowledge Raiffa[14] illustrates how subjective probabilities can be derived.

An important advantage of using a stochastic simulation model is evident when considering the relative ease of testing consequences of stochastic dependence, resulting from the joint dependence of some variables on other common variables. An example is when price and yield are jointly related in determining gross revenue. It is possible to model the applicable stochastic dependencies by using the probability distributions associated with price and yield. Deriving correlations in this

---

[13] R. R. Officer and J. R. Anderson, "Risk, Uncertainty and Farm Management Decisions," Review of Marketing and Agricultural Economics, Vol.36, 1968, pp. 3-19.

[14] Raiffa, op. cit., pp. 104-128.

manner may be more expedient than direct elicitation of joint distributions.

Triangular distribution functions and Monte Carlo methods are used by Sprow[15] in evaluating the potential profitability of research effort. Due to varying degrees of optimism and pessimism it is difficult to interpret single valued estimates. However, by using economic estimates based on probability distributions one is forced to consider both optimistic and pressimistic cases.

Research by Sprow illustrates that no additional advantages were derived by using a PERT beta distributions over triangular distributions. The PERT treatment used for scheduling of networks, can use a beta distribution. This distribution requires minimum, modal and maximum estimates. However, the PERT treatment is not completely specified by these three variables, it also requires the use of standard deviation. Triangular distributions were much more amenable since the decision maker only required knowledge of minimum, maximum and most likely values. The investor did not require knowledge of expected mean, variance and or probability.

---

[15] F. B. Sprow, "Evaluation of Research Expenditures Using Triangular Distribution Functions and Monte Carlo Methods," Journal of Industrial and Engineering Chemistry 59, (July 1967): 35 - 38.

2.3 SUMMARY

The model development is based on several previous studies. The shortfall which occurs in all these studies is the results are based on complete certainty by the investor. In Lee's model, risk is only considered in hindsight by using sensitivity analysis. A Monte Carlo technique would be superior in dealing with several variables which interact collectively to determine overall risk. The use of this technique allows the incorporation of risk by using randomly generated crop prices, yields and interest rates.

Chapter I

THE FARMLAND INVESTMENT MODEL

The major purpose of the analytical model is to simulate the risk of a farmland investment. The model is designed specifically to determine the probability of obtaining different levels of equity growth within a stochastic economic and crop production environment. The farmland investor can evaluate the possible consequences of alternative scenarios by using this interactive computer-based model.

1.1 CONCEPTUAL MODEL DESCRIPTION

To facilitate the comprehension of the model a schematic diagram is presented in Figure 3.1. Initially, an overview is presented which briefly explains the various components and their interrelationships. An in-depth discussion on each component follows.

The program logic of the Monte Carlo experimental design will simulate a maximum of ten successive calendar years. This time period is used because it is expected the greatest financial stress will occur in the initial years following the land investment. If the investor survives ten years it is assumed the chance of going bankrupt beyond this time is minimal. In addition, an attempt to exceed this term will create difficulties in the reliability of the parameters and the resulting distributions. The simulation loop is terminated whenever year ten is reached or bankruptcy occurs.

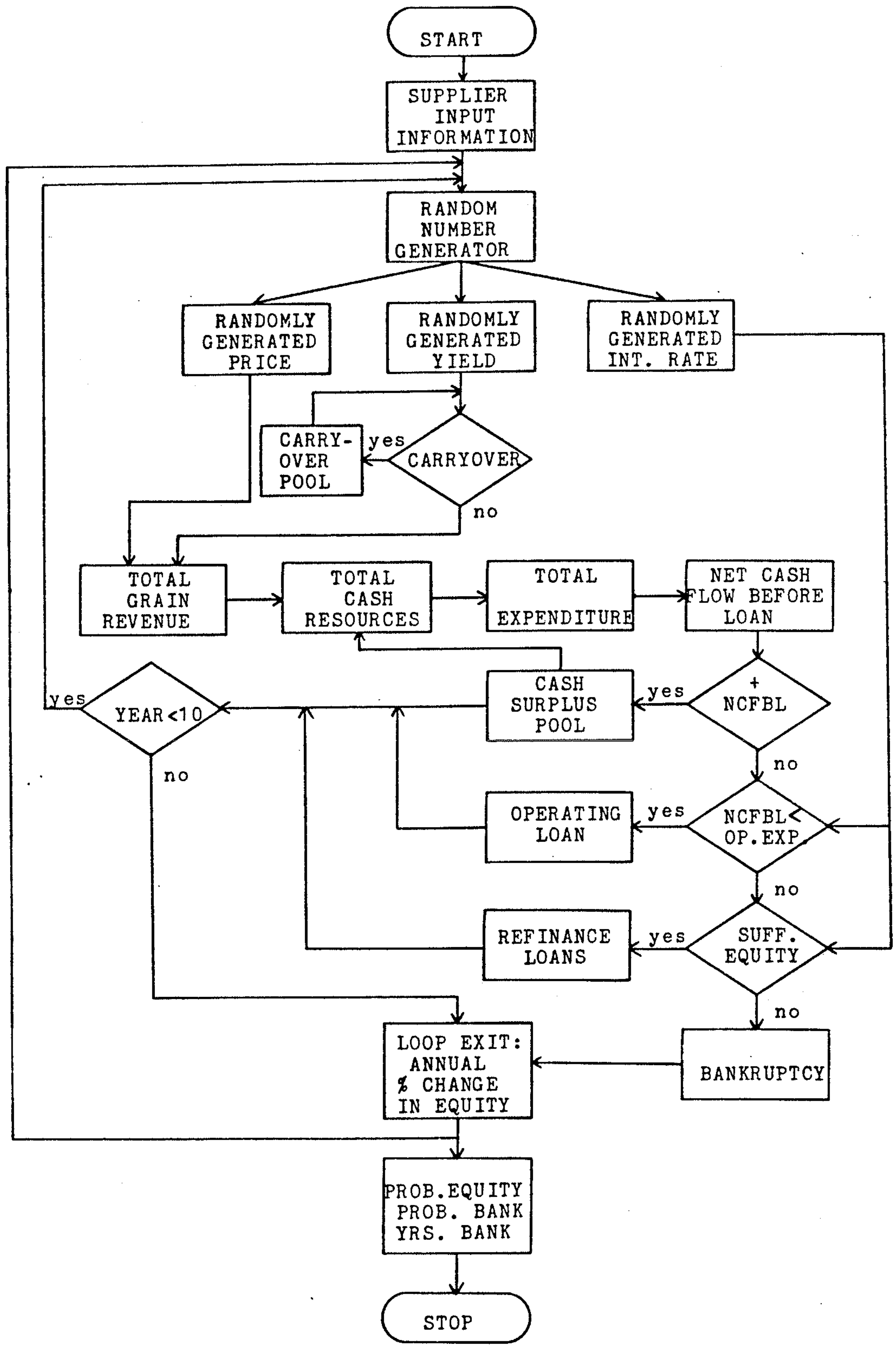

FIGURE 3.1: Schematic Diagram of Farmland Investment Model

Upon the termination of the loop a final calculation is made to determine annual percent equity change and the occurrence of bankruptcy. The program is then initialized to zero and another ten year simulation trial is undertaken. The desired number of trials will depend on the observations required to establish a stable statistical distribution. This is determined by using a chi square test on various sample sizes. After the desired number of trials is established, the probability of annual percent equity change and bankrupty is presented.

The first component of the model is the initial input of investor information. Specific questions are asked to initialize the distribution for the random variables and several deterministic relationships. The information from these questions is stored and at the start of each trial the program is initialized with this identical data source. The specific questions appear in Table 3.1 and are referenced later in Model Components.

TABLE 3.1

Interactive Program Questions

I. Basic Financial, Marketing, and Production Information

1 The number of productive acres purchased (ac):
2 The price paid/acre of productive land ($/ac):
3 The average price of comparable land from recent sales ($/ac):
4 The current price of wheat normally sold ($/bus):
5 The lowest wheat yield ever expected (bus/ac):
6 The highest wheat yield ever expected (bus/ac):
7 The most frequent wheat yield expected (bus/ac):
8 The average quota expected per year (bus/ac):
9 The expected annual increase in quota (%):
10 The total operating expenses/acre ($/ac):
11 The expected annual increase in operating expense (%):
12 The present cost of fertilizer/acre ($/ac):
13 the present cost of pesticide/acre ($/ac):
14 The present land taxes/acre ($/ac):
15 The current operating loan interest rate (%):
16 The operating loan outstanding ($):
17 The basic living and personal expenditures/year ($/yr):
18 The expected increase in cost of living expenses (%):
19 The present non-crop income ($/yr):
20 The expected annual increase in non-crop income (%):
21 The total value of cash & near cash, & operating supplies ($):
22 The beginning wheat & wheat equivalent inventory (bus):
23 The market value of machinery ($):
24 The average replacement frequency of machinery (yrs):
25 The total number of rented productive acres (ac):
26 The total number of owned productive acres after purchase (ac):
27 The expected income tax liability for current year ($):

II. Loan Type Used to Finance Land Purchase

A. Amortized, fixed interest rate, land mortgage

28 The percentage of the land purchase that is paid down (%):
29 The mortgage rate (%):
30 The amortization period of the loan (yr):

B. Amortized, renewable, land mortgage

28 The percentage of the land purchase that is paid down (%):
29 The mortgage rate (%):
30 The amortization period of the loan (yr):
31 After how many years is the loan renewed (yr):

Table 3.1 - Continued

III. Existing Loan Information

A. Amortized, fixed interest rate
   1 The initial length of the loan (yr):
   2 The number of payments made:
   3 The present annual payment:
   4 The interest rate (%):

B. Equal principle, floating or locked interest rate
   1 The length of the loan (yr):
   2 The number of payments made:
   3 The annual principle payment ($):
   4 Enter the locked interest rate (%) or press return
     if the interest rate is floating:

C. Equal principle, renewable, fixed interest rate
   1 The total length of the loan (yr):
   2 The total number of payments made:
   3 The annual principle payment ($):
   4 The present locked interest rate (%):
   5 After how many years is the loan renewed (yr):

D. Renewable, amortized, fixed interest rate
   1 The number of years the loan is amortized over (yr):
   2 The total number of payments made:
   3 The present annual payment ($):
   4 The initial fixed interest rate (%):
   5 After how many years is the loan renewed (yr):

IV. Model Program Options

A. The Default Sample Size is 30
   Do you wish to change this limit ?
   Enter Number Or Press Return:

B. The Default Debt/Equity Limit to
   Invoke Bankruptcy is 5.67
   Do you wish to change this limit ?
   Enter Y-Yes ; N-Press Return:

C. Do you wish to print the detail on each loan?
   Enter Y-Yes ; N-Press Return

D. Do you wish to print the detail for each sample?
   Enter Y-Yes ; N-Press Return:

The next component is a random number generator. It selects numbers between zero and one and is used in determining values of three random variables.[16] These variables being grain price, grain yield, and an interest rate. Random prices and yields are used to determine the total revenue from grain production. Randomly generated interest rates are applied whenever additional financing is required.

The next group of components deal with the derivation of total grain revenue. Total grain revenue is determined by the product of annual grain sale and random price. The amount of grain sold will be a function of random yield, any existing carryover, and quota on grain deliveries. If quota restricts sales, the remaining grain will be carried over until the next year. Depending on yield and quota in the next year, carryover is reduced or expanded.

After total grain revenue is determined, it will be added to non-grain revenue and cash surplus from the previous year resulting in total cash resources. Total cash resources represent the maximum cash resources available in any one year to defray annual expenditures. If there is a cash shortfall then additional financing will be an alternative.

Total annual expenditures include such factors as new and existing annual loan payments, total operating expenses, capital inputs to accommodate the additional land purchase, living and personal withdrawals and income tax. The magnitude of these expenditures relative to total cash resources will determine net cash flow before operating loan requirements (NCFBL).

---

[16] Whenever a randomly generated value is stated, it is understood to mean random within the specified bounds.

If NCFBL is positive, the cash surplus pool will increase by this exact amount. This pool will be used to offset any negative net cash flow in successive years. It will also be used as a basis for determining the amount of machinery inputs purchased in the current year.

An operating loan will be required if two conditions are met: 1) NCFBL is negative, and 2) NCFBL is less then the value of total operating expense. If these conditions are satisfied, the operating loan will be equal to the absolute value of the negative NCFBL. If only the first condition is met, but not the second, loan consolidation will be an alternative. This alternative is used if there is sufficient equity to refinance all outstanding loans. If this condition is not satisfied the investor will be declared bankrupt and the simulation loop will be terminated.

The program loop will continue as long as bankruptcy does not occur and the simulated year is less than ten. However, when the simulation loop is terminated the annual percent change in equity is calculated. In addition, the bankruptcy event and the year in which it occurred is stored. After the desired number of trials the probability of annual percent equity change and bankruptcy will be displayed. These results will be used to evaluate risk associated with various debt levels and loan arrangements based on farm survival and growth.

3.2 MODEL COMPONENTS

In this section a detailed discussion will be presented on the underlying relationships specified for each component. The criteria used to determine the degree of component specification is based on the net benefits derived from the additional information. Each component has a direct effect on the probability of insolvency and equity change associated with a farmland investment. To simplify the discussion, continual reference should be made to Figure 3.1 and Table 3.1.

3.2.1 Supplier Input Information

The interactive program logic can be divided into four general question categories:

1. Basic financial, marketing, and production information,
2. Type of loan used to finance land purchase,
3. Types of existing loans held by the investor, and
4. Model program options.

The specific question breakdown of each category is presented in Table 3.1. Each question relates directly to one of the simulation model's components. The specific question(s) will be discussed within one of the following components.

Priority was placed on asking the minimum number of questions, yet deriving the maximum information. This information represents the data for the model. The accuracy of the output will be a direct reflection of the accuracy of information supplied.

3.2.2 Random Number Generator

The random number generator selects values between zero and one. Any one value may be interpreted as the percentage of the area under a cumulative probability distribution of the specific bounded variables. These variables include wheat price, wheat yield, and operating loan interest rate.

3.2.3 Randomly Generated Wheat Price

A major source of risk in farmland investment is price variability of the commodity being produced. Table 3.2 presents the average wheat prices received by the farmer and the percent change from the previous year. The price changes range from -21 percent to +35 percent. This variation is dealt with by a specific distribution.

Due to the significant price variation, grain price is represented by a rectangular distribution with variable bounds linked to the price of grain in the previous year. The investor determines the initial distribution by specifying the current price per bushel of wheat. This question is represented by Q4.[17] The price specified should reflect the average grade of wheat he usually obtains. Based on the specified price, a lower and upper price bound are determined. When these bounds are determined the price will be randomly selected between these bounds. However, these distrubution bounds are constrained by overall bounds. The following equations illustrate the procedure used:

$$LP_i = (1-.25)P_{i-1} \tag{3.1}$$

---

[17] Specific reference will be made to the relevant question(s) in each component in it abbreviated form: Q4 (Question 4).

