COMPUTER SIMULATION MODEL
FOR RISK-ADJUSTED INVESTMENT ANALYSIS

by

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ABSTRACT

Computer Simulation Model

for Risk-Adjusted Investment Analysis (April 1984)

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This study involves the development of a simulation model for the analysis of possible investment alternatives. The model is written in Fortran programming language and employs the net present value method of analysis. A unique feature of this model is its ability to incorporate the farmer's attitude toward risk into the analysis.

This simulation model enables interested farmers to analyze a potential investment under varying production and marketing conditions as well as under variations in their attitude toward risk. Alternative simulations of the model reflecting different risk-attitudes reveal that behavior towards risk does have a definite impact on the feasibility of a risky investment. This impact indicated by the decreasing net present value noted as the level of risk-aversion increases.

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I

INTRODUCTION

There are three factors which make careful consideration of investment opportunities so important. One is the loss of portfolio flexibility incurred by farmers investing in fixed assets (i.e., equipment, buildings and land). This loss of flexibility is directly related to the difficulty farmers have in disposing of these assets in periods of economic downturns in agriculture. Second, most investments are made under conditions of uncertainty. In agriculture, uncertainty uncertainty is tied to variations in biological as well as economic conditions. Forecasts made under these conditions should be carefully reviewed before purchases are made. The third factor concerns the acquisition of the capital needed to finance investment projects. Typically large sums of capital are required when purchasing fixed farm business assets. Farm capital expenditures therefore deserve serious consideration and well-researched planning.

Once the decision has been made regarding the feasibility of a particular investment, the farmer must consider the other investment opportunities available to him and then rank these investments in order of their net economic benefit to his firm.

There are many methods available for analyzing investment projects. This study will use the net present value capital budgeting

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Format and style of this Senior Honors Thesis follows those found in the *American Journal of Agricultural Economics.*

model. One factor mentioned above that theoretically plays a significant part in investment analysis is the degree of risk associated with each project and how the farmer feels about accepting this risk. Many economists have long recognized the fact that risk attitudes affect the net present value associated with a particular investment alternative. Yet, there has been very little work done in agriculture to extend a risk-adjusted net present capital budgeting model to farmers and ranchers. Such a model could also be a valuable teaching aid in farm financial management classes.

The purpose of this study is to develop a simulation model which will (1) allow farmers and ranchers to analyze their investment opportunities in light of their personal feelings toward the riskiness of each alternative and (2) provide students with a means of observing the effects that risk and risk behavior has on the desirability of potential investments. The intended audience for this study includes (1) Agricultural Extension Service agents involved in addressing investment-related questions raised by farmers and (2) instructors presenting this capital budgeting method in their farm financial management classes.

CHAPTER II

REVIEW OF THE LITERATURE

The review of literature presented in this chapter is divided into the following topics: (1) the literature on the net present value capital budgeting method, (2) the literature on risk theory and (3) the literature on practical applications of risk-adjusted net present value models.

Net Present Value Method

For many years economists have supported the use of the net present value capital budgeting method for analyzing potential investment choices. They have also recognized the importance of incorporating risk into the net present value analysis. Penson and Lins (1980) choose the net present value method over other available methods due to its consideration of the time value of money and its ability to explicitly account for a farmer's attitude toward risk in the discount rates used to express future cash flows in present value terms.

The general form of the net present value (NPV) model can be expressed as follows:

$$(1) \qquad NPV = \sum_{i=1}^{n} [Y_i / \prod_{j=1}^{i}(1+r_j)] - C + T/\prod_{j=1}^{i}(1+r_j)$$

where Y_1, Y_2, ..., Y_n represent the *expected* annual net cash flows associated with the investment; r_1, r_2, ..., r_n represent the annual risk-adjusted discount rates associated with the investment; n is the length of the farmer's planning horizon; T represents the terminal value and C represents the equity capital invested by the farmer. The investment project is said to be feasible from an economic standpoint if the net present value given by equation (1) is positive (i.e., NPV is greater than zero). The project, however, is not feasible from an economic standpoint if the net present value is negative (i.e., NPV is less than zero).

Schall and Haley (1980) explicitly state that, in their judgement, the net present value capital budgeting method is superior to the internal rate of return method and payback method since the net present value method can handle any problem that either of these other two methods can handle, while the reverse is not true in all cases.[1] Schall and Haley also discuss the use of risk-adjusted discount rates for the analysis of future cash flows and present a method of computing these risk-adjusted discount rates.

Risk Theory

Penson and Lins categorized farmers into three groups in terms of their feelings towards risk. A farmer is said to either be risk-neutral, risk-averse or risk-loving. The risk-neutral farmer, for example, would use a risk-free rate of return as his required rate

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[1] For a description of the internal rate of return and payback capital budgeting methods, see Schall and Haley (1980), pp. 196-205.

of return even when risk is present. A graphic illustration of this behavior is presented in Figure 2.1. His risk-return preference curve, which illustrates the relationship between the risk per dollar of expected return on an investment and the minumum rate of return the farmer requires from the investment, is a horizontal line. This suggests that risk has no effect on his required rate of return.