TABLE 3.2

Wheat Prices and Annual Changes

Year (yr)	Price ($/bu)	Price Change From Previous Year (%)
1973	4.30	
1974	4.00	-7
1975	3.53	-11
1976	2.80	-21
1977	2.67	-5
1978	3.61	+35
1979	4.63	+26
1980	5.52	+30
1981	4.50	-12
1982	3.95*	-14

SOURCE: Manitoba Department of Agriculture, Manitoba Agriculture: 1981 Yearbook, (Winnipeg, Manitoba: Government Printing, 1981), p. 50.

* prelimary

$$UP_i = (1+.25)P_{i-1} \quad (3.2)$$

if: $LP_i < 3.27(1+OEI)^i$ (3.3)

then: $LP_i = 3.27(1+OEI)^i$ (3.4)

and: $UP_i = [3.27(1+OEI)^i/.75]1.25$ (3.5)

if: $UP_i > (3.27 + 2.60)(1+OEI)^i$ (3.6)

then: $UP_i = (3.27 + 2.60)(1+OEI)^i$ (3.7)

and: $LP_i = [(3.27 + 2.60)(1+OEI)^i/1.25].75$ (3.8)

$P_i = LP_i + [(UP_i) - (LP_i)]R \quad ; \quad 0 < R < 1$ (3.9)

where:

LP = lower bound wheat price,

UP = upper bound wheat price,

P = randomly generated wheat price,

i = time in years,

OEI = expected annual increase in operating expense (inflation factor), and

R = random generated variable.

The general purpose of the above equations is to have a bounded price distribution with an upward trend. This objective is satisfied by using two sets of bounds. The first set of bounds are used to determine the price distribution. The second set of bounds not only confine the first set, but can result in an upward price trend. However, wheat prices can fall in several successive years even with the existing upward bias. This upward bias is specific to the investor, who can specify a lower limit of no change (0 percent).

The price distribution is based on a maximum price change of + or -25 percent of the previous year's price,[18] as represented in Equation 3.1 and 3.2. This range will account for the majority of the price changes illustrated in Table 3.2. However, as Table 3.2 exhibits, the magnitude of positive changes are greater than that of the negative changes. Price changes which exceed the positive 25 percent change contribute to an upward price trend represented in Figure 3.2. This trend is dealt with in the overall bounds.

Historical data is used to derive an overall upper and lower price bound as well as an upward trend. Prices prior to 1970 were relatively stable and therefore are used as an initial base. A lower price bound is derived by using the price received in 1970 and inflating it by an annual rate of 7 percent. Prices experienced between 1972 and 1982 have not fallen below this bound. Therefore, the lower limit base price expected in 1982 is $3.27. The upper limit in 1970 is based on the price peaks of 1973 and 1980. It is derived by taking the average difference between the price peaks and the lower price limit for 1973 and 1980. The resulting value of $2.60 is added to the lower price limit derived in 1982. Therefore, the 1982 lower and upper price base are respectively $3.27 and $5.87. These price limits will be used to form the overall price bounds in years beyond 1982.

The rate of increase of this price bound after 1982 is determined by the rate of total operating expense increase specified in Q11. This inflation factor is employed for both the expected increase of operating inputs and product output. This linkage is supported by the economic

[18] In year one of the simulation, the previous year's price is equal to the initial input price.

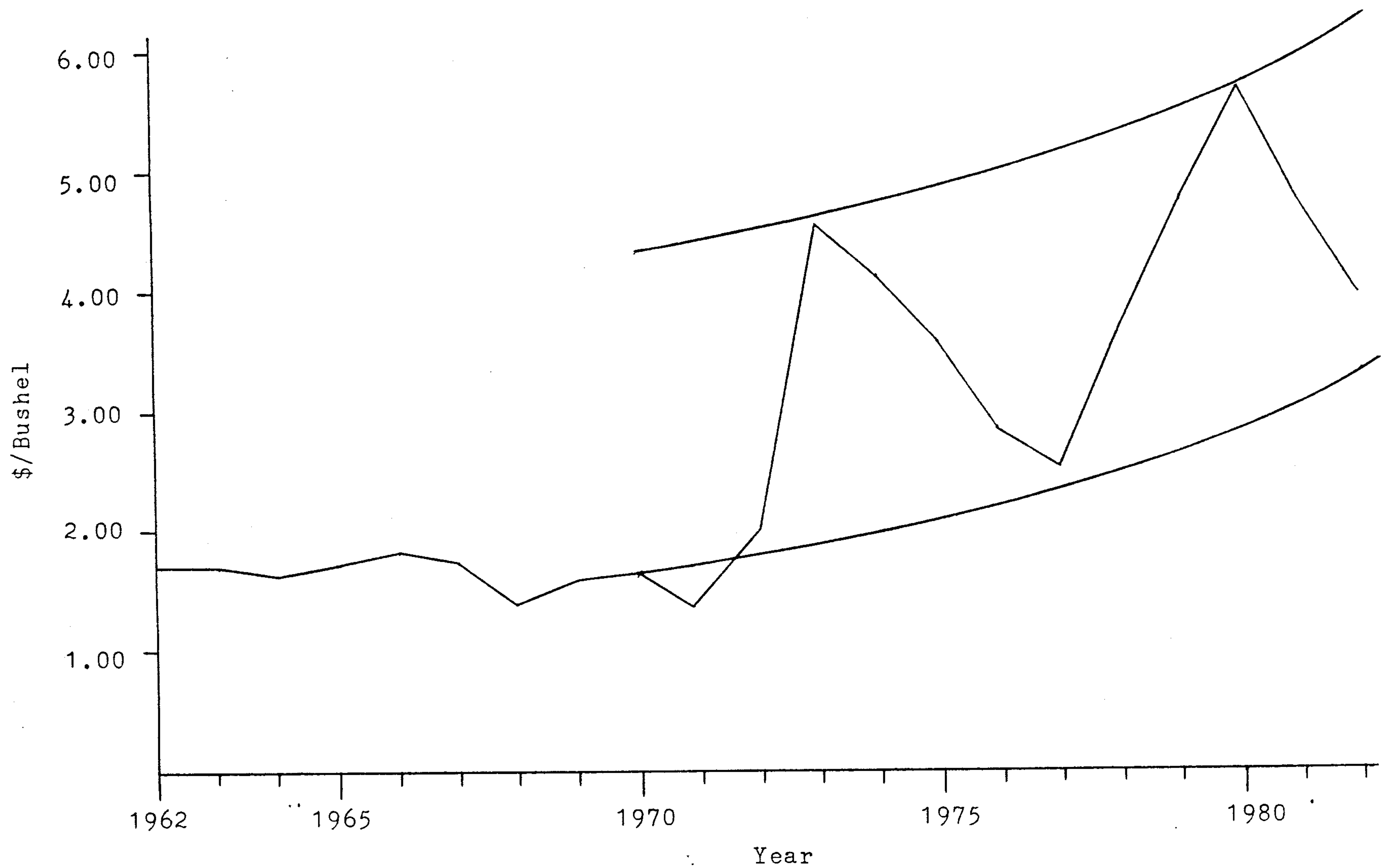

Figure 3.2: Annual Wheat Prices and Price Bounds

relationship that price of inputs and output are related and on average should move together. However, in successive price changes this may not be apparent due to the possibility of prices continually falling between the overall price bounds.

The overall bounds which confine the price distribution are represented in Equation 3.3 and 3.6. If the price distribution determined in Equation 3.1 and 3.2 satisfies either Equation 3.3 or 3.6, the distribution will be reset. If price drops belodw the lower bound, Equation 3.4 and 3.5 will reset the distribution. If the upper bound is exceeded the Equation 3.7 and 3.8 will be used.

The purpose of resetting the distribution is to maintain a distribution range of + or -25 percent from the mean price. When resetting occurs, the lower price bound will equal the lower overall price bound or the upper price bound will equal the upper overall price bound.

The random generated price is obtained by taking the product of the range of the distribution bounds and the random value. It is then added to the lower distribution bound.

3.2.4 Randomly Generated Yield

Crop yield will have a major impact on the growth and survival of the farm firm. Wheat yields exhibit a random nature since they are largely affected by weather. This randomness is a major contributor to uncertainty within farmland investment.

The distribution used for yield differs from price since yield is not as volitile. Due to its central tendency it is represented by a triangular distribution. This method of specifying yield is an important aspect of the model due to its ease of use, nonnormality capacity and it economy of elicitation. To initialize the distribution the investor specifies the minimum, maximum and modal yield as specified by Q5, Q6, and Q7 in Table 3.1. The derivation of the triangular distribution is specified by the following equations:

$$f(x) = 2(x-a)/(b-a)(m-a) \quad ; \quad a<x<m \tag{3.10}$$

$$f(x) = 2(x-a)/(b-a)(m-b) \quad ; \quad m<x<b \tag{3.11}$$

where:

a = minimum wheat yield,

m = modal wheat yield,

b = maximum wheat yield, and

x = the value of the wheat yield.

Probability density function Equations 3.10 and 3.11 are then integrated resulting in the following cummulative probability functions:

$$F(X) = (x-a) / (b-a)(m-a) \quad ; \quad a<x<m \tag{3.12}$$

$$F(X) = 1-(x-b) / (b-a)(b-m) \quad ; \quad m<x<b \tag{3.13}$$

where F(X) represents a random value between zero and one to derive a stochastic variable x. The value of x is solved for in Equation 3.14 and 3.15:

$$x = a+[R(b-a)(m-a)] \quad ; \quad 0 <R< m-a/b=a \tag{3.14}$$

$$x = b-[(1-R)(b-a)(b-m)] \quad ; \quad m-a/b-a <R< 1 \tag{3.15}$$

where:

R = random generated value.

The variation of the stochastic variable x is dependent on the range of the minimum and maximum yield. This range represents the degree of risk associated with yield as perceived by the investor. By specifying the modal yield the investor can incorporate skewness to account for risk specific to the agronomic condition of the region, or crop insurance which guarantees a yield at a lower level.

3.2.5 Randomly Generated Interest Rates

The interest expense represents a cash requirement which can influence farm business growth and survival. The magnitude of the interest expense will be directly affected by the principle outstanding and the interest rate. Due to the nature of farmland investment the land mortgage will probably represent the largest portion of the farm investor's outstanding principle.[19] The financial burden associated with interest expense will be intensified if the investor has any previous loans or requires contingent loans to finance machinery and/or operating expenses. Therefore, financial commitments such as loan payments do create added net cash flow uncertainty since a fixed commitment must be paid out of volatile cash inflow. This uncertainty is further complicated by loans which possess floating interest rates or renegotiable loans with uncertain future interest rates.

---

[19] Nature of farmland investment refers to the land purchase indivisibility and low turnover which may make purchases larger than ideally desired.

Interest rates are represented as a random variable similar to price. Support for depicting interest rates as random variable is presented in Table 3.3. Only annual changes of interest rates are represented even though there may be significant changes within the year. As illustrated the annual percent changes are extremely volitile and range from -21 percent to +41 percent. Thus, a rectangular distribution is used in the simulation model.

Table 3.3, supports an assumption which is explicit in several price relationships. Grain prices and input prices are assumed to have a general upward trend. Since the consumer price index has always been positive, it is expected that inflation will be apparent in the time horizon of the simulation. Therefore, wheat prices will have an upward bias according to the investor's perceived inflation rate. However, wheat prices still have the potential to drop several years in a row. This being the case, land prices are expected to show a similar relationship.

The rectangular interest rate distribution is specified by two sets of bounds. The first set of bounds are fixed. The second set of bounds are variable, which are confined within the fixed set of bounds. The distribution is represented in the following equations:

$$LI_i = (1-.25)\,IR_{i-1} \qquad (3.16)$$

$$UI_i = (1+.25)\,IR_{i-1} \qquad (3.17)$$

$$\text{if:} \quad LI_i < (CPI-2) \qquad (3.18)$$

$$\text{then:} \quad LI_i = (CPI-2) \quad ; \quad UI_i = (CPI-2)/(.75)1.25 \qquad (3.19)$$

$$\text{if:} \quad UI_i > (CPI+7) \qquad (3.20)$$

$$\text{then:} \quad UI_i = (CPI+7) \quad ; \quad LI_i = (CPI+7)/(1.25).75 \qquad (3.21)$$

$$IR_i = LI_i + (UI_i - LI_i)R \quad ; \quad 0 < R < 1 \qquad (3.22)$$

where:

TABLE 3.3

Range Of Interest Rate And Inflation Rate

Year (yr)	Average Bank Prime Rate (%)	Change From Previous Year (%)	Change In CPI (%)	Deviation Between CPI And Interest Rate
1970	8.17			
1971	6.48	-21	2.9	+3.6
1972	6.00	-7	4.8	+1.2
1973	7.65	+28	7.5	+0.2
1974	10.75	+41	10.9	-0.2
1975	9.33	-13	10.8	-1.5
1976	10.04	+8	7.5	+2.5
1977	8.50	-15	8.0	+0.5
1978	9.69	+14	9.0	+0.7
1979	12.92	+33	9.1	+3.8
1980	14.25	+10	10.1	+4.2
1981	19.38	+36	12.5	+6.9
1982	16.94	-13	11.6	+5.3

SOURCE: Bank of Canada, Bank of Canada Review, (Ottawa, Ontario: Government Printing, 1970-1982), pp. 20:36.

LI = lower interest rate bound,

UI = upper interest rate bound,

IR = random generated interest rate,

CPI = the expected annual increase in cost of living, and

i = time in years.

The fixed bounds are determined by the investor specifying the expected annual increase in cost of living expenses Q18. Fisher[20] obtained very high correlations by comparing an index of anticipated price level changes and money rates. Fisher's study results in the nominal rate of interest adjusting by exactly the amount of the anticipated inflation. This index is used as an inflation factor to calculate the interest rate bounds. Based on this index the lower bound is determined by subtracting 2 percent and the upper bound is calculated by adding 7 percent to the specified rate. This interest rate range is supported by Table 3.3. If one compares the deviation between the annual percent change in CPI and the average annual interest rate, the corresponding rounded deviations are -2 and +7 percent.

Within these fixed bounds, variable bounds are employed. The investor will initiallize these bounds as well. The current operating interest rate (Q15) is specified, and is confined to the interest rate range within the fixed interest rate bounds. The annual interest rate range is + or -25 percent about the specified interest rate or the previous years random generated interest rate. The bounds of + or -25 percent are used to account for the majority of the changes that have occurred

[20] I. Fisher, The Theory Of Interest, (The Macmillian Company, 1930), pp. 270-280.

between 1970 and 1982.

Interest rates possess the same resetting feature as illustrated in price distribution. If the bounds determined in Equation 3.16 and 3.17 satisfy either Equation 3.18 or 3.20, then the distribution will be reset. Depending on which bound is exceeded, the distribution will be reset according to Equation 3.19 or 3.21. There will be unrestricted interest rate changes between the fixed bounds. However, when the distribution exceeds the fixed bound it will be reset with an opposite bias in interest rate change.

Finally, the random generated interest rate is based on the upper and lower bounds. The annual range between LI and UI is determined and multiplied by the random number. The product is then added to the lower interest rate bound.

3.2.6 Grain Sale And Carryover

Grain sales are critical in determining net cash flow. The amount of annual sale will be affected by the specified quota and crop yield. Serious financial consequences can occur if either quota or crop yield restrict crop sales.

Total annual grain production is determined by multiplying the random generated yield by the total number of productive acres (rented and owned). The number of acres are specified by the investor in Q25 and Q26. However, total annual grain production plus last years carryover (or initial carryover Q22) may not be completely sold in one year due to delivery quota restrictions.

Expected annual wheat quota is supplied by the investor (Q8), as well as, the expected annual increase in quota (Q9). The amount of the grain sold in a year will be specified by the following equations:

$$Sale_i = \min\{[(TA)(QUO)(1+QINC)^i] ; [(TA)(YLD)+(CO_{i-1})]\} \qquad (3.23)$$

where:

Sale = expected annual wheat sale,

TA = total acres (rented and owned),

QUO = expected quota per acre,

QINC = expected annual increase in quota,

YLD = random generated wheat yield per acre, and

CO = wheat carryover.

Grain sale will be the minimum of the two calculations. Some grain carryover will occur if the first calculation is the minimum value since it is essentially being restricted by the quota. If the second calculation is the minimum value no carryover will exist for the next year. Whenever carryover does exist it will be held over until the next year.

This component tends to stabalize sales because of the grain delivery quota. This stability will only occur if total grain production plus the previous years carryover is greater than quota allowance for grain sale. However, stabalization will not occur if quota does not restrict grain sales. These characteristics are quite indicative of grain farming and important in determining the risk associated with farm growth and survival.

3.2.7 Total Grain Revenue and Cash Resources

Total grain revenue is determined by the product of the random price of wheat and the amount of grain sold. The level of this estimate will have a critical effect on farm firm survival. The greatest amount of risk will occur at this point since both determining variables are randomly generated and independent of each other.

In addition to total grain revenue, total cash resources are composed of non-crop income and cash surplus from previous years. Total cash resources are used to meet all annual cash requirements and if a deficit occurs additional financing will by considered.

The inclusion of non-crop income (before tax) allows the investor the flexibility of entering income received from non-grain enterprises or off-farm income and their expected increase. This is an important consideration since it may make the difference between bankruptcy and survival. This information is specified by Q19 and Q20.

Another important element of the total cash resources is the previous year's cash surplus pool. In Q21, the investor specifies the amount of current liquid assets, thus, initializing the cash surplus fund. This fund contains cash, near cash and operating supplies. Near cash assets refer to those assets which can easily be converted to cash if required. Initial operating supplies are included because total operating expenses are calculated independent of initial operating supplies. Initial grain revenue is not dealt with in this fund since it was handled in grain carryover.

In the initial year, the cash surplus is first committed to the down-payment for the land purchase. Any remaining surplus will be important in reducing financial stress in the initial years. In any period following the first year, the cash surplus will be allowed to build up or drop to zero. Its magnitude will be determined by the relative magnitudes of total cash resources and total expenditures.

3.2.8 Total Expenditures

Total expenditures have to be evaluated in analysing farmland investment risk. Total expenditures are subtracted from total cash resources to determine net cash flow before any additional financing. The elements within total expenditures include: new and existing loan payments, total operating expenses, capital purchases, living and personal withdrawals and income tax. These elements will be individually discussed.

3.2.8.1 Annual Loan Payments

The basis of the annual land purchase payments are specified in Q1 and Q2. The investor specifies the number of productive acres purchased and the price paid per acre. The precise annual payments are determined by the information specified in respect to the financial arrangements contracted to finance the land purhase. The investor has a choice between an amortized, locked interest rate loan; and a renewable, amortized, locked interest rate loan. Both of these loans and related questions are specified in Table 3.1.

The amortized annual payments will be based on the specified downpayment, interest rate and the length of the loan. If the investor uses a non-renewable loan the payments will be equal for the entire life of the loan, provided loan consolidation does not occur. If he specifies a renewable loan, the initial payments will be based on the initial specified interest rate. When the loan is renewed the remaining principle is refinanced over the remaining life of the loan at a random interest rate.

Since fixed contractual commitments result in additional farmland investment risk, it is important to consider both the current land mortgage and any existing loans. This model is designed to accommodate existing loan specification. Four different types of existing loans can be specified. These loans being:

1. amortized, locked interest rate,
2. equal principle, floating or locked interest rate,
3. equal principle, renewable, locked interest rate, and
4. renewable, amortized, locked interest rate.

The specific questions of each loan type are presented in Table 3.1. If the interest rate is floating or the loan is renewable, the new interest rate will be randomly generated. All of the loan types identifiable are conventional and should encompass most situations.

The final loan considered is an operating loan. In Q16 the initial outstanding loan repayment is specified. This payment will contribute to reducing total cash resources in the initial year. Successive operating loans and loan consolidation will be discussed later.

Another factor applied to new and existing loans is interest rate premium. In any one year, one random generated interest rate is determined. This rate is the basis for interest rates with different loan terms. If the type of loan being used is an operating loan, no interest rate premium will be applied. Therefore, the random interest rate will represent the operating loan interest rate. However, a loan which is renewed every two years will have half a percent premium. For every additional year in the renewable term, half a percent increments will be added on. Thus, a five year renewable loan will have a 2 percent premium added onto the random generated interest rate of that year. Any loan term beyond 5 year renewable will still possess a 2 percent premium. This premium is incorporated to reflect the added risk premium credit institutes traditionally implement on longer term loans. This is assumed to be the maximum premium over the operating interest rate.

3.2.8.2 Total Operating Expenses

Total operating expenses and their related annual rate of increase are specified in Q10 and Q11. These are the annual costs associated with sustaining farm operations. Operating expenses per acre include those cash costs specified in Table 3.4. However, there are exceptions concerning the elements involved. First, no interest expense is considered since it is specifically accounted for in other components. Second, land taxes and rental payments are incorporated into total operating expenses.

Land taxes are determined by Q14. This value is added to total operating expenses and is affected by the same inflation factor.

Rent expense represents the amount of money a grain producer would pay a landlord for use of his land. This rental charge is added onto the total operating expenses. It is specified as the land rent per acre and is derived by the following formula:

$$\text{Rent}_i = 1/3[(P_i+P_{i-1}/2)\text{MYLD})] - [(1/3\text{RNT}+\text{T})(1+\text{OEI})^i] \qquad (3.24)$$

where:

TABLE 3.4

Total Operating Expense

Operating Cost	Cost Per Acre ($/ac)
Fertilizers	________
Pesticides	________
Seed	________
Fuel	________
Repairs to Machinery	________
Labor	________
Overhead	________
OPERATING EXPENSES PER ACRE	________

Rent = value of rent to be paid to landlord (\$/acre),

P = randomly generated wheat price,

MYLD = modal yield,

RNT = fertilizer and pesticide expense,

T = real estate tax paid by landlord, and

OEI = expected annual increase in operating expenses.

The rent calculation represents the return a landlord would receive under a third share agreement. In this type of an agreement the landlord receives one third of the revenue, and pays one third of fertilizer and pesticide expense and all the land taxes.

To incorporate rent into total operating expense a different approach is used which gives identical results. First, the landlord's return is the value derived in Equation 3.24. If the tenant pays the landlord the rent, the landlord still gets the correct rent. This results in the tenant treating the land as owned land by paying all costs and keeping all returns. The only additional cost he must pay is the rent to the landlord. This expense is simply the rent multiplied by the number of rented acres. This is the value that will be added onto the total operating costs calculation.

The revenue calculation of Equation 3.24 is the product of the modal yield and the average price over two years. Average price and modal yield are used to reduce fluctuations in rent. This stabalizing force is required since land rent will be used to influence land prices. This will be discussed in a later component.

Subtracted from this revenue is the amount the landlord would pay in a typical share agreement. The first two expenses are fertilizer and pesticide expense which are specified in Q12 and Q13. The landlord only pays one third of these expenses and is responsible for paying all the land taxes (Q14). These expenses are affected by the inflation factor specified in Q11.

Land rental agreements are an important component in the agricultural industry. They will result in reducing risk since they provide an income source without a large capital investment associated with the land purchase.

The following equation illustrates the calculation of total operating expense:

$$TOE_i = OA[(OEAC + T)(1 + OEI)^i] + RA(RENT)^i \qquad (3.25)$$

where:

TOE = total operating expense

OA = owned acres,

OEAC = operating expense per acre,

OEI = operating expense increase,

RA = rented acres, and

RENT = value of rent to be paid to landlord.

3.2.8.3 Capital Inputs

Farmland investment may or may not cause financial hardships; however, an investor would be extremely nearsighted if contingent investments associated with the land purchase were not considered. The investor has to consider the tradeoff between productive efficiency and farm financial survival. This problem is complex due to the risk associated with future cash flows.

Capital requirements are an important feature within the model. A capital investment strategy has been built into the model. This strategy allows the investor to postpone capital requirements for a specified period. After this period the investor is forced to make minimum capital replacement. If a large net cash flow is available a greater capital investment will be made to reduce the income tax liability.

The investor first specifies the market value of his machinery (Q23) and the average replacement frequency (Q24). In year one, the program logic will compare the investor's market value of machinery and the required machinery investment to determine the amount of machinery replacement. The required machinery investment is based on the average machinery investment within Manitoba. The purpose of the average replacement frequency question is to allow the investor the flexibility to determine his own economic depreciation. This depreciation is used to determine investment requirements.

The investor will either be undercapitalized and required to invest, or overcapitalized and no machinery investment will be required. The first situation to be examined is where the investor is undercapitalized. The desired machinery investment in year one is determined by the following equation:

$$CI_i = (TA)(RMI) - (MI)(1-1/ALM) \quad (3.26)$$

where:

CI = capital replacement required in year one,

TA = total productive acres (Rented and owned),

RMI = required machinery investment per acre

(set equal to $158/acre in 1982),

MI = initial current market value of machinery

(supplier input minus one year depreciation), and

ALM = average replacement frequency of machinery.

The capital input in year one will be the difference between the total machinery requirement and the market value of existing machinery discounted for one year of economic depreciation. The desired machinery investment is based on Manitoba census information. In 1981, the average machinery investment was $143 per improved acre.[21] The annual rate of increase in machinery replacement in 1982 has been 10.5 percent.[22] This rate is used to determine the required investment for 1982. Therfore, in 1982 the average machinery investment is $158 per acre.

In the case where the investor is overcapitalized, no additional capital purchases are required in the initial years. However, the machinery value will decline annually by a rate of one over the average replacement frequency. Reinvestment will be required when the depreciated value drops below the required level of machinery investment. It is assumed that the average replacement frequency is based on use of the machine as the criteria for replacement. Therefore, an investor who uses his machinery three times as much is expected to replace his machinery in one third of the time.

---

[21] Manitoba Department of Agriculture, 1981 Yearbook Manitoba Agriculture, Winnipeg, annual, 1980, pp. 96-98.

[22] Statistics Canada, Farm Input Price Index, Catalogue 62-004, Ottawa, quarterly, Table 3.

Additional machinery investment modifications are made in year two and three. If the investor is undercapitalized, the required capital investment is made in year one. However, two years grace thereafter is allowed where the investor does not have to make any machinery investment. This period of grace will only occur if there is negative net cash flow before an operating loan (NCFBL). The reason for the above strategy is to reduce the probability of bankruptcy in the initial years. This strategy is also indicative of an actual investor who will postpone replacement when under financial stress.

After year one, the factors determining the amount of capital purchases will depend on the specific year and NCFBL assuming the investor is below the desired level of replacement. The program logic is formulated to compare a desired machinery replacement with the actual replacement. The difference between the desired and actual is referred to as a machinery deficit pool. Whenever the investor makes a capital replacement the deficit will be reduced. If no repacement is made or a minimal replacement, the deficit will acculmulate.

The desired annual machinery investment will be determined by Equation 3.27 and contributes to the deficit pool.

$$CI = (RMI)(TA)(1/ALM)(1+OEI)^{i} \qquad (3.27)$$

Equation 3.28 represents the derivation of the machinery deficity pool:

$$MACDEF_{i} = (MACDEF_{i-1}(1+OEI)) + CI - MACREP_{i} \qquad (3.28)$$

where:

MACDEF = machinery deficit pool, and

MACREP = machinery replacement.

The machinery replacement in year two and three is as follows:

$$MACREP_i = Max[NCFBL_i \; ; \; 0 \;] \tag{3.29}$$

subject to: $NCFBL_i < MACDEF_i$,

else: $MACREP_i = MACDEF_i$.

Thus, in year two and three the minimum capital replacement will be zero or a positive NCFBL. Machinery replacement in any one year cannot exceed the machinery deficit. The portion of the machinery deficit that is not discharged will be carried forth into the following years. Machinery deficit is also subject to an inflation factor. If the investor postones capital replacement, its inflated value will have to be repalced.

From year four onward the investor has to make a minimum investment as follows:

$$MACREP = CI \; . \tag{3.30}$$

The above condition will be satisfied if NCFBL is negative. However, if his NCFBL is positive the investor is allowed to reduce the machinery deficit pool by the following equation.

$$MACREP_i = min[NCFBL_i \; ; \; MACREP(where:MACDEF=0)] \tag{3.31}$$

In the event that the investor is overcapitalized, the result will be a delay machinery investment. The delay in machinery replacement will be determined by the value of the depreciated machinery investment relative to the required machinery investment. The investor's machinery value will decrease according to Equation 3.32.

$$MI_i = MI_{i-1}(1-1/ALM) \tag{3.32}$$

Machinery replacement will occur when the depreciated machinery investment is less than the required machinery investment. Then the undercapitalized process will continue as previously discussed.

3.2.8.4 Living and Personal Withdrawals

The investor has the flexibility to determine the tradeoff between living expenditures and farm equity growth. In Q17 and Q18 the investor specifies the expected annual living and personal withdrawals and the expected annual rate of increase. This value will represent a lump sum cash flow commitment in the relevant year.

3.2.8.5 Income Tax Expense

Income tax is another cash outflow. This factor will have an effect on any postive net cash flow. When net cash flow is negative, very little if any income tax will be paid.

Before determining the income tax payable, taxable income has to be calculated. The following equation defines taxable income:

$$TAXINC_i = (TGR_i + NGI_i) - (TOTINT_i + TOE_i + CCA_i) \tag{3.33}$$

where:

TAXINC = taxable income,

TGR = total grain revenue,

NGI = total nor-grain income,

TOTINT = total interest expense,

TOE = total operating expense, and

CCA = capital cost allowance.

Taxable income is determined on a cash basis. Total cash income is made up of both grain revenue and non-grain income. Deducted from total cash income is a cash expense and a depreciation expense.

The first expense to be considered is total loan interest. In any one year the interest expense is based on the interest rate(s) and the total principle oustanding at the end of the previous year. The outstanding principle is based on the land loan, operating loan, and all existing loans. The interest expense is totally deductible from taxable income.

Another expense which is totally deductible is cash operating expenses. They represent goods and services which are used up within the current production year.