Figure 2.1 also illustrates the behavior of farmers who are risk-averse. Changes in the amount of risk associated with an investment *will* have an affect on this farmer's required rate of return. The farmer having a risk-return preference curve with a slope of +.20 would be considered lowly risk-averse when compared to a farmer with a slope of +.70, who would be considered highly-risk averse. Both of these farmers would require an additional return on their investment because of the risk involved. A highly risk-averse farmer, however, requires a higher additional return or *risk premium* than a lowly risk-averse farmer.

The final category of farmers is the risk-lover. This is a farmer whose risk-return preference curve would have a negative slope (e.g., -.20). This suggests he would prefer more risk and less return to less risk and more return. This type of behavior is not economically rational and thus will not be considered in this study.

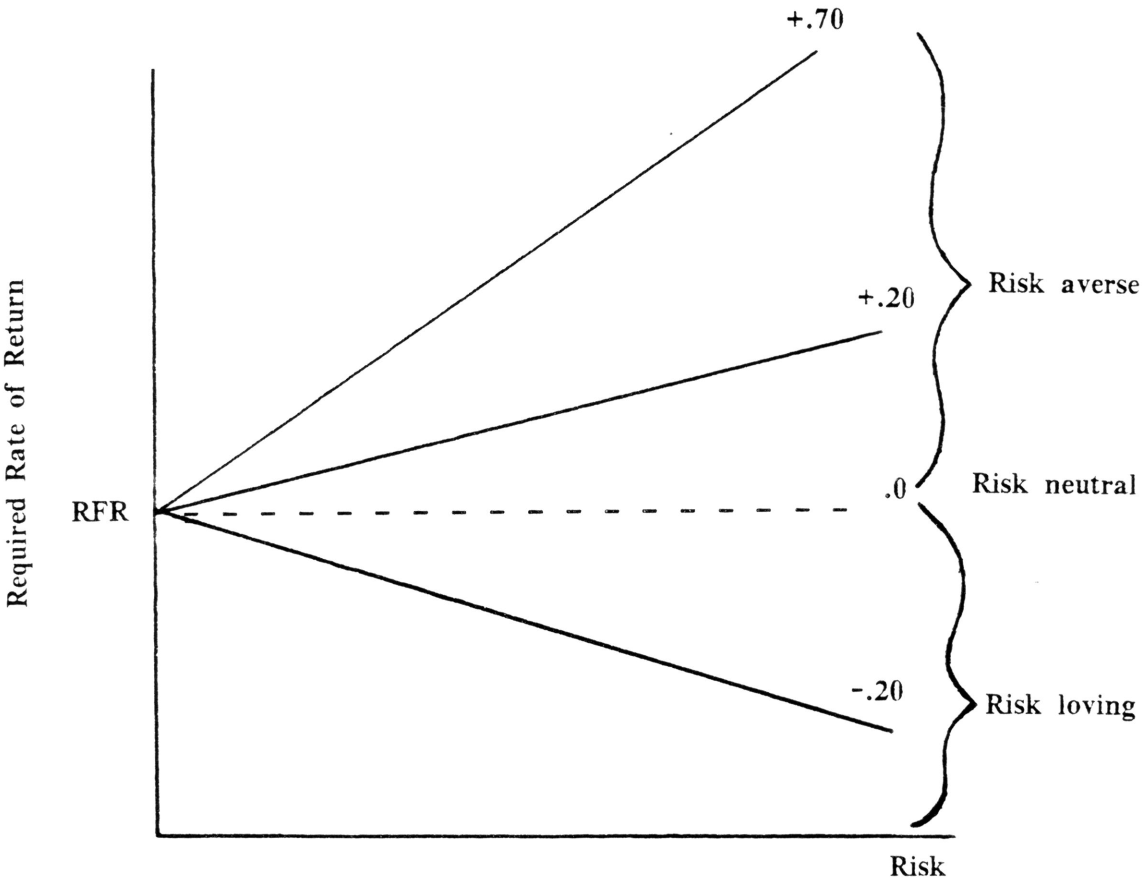

Figure 2.1: Illustration of Alternative Risk-Return Preferences

Practical Applications

The practical applications of incorporating risk attitudes into computerized capital budgeting models have been somewhat limited, especially in agriculture. Fung and Stapleton (1980) describe a model they have developed which incorporates risk, but it seems to cater to nonagricultural firms. Schall and Sundem (1980) researched the relationship between risk variables and the capital budgeting methods and concluded, in part, that the firms that would benefit the most from using more sophisticated methods involving risk analysis were not using them. The types of firms Schall and Sundem refer to in their study are firms facing the greatest uncertainties in their business environments. Agricultural firms easily fall into this category, since they face one of the most uncertain business environments possible due to their dependence on biological conditions, an inelastic demand for their products and a lack of market power which forces them to be "price takers" in their input and product markets.