The original cost of machinery or buildings do not reduce taxable income by the purchase price as is the case with other operating expenses. However, due to wear and obsolescence a portion of these assets are allowed to be charged as an operating expense. This charge being referred as capital cost allowance.

The CCA deduction is based on the undepreciated cost of capital multiplied by a specified rate. Since the majority of the machinery value in a grain farm is in Class 10, which is essentially self-propelled machinery, a maximum CCA rate of 15 percent is allowed. Within this model, this rate is used consistently even though all other types of machinery have a lower rate. Using the higher rate uniformly will offset the tax deduction from tax credits which have not been specifically addressed in this study. Equation 3.34 and 3.35 calculate the total undepriciated cost of capital which is then used to determine CCA.

$$TOTUCC_i = MI_i(1-.15)^{i-1} + TOTREP_i \qquad (3.34)$$

Where:

TOTUCC = total undepreciated cost of capital,

MI = market value of initial machinery investment, and

TOTREP = total capital replacement.

In this equation, the initial machinery investment is assumed to equal the undepreciated cost of capital. This assumption avoids additional supplier input information which may not benefit the final results significantly. Total capital replacement is represented by the following equation:

$$TOTREP_i = TOTREP_{i-1}(1-.15) + MACREP_i \qquad (3.35)$$

The value of MACREP has already been discussed in the capital inputs section.

The initial machinery investment and machinery replacement is discounted annually by a factor of .85. The assumption has been made that all machinery will be depreciated at a CAA rate of 15 percent. This is based on CCA rates in Revenue Canada Taxation Guide which allows CCA at one half the stated maximum rates under Part XI.[23] To determine the actual CCA deduction Equation 3.36 is employed.

$$CCA_i = .15\ (TOTUCC_i) \qquad (3.36)$$

---

[23] The Department of National Revenue, Farmer's Income Tax Guide, (Winnipeg: Revenue Canade Taxation, 1982), p.25.

This tax deduction is based on the TOTUCC in any one year. As indicated previously, CCA deduction will be affected by the initial machinery investment and annual machinery replacement.

Once the taxable income is determined it will be multiplied by a marginal tax rate (MTR), to derive the income tax payable. However, since each investor's tax strategy differs, an assumption was made on the applicable marginal tax schedule. The tax schedule was based on determining a taxable income where the investor's tax rate would be zero. At the other extreme, a maximum tax rate is used after taxable income reaches a specific level.

The minimum tax rate is zero which occurs at a taxable income of 5000 dollars. At this level, the investor is assumed to pay no income tax. The basis for this calculation is that he will have personal exemptions which will reduce his tax liability to zero.

On the other extreme, if the investor has an taxable income of 50,000 dollars or greater, it is assumed that he will be taxed a maximum rate of 28 percent. This rate is used since it is the maximum rate that an incorporated farm would pay. The taxable income of 50,000 dollars is used since if he did not incorporate he would be paying tax at a rate in excess of 50 percent.

For any taxable income between 5,000 and 50,000 dollars, the following formula is used to determine the applicable MTR.

$$MTR_i = 6.222 * 10^{-6}(TAXINC_i) - .0311 \qquad (3.37)$$

Once the MTR is determined, the income tax payable is determined as follows:

$$TAXPAY_{i+1} = MTR_i(TAXINC_i) \qquad (3.38)$$

where:

TAXPAY = income tax payable.

As indicated in Equation 3.38, the tax payment is made in the following year. This is comparable to farm tax payments. The tax liability in year one is obtained in Q27, where the investor specifies the information.

3.2.9 Financing

As previously stated, total expenditures are subtracted from all relevant revenues to obtain NCFBL. As illustrated in Figure 3.1, NCFBL passes through several decision points. The first decision point tests whether NCFBL is positive. If this condition is satisfied, NCFBL will contribute to the cash surplus pool. This pool is used to offset any negative NCFBL in following years by making up part of total cash resouces. However, if NCFBL is negative, then the next condition will be tested. This condition determines if NCFBL is less than or equal to total operating expenses. An operating loan will be used if this condition is met. This is in accordance with the definition an operating loan to only finance the operating expenses. The amount of operating loan will be equal to the absolute value of the negative NCFBL.

The operating loan repayment will be derived from Equation 3.39.

$$OLR_i = (OL_{i-1})(1+IR)^{0.75} \qquad (3.39)$$

where:

OLR = operating loan repayment in current year, and

OL = operating loan in previous year, and

IR = random generated interest rate.

The loan repayment is made at the start of the next year. The interest expense is based on the random interest rate and the amount of operating principle outstanding. The interest rate is only raised to the power of .75 since it is assumed that operating loan will only be required for three quarters of a year. This is consistent with the operating loan being taken out at the start of the first quarter when there is large cash requirements for crop inputs. The loan is paid at the start of the first quarter of the following year. It is expected that net cash flow will be at its maximum, thus, paying off the operating loan.

If the magnitude of any negative NCFBL is greater than total operating expenses, additional tests will be performed. Loan Refinancing will occur if there is sufficient equity to warrant refinancing. First, loan consolidation of all existing loans, initial land mortgage and current operating loan will occur. Loan consolidation will represent the total outstanding principle. This value will be compared with the current equity position to derive a debt/equity ratio. If the derived debt/equity ratio is less than a predetermined debt/equity ratio, refinancing will occur. The predetermined debt/equity ratio is maximum amount of leverage the investor is allowed before being declared bankrupt.

3.2.10 Simulation Loop Termination

The simulation loop will continue as long as one of the three financing decision points are satisfied and the year is less than ten. However, the simulation loop will be terminated if the loop is equal to ten or there is insufficient equity to refinance the consolidated loans.

3.2.10.1 Annual Equity Calculation

When the simulation loop is terminated, the investor's equity position is calculated. However, prior to this calculation is the calculation of equity in the initial year. Initial equity is calculated by the following formula:

$$EQ_o = (CR_o + P_o(CO_o) + MI_o + LNP_o(LND_o) - LIA_o \qquad (3.40)$$

where:

EQ = initial equity,

CR = initial value of cash and near cash reserve, and operating supplies,

P = initial price of wheat,

CO = initial wheat and wheat equivalent inventory,

MI = initial market value of machinery,

LNP = the average price of comparable land from recent sales,

LND = the total number of owned productive acres after land purchase, and

LIA = the initial outstanding liabilities.

From the previous equation, the initial equity is determined by calculating total assets and subtracting any outstanding liabilities. The value of the liabilities is as follows:

$$LIA_o = DP_o - OLR_o - PRN_o - TAXPAY_o \qquad (3.41)$$

where:

DP = downpayment on land purchase,

OLR = initial operating loan liability,

PRN = initial total principle outstanding including existing loans and land mortgage, and

TAXPAY = outstanding tax liability.

The initial equity position is based exclusively on supplier input information prior to any simulation. However, any successive equity calculations will be dependent on the simulation process. The equity position derived from the simulation process is calculated slightly different from initial equity. This calculation, illustrated in Equation 3.42, will occur in year ten or the year of bankruptcy:

$$EQ_i = (CA_i + P_i(CO_i) + TMV_i + LNP_i\ (LND) - LIA_i \tag{3.42}$$

where:

EQ = equity in year ten or year of bankruptcy,

CA = cash assets,

TMV = total machinery investment, and

LNP = land price per productive acre.

Liabilities in successive years are calculated as follows:

$$LIA_i = OLR_i - PRN_i - TAXPAY_i \tag{3.43}$$

where:

LIA = outstanding liabilities in year ten or year of bankruptcy.

This equation is the same as Equation 3.41, except downpayment is no longer considered.

Equation 3.42 does have several different underlying features from the initial equity calculation. First, cash assets are equal to NCFBL whenever NCFBL is positive. If NCFBL is negative, the magnitude of the negative NCFBL will be equal the operating loan which is accounted for in outstanding principle. This results in cash asset being equal to zero. Second, whenever the elements within Equation 3.42 are specific to the year, the appropriate value will be used. This is apparent with: price of wheat and land, carryover, machinery and liabilities.

The amount of equity associated with machinery value can be understood best by determining the value of the initial machinery value and machinery replacement in any one year as follows:

$$TMV_i = MI_i + SCR_i \tag{3.44}$$

$$MI_i = MI_i (1-1/ALM)(1+OEI) \tag{3.45}$$

$$MV_i = MACREP_i (1-1/ALM)(1+OEI) \tag{3.46}$$

$$SCR_i = SCR_{i-1} (1-(1/ALM))(1+OEI)+MV_i \tag{3.47}$$

where:

TMV = total machinery value,

MI = value of initial machinery in any one year,

SCR = summed value of machinery replacement,

MV = value of machinery replacement at year end,

MACREP = machinery replacement,

ALM = average replacement frequency of machinery, and

OEI = inflation factor.

The calculation of total machinery value is based on economic depreciation (ALM) and the investor's perceived inflation rate (OEI). Equation 3.45 determines the value of the initial machinery investment in any one year. The machinery investment is first depreciated and then inflated to arrive at an approximate market value. This same approach is used for machinery replacement. The value of machinery replacement is determined in Equation 3.46, and is then added to the summed value of machinery replacement (Equation 3.47). Therefore, depending on the relative values of depreciation and inflation, the total machinery value may decrease or increase.

3.2.10.2 Land Price Derivation

A major component of the equity calculation is the land value in any simulated year. The price of a productive acre of land is based on two factors: 1) the price of land in the previous year, and 2) the land rent. The price of land in the previous year is initiallized by Q3, where the investor supplies the average price per acre from recent sales of comparable land. The land rent is determined by Equation 3.24, which was previously discussed. The land rent represents the return from a productive acre of land. The greater the land rent in any year will result in an increase in land price. Research by Kraft,[24] shows rent received as a percentage of purchase price is approximately 4 percent in the seventies. Based on this evidence if less than 4 percent is received land price will drop. However, the drop in land price will not be as great as an increase, if the land rent is greater than 4 percent. This phenomena is based on land values being traditionally "sticky downward." This is evident from previous studies which show land prices increasing significantly more when returns are high compared to land price

---

[24] D. F. Kraft, Analysis of the Farmland Market in the Prairie Provinces, Occasional Series #6, Department of Agricultural Economics, University of Manitoba, 1981.

drop when returns are low. This is also supported by the fact that if land prices drop, the market becomes smaller and very little land is traded.

To accommodate the nature of the farm land market, two formulas are used. If rent is less than 4 percent Equation 3.48 will be employed; otherwise, Equation 3.49 will be used if returns are greater than 4 percent.

$$LNP_i = 1.1746*Rent_i^{0.05}*LNP_{i-1}^{0.95} \qquad (3.48)$$

$$LNP_i = 1.6207*Rent_i^{0.15}*LNP_{i-1}^{0.85} \qquad (3.49)$$

Support for the derivation of land prices is based on research by Fields.[25] In Equation 3.48, when returns are low more weight is placed on last year's land price then rent value. However, when rent is greater then 4 percent, greater weight is placed on the land rent which causes the land price to appreciate at a much faster rate. In both equations previous land prices are based on previous rent. Recalling from Equation 3.24, rent is a function of net revenues specific to any simulated year.

3.2.10.3 Annual Percent Change in Equity

Whenever the simulation loop termination occurs, annual percent change in equity will be calculated. Equation 3.50 determines the average annual percent change in equity by comparing the initial equity position and the equity in the final simulated year. It is illustrated as

---

[25] V. J. Fields, 'The Influence Of Grain Freight Rates On The Farm Land Market In The Provinces,' thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1980.

follows:

$$\%EQ = \text{Anti ln} [\ln(EQ_i/EQ_o)/i)] - 1 \quad (3.50)$$

where:

%EQ = annual percent change in equity.

This calculation will occur at the end of each trial and will form the basis for the probability distribution.

3.2.11 Probability Distributions

Risk assessment of farmland investment will be based on the probability of attaining specific annual changes in equity, and the probability of the incidence of bankruptcy. The equity change probability distribution will be divided into thirteen equal, 2 percent categories. Two additional categories will be used at the extreme of the probability distribution. They represent equity changes which are not accounted for within the incremental changes. Directly related to each of the equity change categories are equivalent bankruptcy categories. These categories will represent the probability of bankruptcy in each equity change category. However, to obtain a probability distribution a specific number of trials will have to be performed. The number of trials will depend on a chi square test which will determine the number of trials at which the probability distributions will not be significantly different.

Chapter IV

EMPIRICAL RESULTS AND ANALYSIS

This chapter examines the empirical results for the model specified in the previous chapter. However, in order to conceptualize the results it is necessary to examine various individual simulation trials. The summation of these trials is the basis for the derived probability distributions. Finally, several experiments will be conducted to determine the effects of debt levels and loan arrangements on farm firm survival and growth.

4.1 DESCRIPTION OF MODEL RESULTS

In this section, two scenarios are examined to illustrate the capabilities of the simulation model. Table 4.1 presents the information used in each case which is typical for several regions within Manitoba. The first scenario involves financing the farmland investment with a thirty year, fixed interest rate, land mortgage (II., A.). One trial will be examined in-depth which will form the basis for the following trials. The second scenario uses a thirty year term, three year renewable interest rate, land mortgage (II., B.) ceteris paribus. Two trials will be examined to focus on characteristics specific to each trial.

TABLE 4.1

Investor Input Information

I. Basic Financial, Marketing, and Production Information

1 The number of productive acres purchased (ac): 300
2 The price paid/acre of productive land ($/ac): 600
3 The average price of comparable land from recent sales ($/ac): 600
4 The current price of wheat normally sold ($/bus): 4.25
5 The lowest wheat yield ever expected (bus/ac): 10
6 The highest wheat yield ever expected (bus/ac): 54
7 The most frequent wheat yield expected (bus/ac): 30
8 The average quota expected per year (bus/ac): 28
9 The expected annual increase in quota (%): 3
10 The total operating expenses/acre ($/ac): 79
11 The expected annual increase in operating expense (%): 7
12 The present cost of fertilizer/acre ($/ac): 30
13 the present cost of pesticide/acre ($/ac): 15
14 The present land taxes/acre ($/ac): 6
15 The current operating loan interest rate (%): 11.5
16 The operating loan outstanding ($): 0
17 The basic living and personal expenditures/year ($/yr): 15000
18 The expected increase in cost of living expenses (%): 7
19 The present non-crop income ($/yr): 0
20 The expected annual increase in non-crop income (%): 0
21 The total value of cash & near cash, & operating supplies ($): 45000
22 The beginning wheat & wheat equivalent inventory (bus): 4500
23 The market value of machinery ($): 90000
24 The average replacement frequency of machinery (yrs): 10
25 The total number of rented productive acres (ac): 200
26 The total number of owned productive acres after purchase (ac): 600
27 The expected income tax liability for current year ($): 2500

II. Loan Type Used to Finance Land Purchase

A. Amortized, fixed interest rate, land mortgage
28 The percentage of the land purchase that is paid down (%): 10
29 The mortgage rate (%): 13.5
30 The amortization period of the loan (yr): 30

B. Amortized, renewable, land mortgage
28 The percentage of the land purchase that is paid down (%): 10
29 The mortgage rate (%): 11.5
30 The amortization period of the loan (yr): 30
31 After how many yrars is the loan renewed (yr): 3

Table 4.1 - Continued

```
=====================================================================
ce III.  Model Program Options
---------------------------------------------------------------------

A. The Default Sample Size is 30
   Do you wish to change this limit ?
   Enter Number Or Press Return: 3000

B. The Default Debt/Equity Limit to
   Invoke Bankruptcy is 5.67
   Do you wish to change this limit ?
   Enter Y-Yes ; N-Press Return:

C. Do you wish to print the detail on each loan?
   Enter Y-Yes ; N-Press Return

D. Do you wish to print the detail for each sample?
   Enter Y-Yes ; N-Press Return
=====================================================================
```

4.1.1 Scenario 1 - Nonrenewable Land Mortgage

The detailed output of a ten year simulation trial is presented in Table 4.2. This table represents one observation in determining the probability of bankruptcy and annual percent change in equity. Therefore, it is important to comprehend the results in order to appreciate the final results.

The first column indicates the simulation year. Ten years is the maximum number of years which can be simulated provided bankruptcy does not occur. If bankruptcy does occur, only the information to that year will be presented.

Sales (Column 2) are ultimatedly determined by yield represented in Column 4. Volatility in wheat yield will be reflected in one of two columns. If delivery quota restricts sales, carryover will fluctuate and sales will remain quite stable. This is the situation in years 1 to 5. However, if sales are not constrained yield fluctuations will be reflected in sales, as illustrated in years 6, 9, and 10.

The random generated variables are represented in Column 4, 5, and 6. The derivation of yield, price, and interest rate are determined by Equations 3.14 and 3.15, 3.9, and 3.22 respectively. These values are fundamental to cash flow calculations throughout the trial.

The bounds which are imposed on these variables are an important consideration. Yield is represented by a triangular distribution based on information supplied in Table 4.1. By examining the yields which occur in the 10 year period, it is apparent that the modal yield is approximately 30 bushels per acre. This yield being the "most likely yield" spicified in the input information. Wheat price and the interest rate

TABLE 4.2

Simulation Trial Under Scenario 1

Trial 1

(1) Year	(2) Sales (Bus)	(3) Carry -over (Bus)	(4) Yield (Bus/ Ac)	(5) Price $	(6) Interest Rate %	(7) Begin Cash Assets $	(8) Cash Reserve $	(9) Debt Pay- ments $	(10) Total Operate Expense $	(11) Replace Capital Inputs $	(12) Living & Personal Withdraw $	(13) Income Tax $	(14) Net Cash Flow Before Loan $	(15) Land Price ($/Ac)	(16) Land Rent ($/Ac)
1	23072	4913	29.4	3.83	0.1158	27000	115369	22371	76345	45400	15000	2500	-46248	583	17.93
2	23764	6206	31.3	3.97	0.1154	-50209	44156	22371	80903	0	16050	0	-75168	559	15.25
3	24477	4416	28.4	6.60	0.1381	-81583	79861	22371	88814	0	17173	0	-48497	593	27.56
4	25211	5376	32.7	7.05	0.1040	-53439	124295	22371	97399	16568	18376	4604	-35023	692	41.33
5	25968	6378	33.7	5.87	0.1125	-37719	114682	22371	102606	17728	19662	8158	-55843	745	36.16
6	24872	0	23.1	6.37	0.0878	-60491	97961	22371	108276	18969	21038	329	-73022	754	31.14
7	27549	8135	44.6	5.45	0.0707	-77778	72269	22371	114647	20297	22511	162	-107719	747	27.27
8	28375	3435	29.6	6.23	0.0611	-113384	63424	22371	121774	21718	24087	0	0	733	24.69
9	27867	0	30.5	7.87	0.0616	0	219402	25315	131952	36126	25773	236	0	768	34.69
10	22824	0	28.5	8.88	0.0807	0	202641	25315	142894	24865	27577	10892	-28901	857	45.64

ENDING EQUITY = 441,801 TOTAL ASSETS = 750,501 TOTAL PRINCIPLE = 307,571 INCOME TAX = 1,129 INITIAL EQUITY = 331,625

(1) Col. 6 = operating loan interest rate.
(2) Col: 7 (YR=1) - (beginning cash assets) - (downpayment) - (operating loan repayment).
(3) Col. 7 (YR 1) = if positive it is equal to Col. 14 in previous year,
if negative it is the operating loan repayment.
(4) Col: 8 = [Col. 2) * (Col. 5)] + (Col. 7)
(5) Col. 14 = (Col. 8) - (Col. 9 + Col. 10 + Col. 11 + Col. 12 + Col. 13).

are both constrained by overall bounds. However, price is allowed to trend upwards. Even though prices do generally increase there is a significant degree of price fluctuation. The overall interest rate bounds are fixed, however, they still have potential to illustrate volatility similar to wheat price.

Column 7 illustrates the beginning cash assets. In year one it is calculated by subtracting the downpayment and initial operating loan repayment from the specified cash assets (Q21). For example, in Table 4.2, $27,000 is derived by taking the initial cash assets of $45,000 and subtracting the downpayment of $18,000. In this example, there was no initial operating loan repayment. In the following years, beginning cash assets will equal NCFBL (Column 14) in the previous year, if NCFBL is positive. If NCFBL is negative in the previous year, it will represent the operating loan required. Beginning cash assets will then represent the operating loan repayment based on Equation 3.39. The applicable interest rate is the rate specified in Column 6 in the year that the operating loan is required. Therefore, negative beginning cash asset values represent an operating loan repayment which must be paid at the start of the specified year.

The final case is where beginning cash assets equal zero. This situation will occur if one of two conditions are satisfied. The first is when refinancing occurs in the previous year. In year 8, since the operating loan (negative value of NCFBL) would have been greater than total operating expense, refinancing was required. The operating loan required is equal to the positive value of NCFBL in the year of refinancing. This value can be calculated as follows:

$$\text{Col.14} = (\text{Col.8}) - [(\text{Col.9}) + (\text{Col.10}) + (\text{Col.11}) + (\text{Col.12}) + (\text{Col.13})] \quad (4.1)$$

Based on this equation the operating loan is $126,526 which is greater than the total operating expense of $121,774. Therefore, the operating loan which would have been required in year 8 is consolidated with the remaining land mortagage. This consolidated loan is then refinanced. This being the case, NCFBL in year 8 and beginning cash assets in year 9 are equal to zero since loan consolidation has reduced the NCFBL to zero.

The second case where beginning cash assets equal zero is when machinery replacement reduces a positive NCFBL to zero. In year 9, the investor did not have to make an operating loan repayment (Column 7 = 0) so cash demands were signicantly reduced. This allowed positive NCFBL to replace the minimum machinery requirement, as well as, reduce a portion of the machinery deficit. The machinery deficit had accumulated because no machinery purchase was made in year 2 and 3. The deficit was not completely reduced since there was no residual NCFBL in year 9. Specific machinery requirements will be supported in a later discussion.

Cash reserve is calculated in Column 8 and is based on the following column calculation.

$$\text{Col. } 8 = [(\text{Col.}2) * (\text{Col.}5)] + (\text{Col.}7) \qquad (4.2)$$

Cash reserve represents the total cash inflow from grain sales less the operating loan repayment. The reserve is used to pay for all annual expenditures. Any shortfall will result in a negative NCFBL which will determine the amount of operating loan required. However, if certain conditions are met, refinancing or bankruptcy may occur.

Annual debt payments associated with the land mortgage are represented in Column 9. These payments are based on the supplier input information specific to a nonrenewable loan. If refinancing occurs, annual debt payments will denote the payments associated with loan consolidation. In this trial, refinancing occurred in year 8. The amount of the new payments will be based on the principle remaining on the land mortgage and the operating loan required. The operating loan required is equal to $126,526. The derived operating loan is added to the remaining principle of the land mortgage at year end. The year end value is taken since the investor has made a payment within that year which reduces the principle. The amount of land mortgage principle remaining is equal to $155,491. Therefore, the total principle outstanding is $282,017. This principle is amortized with the same type of loan which financed the initial land mortgage. The only change is the interest rate. The operating loan interest rate in year 8 is 6.11 percent. A 2 percent premium is added on, based on the loan term.[26] Therefore, financing a $282,017 loan for 30 years at a interest rate of 8.11 percent results in annual payments of $25,311.[27] Even though the investor has considerably more principle to pay then the initial debt of 162,000, his annual payments have not increased substantially. This is because the applicable interest rate has dropped from 13.5 percent to 8.11 percent.

---

[26] A discussion of interest rate premium is presented in subsection 3.2.8.1.

[27] This calculation does not equal $25,315 due to rounding error. This will also be apparent in several following calculations.

Total operating expenses, Column 10, is derived by multiplying the total number of acres by the appropriate inflated sum of operating expenses per acre and land tax. Added to this value is the rent which the tenant pays the landlord. Total rent is determined by the number of rented acres multiplied by the rent paid. Using the formula specified by Equation 3.25, the value of total operating expense is derived.

Column 11 represents the annual capital replacement. According to Equation 3.26 to 3.32, the investor is first required to have a specific machinery investment comparable to the land base. In this case the farmer owned $90,000 worth of machinery and after one year of depreciation its value was $81,000. The required machinery investment is $158 per acre multiplied by 800 acres, or $126,400. The investor's machinery deficit in year one is therefore $45,400. This machinery purchase is a requirement in year 1. However, in the following years different conditions apply. In year 2 and 3, the investor is not required to make any machinery replacement if a negative NCFBL occurs. This situation is exemplified in year 2 and 3. As specified by Equation 3.27, the desired replacement in year 2 and 3 would have been $14,472 and $15,485 respectively. Since these purchases were not made, they result in a machinery deficit pool as specified by Equation 3.28. Therefore, in year 3 the maximum amount that the investor could have invested in machinery is $30,970. From year 4 to year 8 NCFBL is negative, therefore, only the minimum machinery requirement was made. However, in year 9 NCFBL was sufficient to meet the investor's minimum replacement of $23,165, and reduce the machinery deficit by $12,961. The deficit of $30,970 in year 3 would be the inflated replacement value of $46,478 in year 9. Of this amount the deficit of $46,478 was reduced by $12,961. Finally, in year ten, with a negative NCFBL, only the minimum machinery replacement was made.

Living and personal withdrawals (Column 12) are represented as a simple calculation by specifying the initial living expense and the annual percent increase.

Income tax is represented in Column 13 and is based on Equation 3.33 to 3.38. Income tax is based on the taxable income of the previous year. Income tax in year 1 is the investor's specified tax liability. In year 2 and 3 no income tax is paid since taxable income is very low. However, in years 3 and 4 grain prices increased significantly resulting in a significant increase in income tax in years 4 and 5.

A specific example of income tax payable will be considered in year 4. The tax paid of $4,604 is based on the relevant revenues and expenses of year 3. The first calculation required is the taxable income determined by Equation 3.33. In this trial there is no off-farm income, therefore, revenue is only comprised of total grain revenue. The revenue in year 3 is the product of sales and price which equals $161,548. From this gross income, total interest expense, total operating expense and capital cost allowance are deducted. Total interest is equal to the interest expense on the land mortgage and the operating loan. These interest expenses are respectively $21,725 and $6,415. The operating loan interest expense is the absolute difference between the NCFBL in year 2 and the beginning cash assets in year 3. Total operating expense is the explicit cost represented in Column 10. This expense includes, operating expense, real-estate tax and rent expense. The final expense is CCA which is based on the total undepreciated cost of capital (Equation 3.34). In year 1, the total undepreciated cost of capital (TOTUCC) is the initial $90,000 machinery investment plus the purchased $45,400 worth of machinery. There was no machinery investment made in year 2 or 3, therefore, the TOTUCC of $135,400 in year one is depreciated at an annual rate of 15 percent. Thus, in year 3, TOTUCC is equal to $97,827. Based on a CCA rate of 15 percent, CCA is equal to $14,674. The resulting net taxable income is equal to $29,920. Based on Equation 3.37, the marginal tax rate is determined to be 15.5 percent. Using Equation 3.38 the income tax payable is equal to $4,639 which is approximately equal to the value in year 4.

NCFBL represented in Column 14 is used to determine the amount of operating loan which is required in any one year. It is also used to determine the amount of machinery replacement which will occur. Both of these factors have already been discussed.

The land price in Column 15 is derived from Equation 3.48 and 3.49. The two major elements of these equations are land rent and previous year's price. The land rent is specified in Column 16 and is determined by Equation 3.24. The main purpose of determining land rent (other than for the purpose of rent expense) is to determine the land price for the final equity calculation.

To determine the annual percent equity change, both initial and final equity values are required. The initial equity is determined by calculating the total assets and subtracting any outstanding liabilities. This calculation is specified in Equation 3.40 and 3.41. Based on the information supplied in Table 4.1, the investor's asset value after the land purchase equal $514,125. The relevant liabilities which occur are the downpayment for the land ($18,000), land mortgage ($162,000), and the outstanding tax payment ($2,500). This results in a initial equity position of $331,625.

The final equity position is also calculated by determining the total assets and subtracting all liabilities, as specified in Equation 3.42. The main difference in the total asset calculation is that the machinery investment is a function of depreciation, inflation and machinery replacement. In Equations 3.44 to 3.47, the machinery value calculations are illustrated. Applying Equation 3.45, the value of the initial machinery investment of $90,000 at the end of year 10 is equal to $61,731. The value of all machinery replacement in year 10 using Equation 3.46 and 3.47 results in a total value of $174,467. The machinery replacement values used are those specified in Column 11. Thus, the contribution of machinery value to total assets is $236,198. Other asset values include grain caryover and beginning cash assets, however, both of these values are equal to zero in year 10. The only other asset to be accounted for is land value. Its value of $514,200 is based on the total number of acres and the final land price. The summation of machinery and land value is equal to $750,501.

Deducted from total assets are total remaining principle and the following year's tax liability. The principle remaining on the consolidated loan is $276,980 and the operating loan repayment is $30,633 which is equal to $307,571. Income tax of $1,129 is the final outstanding liability to be accounted for, which is based on the relevant revenues and expenses in year 10. The resulting equity is $441,801.

Applying Equation 3.50, the annual percent change in equity is calculated. Under this scenario, the investor's equity has increased from $331,625 to $441,801. This represents an annual percent equity change of 2.9 percent. This equity change represents one observation which could be used in determining a final probability distribution.

4.1.2 Scenario 2 - Renewable Land Mortgage

The main purpose of this section is to illustrate the application of a renewable loan, and model features which were not apparent in the previous trial. The results of Table 4.3 and 4.4 represent two trials based on the information supplied in Table 4.1 specific to a renewable loan.

The financing component represented by Column 9 in Table 4.3 illustrates the main difference from the previous table. The initial land purchase is being financed by a 30 year loan which is renewed every three years. Since the renewable term of the loan is three years, the land mortgage interest rate will be 1 percent above the operating loan interest rate. In year 3, the investor is required to renew his land mortgage. The interest rate specified in Column 6 is 10.33 percent, therefore, the remaining principle on the land mortgage is financed at a rate of 11.33 percent amortized over the remainging 27 years. In year 6 he renews the loan again at an interest rate of 7.62 percent. However, in year 7, the investor experienced a low yield, and a large operating loan repayment which forced him to refinance. The new consolidated loan was $280,999 which consisted of $153,922 from the initial land mortgage and $127,077 of operating loan. The applicable interest rate is 9.04

TABLE 4.3

Simulation Trial Under Scenario 2

Trial 1

(1) Year	(2) Sales (Bus)	(3) Carry -over (Bus)	(4) Yield (Bus/ Ac)	(5) Price $	(6) Interest Rate %	(7) Begin Cash Assets $	(8) Cash Reserve $	(9) Debt Pay- ments $	(10) Total Operate Expense $	(11) Replace Capital Inputs $	(12) Living Personal Withdraw $	(13) Income Tax $	(14) Net Cash Flow Before Loan $	(15) Land Price ($/Ac)	(16) Land Rent ($/Ac)
1	23072	4953	29.4	4.69	0.1113	27000	135202	20859	77196	45400	15000	2500	-25753	595	22.18
2	23764	5982	31.0	4.53	0.0875	-27874	79727	20859	82305	0	16050	2061	-41549	591	22.26
3	24298	0	22.9	5.60	0.1033	-44245	91796	20859	88376	0	17173	0	-34615	603	25.38
4	25211	89	31.6	6.49	0.0843	-37265	126351	19183	95858	16568	18376	330	-23965	661	33.62
5	25968	2851	35.9	5.63	0.0669	-25465	120861	19183	101820	17728	19662	5384	-42917	699	32.23
6	23096	0	25.3	6.96	0.0662	-45051	115733	19183	108630	18969	21038	277	-52364	731	32.90
7	13036	0	16.3	7.97	0.0804	-54942	48981	14383	117732	20297	22511	1135	0	812	42.70
8	16428	0	20.5	6.93	0.0824	0	113776	27453	124961	21718	24087	0	-84443	864	40.63
9	29227	2740	40.0	8.75	0.0858	-89612	166181	27453	133509	23238	25773	0	-43792	915	42.47
10	30104	7256	43.3	10.42	0.0837	-46579	267233	27453	145295	46283	27577	20626	0	1038	57.65

ENDING EQUITY = 636,143 TOTAL ASSETS = 943,548 TOTAL PRINCIPLE = 274,288 INCOME TAX = 33,116 INITIAL EQUITY = 331,625

TABLE 4.4

Simulation Trial Under Scenario 2

Trial 2

(1) Year	(2) Sales (Bus)	(3) Carry -over (Bus)	(4) Yield (Bus/ Ac)	(5) Price $	(6) Interest Rate %	(7) Begin. Cash Assets $	(8) Cash Reserve $	(9) Debt Pay- ments $	(10) Total Operate Expense $	(11) Replace Capital Inputs $	(12) Living & Personal Withdraw $	(13) Income Tax $	(14) Net Cash Flow Before Op. Loan $	(15) Land Price ($/Ac)	(16) Land Rent ($/Ac)
1	17635	0	16.4	4.02	0.1196	27000	97922	20859	76535	45400	15000	2500	-62372	586	18.88
2	23764	4482	35.3	4.83	0.0931	-67889	46802	20859	81939	0	16050	0	-72046	578	20.43
3	18673	0	17.7	6.26	0.0980	-77021	39806	20859	89325	0	17173	0	-87552	622	30.11
4	24968	0	31.2	5.68	0.0785	-93909	47909	18424	95707	16568	18376	0	0	672	32.87
5	25968	1338	34.1	6.63	0.0934	0	172038	24958	101999	25420	19662	0	0	712	33.13
6	14101	0	16.0	5.08	0.0956	0	71626	24958	107747	18969	21038	4845	-105931	712	28.49
7	13484	0	16.9	5.57	0.0881	-113436	-38384	24958	113487	20297	22511	0	0	693	21.47
8	26681	0	33.0	6.36	0.1083	0	169596	49390	121547	21718	24087	0	-47147	687	23.55

ENDING EQUITY = 88,602 TOTAL ASSETS = 609,627 TOTAL PRINCIPLE = 521,024 INCOME TAX = 0 INITIAL EQUITY = 331,625 percent amortized over 30 years, which results in annual payments of $27,453. This trial does illustrate significantly more financing requirements then the previous nonrenewable loan.

This trial also illustratates a much greater ending equity. The main reason is the generally higher prices in land values, especially towards the later simulated years. The most significant increase in land value occurred in year 10, which was the result of both high yields and high prices. The large yield also resulted in a large carryover which contributed $75,608 to the investor's equity position.

Offsetting the ending equity position is the income tax liability. The liability associated with year 10 is $33,116. However, this liability would have been higher if the investor did not invest in machinery above the minimum requirement. His machinery investment in year 10 was $46,283 compared to the minimum of $24,786. Therefore, his CCA deduction was correspondingly higher. The result of the various characteristics associated with this trial is a annual increase in equity of 6.7 percent.

The second trial of Scenario 2 is presented in Table 4.4. The main difference in this trial is that the investor experienced insolvency in year 8. The two main factors contributing to insolvency are numerous low yields and consistently low prices. The consequences of these factors are reflected in the majority of related components.

The obvious consequence is reflected in the cash flow. First, revenue from grain sales fluctuate significantly due to significant changes in grain sales. Since yield is generally low, quota restrictions seldom occur, which results in volitility in yield being transferred to grain sale. Second, the NCFBL consistently decreases until refinancing is required.

In this example, financing does play a major role. The investor is required to renew the land mortgage and is forced to refinance twice within the period of eight years. In year 4, the investor refinanced $101,166 resulting in annual payments of $24,958. Net cash flow stress in year 5 is reduced due to refinancing, higher price, and improved yields. Therefore, additional machinery replacement occurred. However, in the following two years low yields and prices resulted in large requirements of operating money. In year 7, the existing loan of $253,514 and the operating loan of $219,637 were consolidated. At an interest rate of 9.81 percent, the new annual payments are twice that of the previous year. Year 7 was a critical year for the investor since equity had been severly eroded. The investor's initial equity was $331,625 and in year 7 it was reduced to $124,987. Liabilities at this point were $473,079. Since equity is relatively low, very little additional financing would be required to cause insolvency. In year 8, yield was above average and price increased by 14 percent. The operating loan required was the smallest over the entire trial, however, it was suficient to cause bankruptcy.

The criteria for bankruptcy is a debt/equity rate of 5.67 percent which corresponds to the investor only having claim to 15 percent of the total farm assets. In this scenario the investor's initial debt/equity ratio is 0.49. In year 7 it increases to 3.78 and in year 8 it is 5.88 which exceeded the acceptable solvency limit. In this trial the investor's annual percent change in equity was -15.2 percent. The financing aspect has already been discussed and its effect on this ratio is obvious. However, an additional factor which must be considered is the value of total assets. The machinery investment is quite close to the previous trials, therefore, it did not have a major influence on bankruptcy. The main difference is the land value. Since wheat prices were low, land rent was relatively low as well. This caused land prices to be affected in a similar way. Thus, land price has a major inpact on the probability of bankruptcy.

4.2 SIMULATION EXPERIMENTS

In this section, four scenarios are tested to determine the effect of debt level and loan arrangement on farm firm growth and survival. The basic information required by each scenario is presented in Table 4.5. Information which is common to each scenario is represented by any of the following questions with a specified value. Answers to Question 29 and 31 are represented by a single asterisk which illustrate answers that will vary between each scenario. Table 4.6 represents the specified answers to each question. The differences result in the loan arrangements and the result that they have on interest rate. Scenario 1 illustrates a 30 year non-renewable loan. Scenarios 2 to 4 represent loan arrangements with 1, 3 and 5 year renewable terms respectively. The results from these different loan arrangements will be compared to determine their effect on growth and survival.

TABLE 4.5

Investor Input Information

I. Basic Financial, Marketing, and Production Information

1 The number of productive acres purchased (ac): **
2 The price paid/acre of productive land ($/ac): 600
3 The average price of comparable land from recent sales ($/ac): 600
4 The current price of wheat normally sold ($/bus): 4.25
5 The lowest wheat yield ever expected (bus/ac): 10
6 The highest wheat yield ever expected (bus/ac): 54
7 The most frequent wheat yield expected (bus/ac): 30
8 The average quota expected per year (bus/ac): 28
9 The expected annual increase in quota (%): 3
10 The total operating expenses/acre ($/ac): 79
11 The expected annual increase in operating expense (%): 7
12 The present cost of fertilizer/acre ($/ac): 30
13 the present cost of pesticide/acre ($/ac): 15
14 The present land taxes/acre ($/ac): 6
15 The current operating loan interest rate (%): 11.5
16 The operating loan outstanding ($): 0
17 The basic living and personal expenditures/year ($/yr): 15000
18 The expected increase in cost of living expenses (%): 7
19 The present non-crop income ($/yr): 0
20 The expected annual increase in non-crop income (%): 0
21 The total value of cash & near cash, & operating supplies ($): 45000
22 The beginning wheat & wheat equivalent inventory (bus): 4500
23 The market value of machinery ($): 90000
24 The average replacement frequency of machinery (yrs): 10
25 The total number of rented productive acres (ac): 200
26 The total number of owned productive acres after purchase (ac): **
27 The expected income tax liability for current year ($): 2500

II. Loan Type Used to Finance Land Purchase

A. Amortized, fixed interest rate, land mortgage

28 The percentage of the land purchase that is paid down (%): 10
29 The mortgage rate (%): *
30 The amortization period of the loan (yr): 30

B. Amortized, renewable, land mortgage

28 The percentage of the land purchase that is paid down (%): 10
29 The mortgage rate (%): *
30 The amortization period of the loan (yr): 30
31 After how many yrars is the loan renewed (yr): *

Table 4.5 - Continued

III. Model Program Options

A. The Default Sample Size is 30
   Do you wish to change this limit ?
   Enter Number Or Press Return: 3000

B. The Default Debt/Equity Limit to
   Invoke Bankruptcy is 5.67
   Do you wish to change this limit ?
   Enter Y-Yes ; N-Press Return:

C. Do you wish to print the detail on each loan?
   Enter Y-Yes ; N-Press Return

D. Do you wish to print the detail for each sample?
   Enter Y-Yes ; N-Press Return

TABLE 4.6

Information Specific To Each Scenario

Scenario	Financing Term Question 31 (yr)	Interest Rate Question 29 (%)
1	non-renewable	13.5
2	1	11.5
3	3	12.5
4	5	13.5

Answers to questions 1 and 26 are represented by a double asterisk which indicate answers to questions which will vary within each scenario. Table 4.7 represents the various answers to these questions. The purpose of varying these answers to put the investor under different levels of leverage using the same financial arrangement. The amount of leverage the investor is exposed to is determined by the number of acres that are purchases. The benchmark case will be investment 1 which indicates no land has been purchased and the farm operation is initially debt free. The successive sets of answers illustrate land purchases which represent a greater proportion of the total land base. This results in the investor being exposed to greater risk of failure by using greater amounts of debt capital.

Each investment illustrates the corresponding debt amounts and financial ratios associated with each land purchase. However, prior to each farmland investment, the investor has a 100 percent equity which is

TABLE 4.7

Proposed Investments Under Each Scenario

Investment	Acres Purchased Question 1 (Ac)	Total Acres Question 26 (Ac)	Debt After Purchase ($)	Equity: Asset Ratio	Debt: Equity Ratio
1	0	300	0	100	0
2	108	408	58,522	0.85	0.18
3	263	563	142,125	0.70	0.42
4	502	802	271,330	0.55	0.82
5	921	1,221	497,437	0.40	1.50
6	1,247	1,547	673,299	0.33	2.00
7	1,842	2,142	994,875	0.25	3.00

equal to $331,624.[28] Based on this initial equity the investor undertakes various amount of debt ranging from no debt to $994,875. Corresponding to the different debt loads is the equity/asset ratios which decrease in increments of 15 percent with one exception. Investment 6 is only 7 percent less than Investment 5. The reason for this additional investment is to illustrate any changes in the distributions since it is expected the results will be more sensitive with greater debt.

The debt/equity ratio is displayed since the criteria for bankruptcy is based on the same ratio. Therefore, the upper limit possible would be that at which the bankruptcy level is set. In these scenarios the ratio is set to 5.67 which is equivalent to a equity/asset ratio of 15 percent.

Based on the preceding discussion, 28 experiments will be performed. This is derived by having 7 experiments being executed within each of the 4 scenarios. Each experiment will involve 300 trials in order to derive a probability distribution. This number of trials is used so that any one distribution can be reproduced with no statistical difference.

---

[28] This value is identical to the equity calculation specified in Table 4.2.

4.3 EMPIRICAL RESULTS

This section will examine the simulation results in two stages. The first stage will involve analysing the seven different investments under each scenario. The specific objective is to analyse the probability of equity change and bankruptcy under increasing levels of debt. The benchmark will be the case where the farm operator does not invest in any farmland. Successive investments will be compared to the benchmark. The second stage will involve comparing the four different scenarios to determine if there is a significant difference in farm firm growth and survival by using different financial arrangements.

4.3.1 Effect of Leverage on Farmland Investment Risk

The first set of experiments involves a 30 year, fixed interest rate, mortgage. Table 4.8 presents the probalility distribution of annual percent change in equity and bankruptcy. This table illustrates seven different farmland investments as specified in Table 4.7. The resulting probability distributions are represented by 13 equal, equity change categories. Two additional categories are employed at each extreme of the probability distribution. These two extreme categories represent anual equity changes which either decrease at an annual rate greater than 8 percent, or increase at an annual rate greater than 18 percent.

Based on common information provided in Table 4.5 and specific investment information provided in Table 4.7, the resulting probability distributions were derived. Investment 1 represents the benchmark case where the investor operates 300 productive acres of land with no outstanding liabilities. The resulting distribution is displayed in Figure

TABLE 4.8

Farm Firm Growth and Survival Under Scenario 1

(non-renewable, 30 year, amortized loan - 13.5%)

Investment	Debt: Equity Ratio	Probability of Annual Percent Change in Equity (Probability of Bankruptcy)														
		- -8	- 6-8	- 4-6	- 2-4	- 0-2	+ 0-2	+ 2-4	+ 4-6	+ 6-8	+ 8-10	+ 10-12	+ 12-14	+ 14-16	+ 16-18	+ 18+
1	0	5	1	0	5	5	17	32	29	5	1	0	0	0	0	0
2	0.18	4	1	3	2	8	17	24	25	12	3	0	0	0	0	0
3	0.42	6 (2)	0	3	4	8	14	17	21	17	8	2	1	0	0	0
4	0.82	29 (25)	1	3	4	5	6	10	15	12	10	3	1	0	0	0
5	1.5	61 (60)	1 (1)	0	1	2	1	5	5	7	7	5	4	1	0	0
6	2	71 (70)	3 (3)	1 (1)	1 (1)	1	0	0	2	6	3	5	6	0	1	0
7	3	83 (82)	4 (4)	1 (1)	2 (2)	1 (1)	0	0	0	1	2	1	2	1	1	1

4.1. The distribution appears to be normal with a mean of approximately 4 percent. The variation of this distribution ranges from approximately -4 percent to +10 percent annual equity change. Seventy-eight percent of the observations occur within the three categories ranging from 0 to 6 percent. In this case there were no bankruptcies, however, 16 percent of the total number of trials represent a negative change in equity over the 10 year period. The negative change would be a reflection of poor grain prices and/or yields similar to situation presented in Table 4.4. The net result of these detrimental factors is usually an increase in total liabilities which is coupled with a devaluation of land values, thus, reducing the final equity position.

In successive investments the investor takes on increasing amounts of debt. With a debt/equity ratio of 18 percent the probability of negative equity change does not increase significantly. However, the distribution does become more dispersed about the mean. Under the third investment, the distribution disperses more then the previous distribution. In addition, 2 percent of the trials result in bankruptcy.

A significant change in the distibution does occur with a debt/equity ratio of 82 percent. In addition to a one in four chance of going bankrupt, the investor has a 42 percent chance of negative equity change. Associated with the higher incidence of bankruptcy is a greater dispersed distribution within the relevant range. In investment 5, the investor reduces the equity in the total farm operation by an additional 15 percent. This results in the probability of bankruptcy more then doubling . Referring to Figure 4.1, the modal value has increased to 9 percent compared to the 4 percent of the benchmark. Thus, the more leverage the investor undertakes, the less frequent the modal value occurs. However, the modal value does have a higher value. This is indicative of a 'make or break' investment. The investor not only has a greater chance of failure but also greater opportunity for growth. In addition, higher levels of leverage cause the distributions to become skewed to the left. This implies the greater probability of less then the modal value of growth.

In Investments 6 and 7 the probability of bankruptcy increases to 75 and 90 percent respectively. The majority of bankruptcies still occur in the category of equity declines greater than 8 percent. However, there are more bankruptcies in lesser equity decline categories. This signifies that the investor has greater chance of failure with a lesser annual equity drop. In the final investment the investor only survived 9 percent of the time. Of this 9 percent, no modal value could be detected which illustrates the the risk associated with this investment.

Tables 4.9, 4.10 and 4.11, present the effects of leverage on farm growth and survival using a renewable loan. They represent a 1, 3, and 5 year renewable term respectively. The total length of the loan is 30 years.

The distributions of the first investments in Scenario 1, 2, 3, and 4 are not significantly different, representing the growth associated with no land investment. This lack of significance also serves to validate the simulation model by allowing reproduction of the results.

Successive investments under each scenario illustrate relationships which are similar to those discussed in Table 4.8. With increasing leverage there is a related increase in risk. A comparison of these relationships will be addressed in the following section.

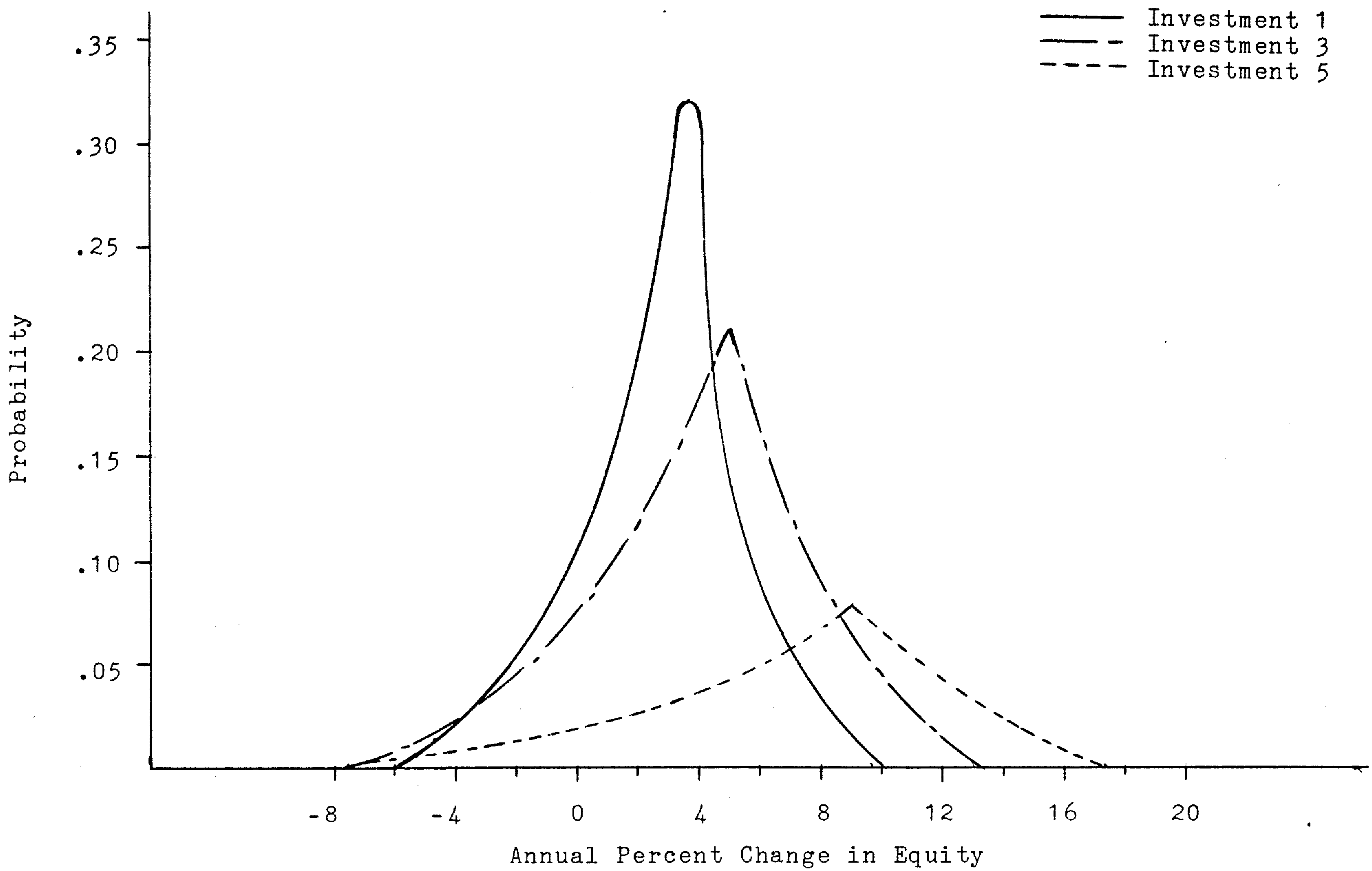

Figure 4.1: Probability Distributions Under Increasing Leverage

TABLE 4.9

Farm Firm Growth and Survival Under Scenario 2

(annually renewed, 30 year, amortized loan - 11.5%)

Investment	Debt: Equity Ratio	Probability of Annual Percent Change in Equity (Probability of Bankruptcy)														
		−	−	−	−	−	+	+	+	+	+	+	+	+	+	+
		-8	6-8	4-6	2-4	0-2	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18+
1	0	4	1	1	3	8	17	31	27	5	3	0	0	0	0	0
2	0.18	5	0	1	3	5	18	27	23	13	5	1	0	0	0	0
3	0.42	8 (2)	1	2	3	6	8	15	22	21	11	3	0	0	0	0
4	0.82	13 (9)	1	1	2	3	6	14	10	23	18	7	3	0	0	0
5	1.5	37 (33)	0 (0)	1 (1)	1	0	3	4	8	9	11	14	8	3	1	0
6	2	57 (55)	1 (1)	1 (1)	0	1	1	1	2	4	7	10	7	5	1	1
7	3	69 (69)	4 (4)	0	0	0	0	0	1	1	1	3	3	7	6	4

TABLE 4.10

Farm Firm Growth and Survival Under Scenario 3

(3 year renewable, 30 year amortized loan - 12.5%)

Investment	Debt: Equity Ratio	Probability of Annual Percent Change in Equity (Probability of Bankruptcy)														
		- -8	- 6-8	- 4-6	- 2-4	- 0-2	+ 0-2	+ 2-4	+ 4-6	+ 6-8	+ 8-10	+ 10-12	+ 12-14	+ 14-16	+ 16-18	+ 18+
1	0	5	1	1	3	9	18	20	24	8	1	0	0	0	0	0
2	0.18	6 (1)	1	1	3	5	18	22	26	13	5	0	0	0	0	0
3	0.42	7 (3)	2	2	4	9	9	14	23	20	7	2	1	0	0	0
4	0.82	22 (17)	1	1	4	4	5	9	13	17	14	6	2	0	0	0
5	1.5	46 (45)	1 (1)	1 (1)	1	1	3	5	5	9	11	8	6	3	0	0
6	2	68 (66)	1 (1)	2 (2)	1 (1)	1	1	1	2	4	7	5	4	2	2	0
7	3	79 (78)	2 (2)	2 (2)	1 (1)	0	0	1	1	0	3	2	3	2	2	2

TABLE 4.11

Farm Firm Growth and Survival Under Scenario 4

(5 year renewable, 30 year amortized loan - 13.5%)

Investment	Debt: Equity Ratio	Probability of Annual Percent Change in Equity (Probability of Bankruptcy)														
		- -8	- 6-8	- 4-6	- 2-4	- 0-2	+ 0-2	+ 2-4	+ 4-6	+ 6-8	+ 8-10	+ 10-12	+ 12-14	+ 14-16	+ 16-18	+ 18+
1	0	5	0	2	4	9	19	29	24	8	0	0	0	0	0	0
2	0.18	5	1	2	4	10	16	22	25	13	2	0	0	0	0	0
3	0.42	9 (3)	1	1	3	9	10	21	21	17	7	1	0	0	0	0
4	0.82	27 (24)	1	1	2	5	8	13	11	15	9	4	3	0	0	0
5	1.5	58 (56)	2 (2)	1 (1)	1	0	2	5	6	9	6	5	4	0	0	0
6	2	72 (72)	1	1	0	0	1	3	1	4	6	4	3	2	1	0
7	3	84 (84)	2 (2)	1 (1)	1 (1)	1 (1)	0	0	1	1	2	1	1	2	2	1

4.3.2 Effect of Loan Types on Farmland Investment Risk

This section involves a comparison of the probability distributions under the four difference financial arrangements. They differ only in the renewable term. The purpose is to examine if different relationships do occur, and the reasons associated with these differences.

Table 4.12 presents the statistical significance of different loan arrangements. Investment 1, 2, and 3 illustrate no significant difference under each scenario. In the first investment all of the distributions are expected to be the same. In the second and third investment several factors could have contributed to a distribution change. These factors include the amount of leverage, the interest rate range of 2 percent, and the renewal term ranging from 1 to 30 years. These results would imply that the financing characteristics of each scenario are not significant enough to have any major influence.

Investment 4 does illustrate significant difference between scenarios 1 : 2 and 2 : 4. Both of these comparisons indicate significance between loan arrangements with different renewal terms. The first comparison (Scenario 1 and 2) is between a non-renewable loan and an annually renewed loan. The second comparison is between a 1 and 5 year renewable term loan. At this level of leverage, financing does have a major influence. The first factor which would contribute to this relationship is the additional leverage which places more weight on the financing component of the simulation model. Second, interest rate premiums will have a greater influence. The annually renewed loan has the lowest interest rate, which could reflect in more favorable farm growth. The third factor which may have the greatest influence is the derivation

TABLE 4.12

Statistical Significance of Different Loan Arrangements

Investment	Significance Between Various Scenarios					
	1-2	1-3	1-4	2-3	2-4	3-4
1	N/S[1]	N/S	N/S	N/S	N/S	N/S
2	N/S	N/S	N/S	N/S	N/S	N/S
3	N/S	N/S	N/S	N/S	N/S	N/S
4	S[2]	N/S	N/S	N/S	S	N/S
5	S	N/S	N/S	N/S	S	N/S
6	S	N/S	N/S	N/S	S	N/S
7	S	N/S	N/S	N/S	N/S	N/S

[1] not signifcant

[2] signifcant

* significant at a 5% level

of random generated interests rates and its relationship to the renewable term. Based on the present economic factors, an inflation rate of 7 percent was used. This results in the interest rate range of 5 to 14 percent as specified by Equations 3.16 to 3.22. The equations which have the greatest impact in this case are 3.20 and 3.21 which create a downward bias on simulated random interest rates. All of the interest rates are near the upper bound and when a new interest rate is required Equation 3.21 will be used to reduce interest rates. Therefore, there is a downward bias on interest rates since whenever a loan is renewed or refinanced, the interest rate distribution will be reset so the upper limit is confined to 14 percent. This aspect will have its greatest influence on the annually renewed loan since random interest rates are used more frequent under this financial arrangement. Therefore, under economic conditions where interest rates are expected to fall it would be to an investor's advantage to be financed with a shorter term loan. This is especially important at high levels of leverage. Under a thirty year fixed loan, unless the investor is required to refinance he is locked into an interest rate of 13.5 percent. The final result is greater risk or survival asssociated with the fixed loan compared to the annually renewed loan at this level of leverage. In investment 4, there is no significant difference between a non-renewable loan and a three of five year loan. This implies if the renewable term is greater than 3 years, there is no significance in loan arrangements under these economic conditions.

In investment 5, the deviation in farm growth and survival reaches its peak under the various financial arrangements. The same relationship occurs as in the previous investment. In this case bankruptcies range between 34 percent to 61 percent which is nearly twice the range experienced in investment 4. This investment also illustrates bankruptcies occurring in more then one equity change category . Thus, financing characteristics have their greatest impact at this level of leverage. Significance occurs in the same categories as the previous investment.

Investment 6 and 7 illustrate a similar relationship as previous investment. The main difference is that the deviation in farm growth and survival narrows. This narrowing would be a result of the refinancing component. Since the investor is levered to such a great extent, the effect of the renewal terms will be lessened. This is because under each scenario the investor will probably have to refinance early in the 10 year simulation term. The annually renewed loan still illustrates the least amount of risk compared to the 3 and 5 year renewable loans. However, there is not a significant difference between the annually renewable loan (Scenario 2) and the 5 year renewable loan (Scenario 4). The reason is the 5 year renewable loan being refinanced just as frequently as the annually renewed loan.

The relationships in Table 4.12, imply that an investor should prefer an annually renewed loan to reduce the chance of bankruptcy. Traditionally bankers and farm investors prefer longer term loans. However, in the early eighties when long term loan interest rates ranged between 17 and 20 percent, there was reluctance upon farm investors to commit funds for several future years. Presently, interest rates have declined and many farmers are refinancing to take advantage of lower interest rates.

The results of the simulations indicate a probability of failure ranging between 9 and 25 percent for a debt equity ratio of 82 percent. This chance of failure appears relatively high, however, it is a reflection of the specified economic conditions. The main reason for a large number of bankruptcies is that the returns from crop production do not warrant the current price of land. As a result, if the land prices decline, the remaining farm equity may not be sufficient to refinance. Other factors which may result in fewer bankrupties are discussed in Limitations of the Study.

Chapter V

SUMMARY AND CONCLUSIONS

5.1 SUMMARY

Current economic conditions require careful consideration of the consequences of farmland investment decisions. This is supported by increased price risk experienced throughout the seventies and eighties. In retrospect, not only has risk increased, but given the underlying supply and demand conditions in grains and oilseed products, price variability is likely to continue and uncertainty could be greater in the future.

The general objective of this study was to evaluate the effect of debt levels and loan arrangements on farm growth and survival within a stochastic environment. This objective was satisfied by first developing a Monte Carlo simulation model to determine the financial consequences of additional farmland investment. This model was then used to evaluate the effects of debt levels and loan arrangements on farm survival and equity growth.

The model development was based on several previous studies which determined a bid price of land using capital budgeting equations. Studies of this nature assume complete certainty by the investor. Although the calculations were operationally sound there is little allowance to adequately incorporate risk. Several methods of evaluating investment risk were reviewed and dismissed as being only of supplementary value. A

Monte Carlo simulation technique was used due to its superiority in dealing with several variables which interact collectively to determine overall risk. This technique allowed objective and/or subjective probability distributions to influence the decision outcome. In addition, a stochastic simulation model offers relative ease in testing consequenses of stochastic dependence, resulting from the joint dependence of some variables on other common variables. Indirect handling of correlations in this manner is more expedient than direct elicitation of joint distributions. Finally, the farmland investor has the advantage of being able to evaluate a specific generated probability distribution of possible outcomes, rather than a single-valued estimate which has been adjusted for risk.

The specific program logic requires the investor supplying information to initialize several deterministic relationships and the distributions for the random variables. This information represents the data source which will be used in each ten year trial. The trials are repeated 300 times to achieve a stable statistical distribution. The probability of annual equity change and bankruptcy is presented upon completion of the simulation process.

Several factors within the model have major influences on the final results. First, the randomly generated wheat price, wheat yield and interest rate affect the net cash flow within the model. Second, the initial values of interest rate and wheat price with respect to expected inflation rate is an important factor since inflation affects the general movement of these two variables. The random variables also have a significant effect on land price derivation and subsequently the investor's equity. The criteria for bankruptcy is based on a debt/equity ratio of 5.67, therefore, land price derivation is critical in the simulated results.

5.2 SUMMARY OF RESULTS

The empirical results are based on four different scenarios representing loan arrangements. Each loan differs according to the renewable term. The first type is a 30 year, nonrenewable, amortized loan. Successive loan types are 1, 3, and 5 year renewable interest rates within the loan period of 30 years. The applicable interest rate is determined by the renewable term of the loan. An annually renewed loan has the same interest rate as the operating loans. The initial operating interest rate was assumed to be 11.5 percent. Each year thereafter the loan is randomly generated. For every additional year in the renewable term, half a percent premium will be added onto the random interest rate. The maximum interest rate premium is 2 percent. Therefore, a five year renewable loan and a nonrenewable loan will have initial interest rates of 13.5 percent.

Within each scenario, seven different farmland investments are undertaken ranging from a debt/equity ratio of 0 to 3. In each scenario, the first investment illustrates a normal distribution of average annual equity growth with a modal value of 4 percent. Successive investments result in the annual equity growth increasing, however, the probability of obtaining this growth is reduced. In an annually renewed loan with a debt/equity ratio of 3, the modal value of equity growth is 15 percent and a chance of financial failure of 73 percent. At this same level of leverage, the 3 and 5 year renewable loans, and the nonrenewable loans illustrate increasing probabilities of failure with no discernible mode. Thus, the annually renewed loan represented the least risk of failure, and as the renewable term of the loan increased there was a corresponding increase in the risk of failure. This result is mainly due to the specification of the initial interest rate with respect to the expected inflation rate. If the expected inflation rate is relatively low compared to the interest rate, interest rates can be expected to decline. Although interest rate is a random variable, fixed bound were incorporated to represent a deterministic relationship between the inflation rate and interest rate. In this study, the inflation rate was 7 percent and the interest rate for a 30 year nonrenewable loan was 13.5 percent which represents a large deviation. Therefore, an investor with an annually renewed loan had the advantage of usually renewing at a lower interest rate compared to a loan with a longer renewable term.

Statistically, the percentage change in equity was not influenced by the terms of credit used to acquire farmland until the debt/equity relationship exceeded 0.82. This implies financial arrangements did not influence farm growth or survival under the specified economic conditions. The simulations indicated the probability of attaining a desired rate of equity growth was not dependent upon how the farmland purchased was financed until debt levels exceed 82 percent of the farm's equity at the time of the investment. At leverage ratios greater than 0.82, a nonrenewable loan was significantly different than a loan where the interest rate is renewed annually. An annually renewed loan and a 5 year renewable loan were also significantly different. In both cases the probability distribution of the percent change in equity for a land investment with annually renewed interest rates inferred a greater likelihood of a higher growth rate would be obtained than with a fixed interest rate or when the interest rate changed every five years.

5.3 LIMITATIONS

An overstatement of the incidence of bankruptcy may occur since the investor is forced to refinance as soon as an operating loan exceeds total operating expense. In most cases there would be a time lag of one year before such action would be taken. In addition, bankruptcy occurs when the debt/equity ratio exceeds a critical level. In this relationship a time lag may be appropriate. The criteria for bankruptcy is consistent for every trial which does pose limitations. In the past, the criteria for bankruptcy has not been consistent and varies depending on the factors which threaten farm survival.

The use of one crop is taken to be representative of all crops grown in the Prairie Provinces. Risk associated with oilseeds and special crops may be understated. However, risk reduction through crop diversification is not taken into account. Risk reduction by the use of crop insurance is indirectly dealt within the yield specification. Allowance within the model may be beneficial since various insurance plans do exist.

Land price derivation is based on a simplistic model which involves two variables. Factors which may cause land price to be valued above or below its productive value are disregarded. Speculation is a main variable which may cause land to trade at a inflated value. This factor would influence equity growth and farm failure.

5.4 SUGGESTIONS FOR FURTHER RESEARCH

Several aspects within this study could be extended. Sensitivity analysis could be performed on the several variables to determine if more or less specification is required. The determination of land price is a major component which could require additional specification. Income tax calculations may provide additional benefits, since this aspect is specific to each investor. No attempt was made to include specific personal exemptions or income averaging which would have influenced equity growth. The bounds which are imposed on wheat price and interest rates restrict their change over time. These restrictions are based on the economic environment in the seventies and early eighties. These restrictions are valid if the price variation experienced in the seventies continue throughout the eighties. However, these restrictions are invalid if economic stability occurs similar to the fifties and sixties.

Useful information may result by examining various scenarios which include such variables as off-farm income and existing loans. Both of these variables are prevalent in typical farm operations. As it is to be expected, the final results will depend on the initial information and the investor's ability to use it to the best advantage.

BIBLIOGRAPHY

Anderson,J.R., J.L.Dillon and B.Hardaker, Agricultural Decision Analysis, The Iowa State University Press, Ames, 1977.

Aukes,R.G., Reducing Borrower And Lender Risk Through The Use of Variable Amortization Plans: A Simulation Study, Department of Agricultural Economics, University of Illinois, 1980.

Barry,P.J., C.B.Baker and L.R.Sanint, 'Farmer's Credit Risks and Liquidity Management,' American Journal of Agricultural Economics, Vol.63, No.2, May 1981.

Barry,P.J. and H.W.Fraser, 'Risk Management in Primary Agricultural Production,' American Journal of Agricultural Economics, Vol.58, No.2, May 1976.

Barry,P.J., J.A.Hopkin and C.B.Baker, Financial Management in Agriculture, The Interstate Printers and Publishers, Danville, 1979.

Bierman,H. and S.Smidt, The Capital Budgeting Decision, MacMillan Publishing Company, New York, 1980.

Crowley,W.D., 'Actual Versus Apparent Rates of Return on Farmland Investments,' Agricultural Finance Review, Vol.35, 1974.

Dovring,F., 'The Farmland Boom in Illinois,' Illinois Agricultural Economics, Vol.22, July 1977.

Farm Credit Corporation, Federal Farm Credit Statistics, Ottawa, 1960-82.

Fields,V.J., 'The Influence Of Grain Freight Rates On The Farm Land Market In The Prairie Provinces,' unpublished M.Sc. thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1980.

Hardin,M.L., 'A Simulation Model For Analyzing Farm Capital Investment Alternatives,' unpublished Ph.D. thesis, Department of Agricultural Economics, Oklahoma State University, Stillwater, 1978.

Fisher,I., The Theory of Interest, Kelley and Millman, New York, 1954.

Harris,D.G. and R.F.Nehring, 'Impact of Farm Size on the Bidding Potential for Agricultural Land,' American Journal of Agricultural Economics, Vol.58, No.2, May 1976.

Helmer,G.A. and L.T.Held, Simulating Farm Survivorship - Suggestions For Financial Simulation Research, paper presented at W-149 Western Regional Project Technical Committee Meeting, University of Wyoming, January 1980.

Hertz,D.B., 'Risk Analysis in Capital Investment,' Harvard Business Review, Vol.42, 1964.

Holt,J., An Old And A New Approach To The Land Purchase Decision, paper presented at a National Extension Workshop, Denver, 1978.

Kay,R.D., Farm Management: Planning, Control And Implementation, McGraw-Hill Book Company, New York, 1981.

Kraft,D.F., Economic Implications of Absentee Ownership of Farmland, paper presented for Farm Business Challenges of the 1980's, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1981.

Kraft,D.F., What's Land Worth Now, Occasional Series #6, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1974.

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

Lee,S.M., L.J.Moore and B.W.Taylor, Management Science, Wm.C.Browm Company, Dubuque, 1981.

Lins,D.A., T.L.Frey and N.E.Harl, Farmland, Agri Business Publications, Skokie, 1982.

Lusztig,P.A. and B.Schwab, Managerial Finance in a Canadian Setting, Butterworth and Company, Toronto, 1977.

Manitoba Department of Agriculture, Manitoba Agricultural Yearbook, Winnipeg, 1980-81.

Musser,W.N., F.C.White and J.C.McKissick, 'Application of the Concept of Cost of Capital to Farm Managment Decisions,' Journal of American Society of Farm Management and Rural Appraisers, Vol.41, April 1977.

Nelson,A.G., Evaluating The Financial Risk Involved In Land Investment Decisions, Oregon State University, July 1978.

Officer,R.R. and J.R.Anderson, 'Risk, Uncertainty and Farm Management Decisions,' Review of Marketing and Agricultural Economics, Vol.36, 1968.

Penson,J.B. and D.A.Lins, Agricultural Finance, Prentice Hall Inc., 1980.

Raiffa,R.D. and E.I.Reinsel,'The Economics of Asset Values and Current Income in Farming,' American Journal of Agricultural Economics, Vol.61, December 1979.

Revenue Canada Taxation, Farmer's Income Tax Guide, Winnipeg, 1982.

Revenue Canada Taxation, General Tax Guide and Return, Winnipeg, 1982.

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

Statistics Canada, Farm Input Price Index, Catalogue Number 62-004, Quarterly, Ottawa, 1962-82.

Statistics Canada, Farm Net Income, Catalogue Number 21-202, Ottawa, 1969-82.

Willet,G.S., What Can I Pay For Farmland, paper presented to Extension Workshop, Denver, July 1978.

Willet,G.S. and M.E.Wirth, How To Analyze An Investment In Farmland, A Western Regional Extension Publication, April 1980.

Appendix A

ANALYSIS OF LAND VALUE

TABLE A.1

Analysis Of Land Value

Worksheet 1

1. Enter average annual before-tax gross receipts $_____
2. Enter average annual before-tax costs, do not include interest on land loan or investment $_____
3. Subtract line 2 from line 1 $_____
4. Enter 1.0 minus your marginal income tax rate _____
5. Multiply line 5 times line 3 $_____
6. Enter your required after-tax real rate of return on the land investment _____
7. Enter your estimate of the average annual rate of general price inflation during the land investment planning period _____
8. Enter your estimate of the average annual rate of change in the land returns arrearing on line 5 _____%
9. Add lines 6 and 7 and subtract line 8 from total _____%
10. Enter interest factor from table 2, Appendix B, for interest rate on line 9 and number of years in planning period _____
11. Multiply line 10 times line 5 _____
12. Enter the proportion of the purchase price to be financed with debt (if no debt used, skip to line 20) _____
13. Enter interest factor from table 2, Appendix B, for interest rate equaling before-tax contractual rate of interest on loan and number of years in loan repayment period _____
14. Divide line 12 by line 13 _____
15. Divide line 12 by number of years in loan repaymet period _____
16. Subtract line 15 from line 14 _____
17. Multiply line 16 times your marginal income tax rate _____
18. Enter interest factor from table 2, Appendix B, for interest rate equaling line 6 plus line 7 and number of years in loan repayment period _____
19. Multiply line 18 times line 17 _____
20. Enter interest factor from table 3, Appendix B, for interest rate equaling line 6 plus line 7 and number of years in planning period _____
21. Enter interest factor from tabe 1, Appendix B, for interest rate equaling your estimate of annual rate of increase in land market price and number of years in planning period _____
22. Enter estimated market price of land _____
23. Multiply line 21 times line 22 $_____
24. Enter your capital gains tax rate _____
25. Multiply line 23 times line 24 _____
26. Subtract line 25 from line 23 and multiply by line 20 $_____
27. Multiply line 20 times line 24 _____
28. Add lines 19 and 27 _____
29. Enter 1.000 minus line 28 _____
30. Add lines 11 and 26 _____
31. LAND VALUE (line 21 divided by number of acres in purchase) _____

TABLE A.2

Analysis Of Ability To Pay For Land

Worksheet II	
1. Enter average annual before-tax gross cash receipts from all enterprises in the expanded business	$______
2. Enter average annual before-tax cash costs for all enterprises in the expanded business	$______
3. Subtract line 2 from line 1	$______
4. Enter average annual depreciation deducted for income taxes paid on expanded business	$______
5. Enter income tax deduction for personal exemptions and zero bracket amount or itemized deduction	$______
6. Add lines 4 and 5	$______
7. Enter your average incone tax rate for expanded business	$______
8. Multiply line 7 times line 6	$______
9. Enter 1.00 minus your average incone tax rate (line 7)	$______
10. Multiply line 9 times line 3	$______
11. Add lines 10 and 8	$______
12. Enter average annual principal payments on long-term debt (over 1 year), do not include debt on land purchase	$______
13. Enter average annual depreciation reserve	$______
14. Enter social security taxes paid on self-employment income	$______
15. Enter annual family living expenses	$______
16. Add lines 12, 13, 14, and 15,	$______
17. Subtract line 16 from line 11	$______
18. Enter interest factor from table 2, Appendix B, for interest rate equaling after-tax contractual rate of interest on loan and number of years in loan repayment period	______
19. Multiply line 18 times line 17	$______
20. Enter equity capital available for downpayment on land purchase	$______
21. MAXIMUM PRICE THAT CAN BE PAID FOR TOTAL ACREAGE (line 19 plus line 20)	$______
22. MAXIMUM PER-ACRE PRICE (line 21 divided by number of acres in lnd purchaes)	$______