Applying Schall and Sundems' conclusions, farmers could greatly benefit from the application of more sophisticated capital budgeting methods. Perhaps with the emphasis placed in recent years being on the risk involved in investment analysis and the increased use of computers, farmers will be able to more informed investment decisions.

CHAPTER III

DEVELOPMENT OF SIMULATION MODEL

There are eight basic steps taken in this study to develop a computer simulation model for risk-adjusted investment analysis. The order of these steps can be seen in the program flowchart in Figure 3.1. These steps include:

1. Read in data supplied by a questionnaire completed by a farmer.
2. Calculate the loan repayment schedules.
3. Calculate the annual depreciation allowance.
4. Calculate potential annual net cash flows.
5. Calculate expected net cash revenue flows, standard deviation and coefficient of variation.
6. Calculate expected net cash flows.
7. Calculate the required rate of return and the annual discount factors.
8. Calculate the net present value.

Each of these steps are discussed in turn below.

Data Requirements

To complete an investment analysis using the simulation model developed in this study, certain information must be obtained. This information is collected through the use of a questionnaire (a completed questionnaire is presented in Appendix A). The information reported by a completed questionnaire is used when completing calculations necessary to determine the net present value of each

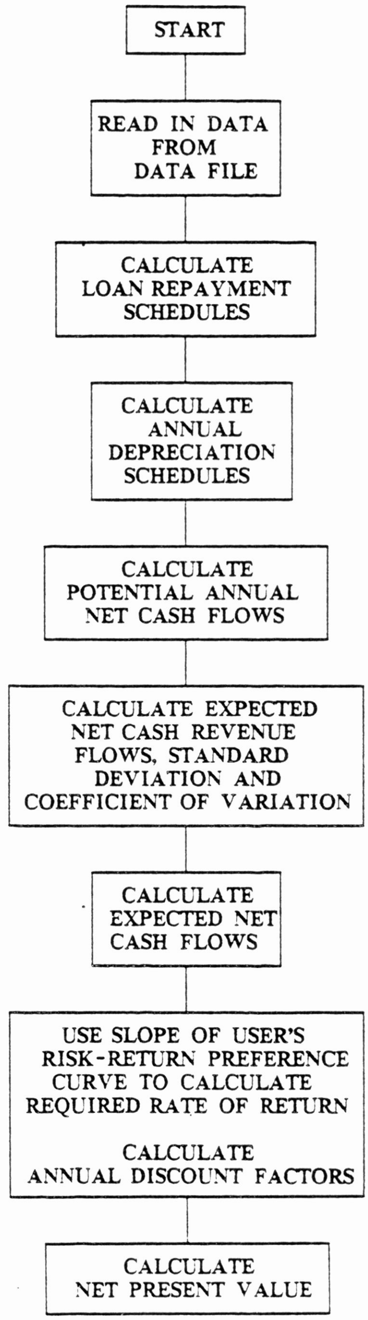

Figure 3.1: Computer Simulation Model Flowchart

investment opportunity. The information needed can be summarized as follows:

1. *The purchase price of the asset(s).* These costs are used in calculating depreciation allowances, the purchase prices of replacement assets and the downpayments involved when financing the replacements.

2. *The terms of debt financing.* Included here are the length of the loan(s), the annual rate being charged on the loan(s), the amount of the loan(s), and the frequency of loan payments. A loan repayment schedule will be set up for the farmer based upon this information. This schedule will reflect any additional loans on replacement property. The principal payments required to compute the annual net cash flows will be separately identified.

3. *Cash downpayment.* This information will be necessary when the net present value is calculated. It will reduce or offset the present value of the generated net cash flows.

4. *Percent debt financing of replacement assets.* This percentage is needed to determine the downpayment for the replacement investments that will

occur in future years. The present value of these downpayments must be taken into account along with the cash downpayment for the initial loan when determing the net present value.

5. *Total noninterest charges.* These charges, which are typically incurred when financing land purchases, are treated like other cash expenses and thus reduce the net present value.

6. *The expected resale value of land in the final year of project.* Land is the only asset in the case example examined in this study that earns a capital gain. All other assets will have a zero tax basis by the end of the planning horizon. This capital gain must be net of taxes before incorporating this value into the net present value analysis.

7. *Tax rate.* The farmer's marginal tax rate will be needed in computing the taxes on cash flows and his capital gains tax when land is sold at the end of the horizon.

8. *User's attitude toward risk.* The slope of the farmer's risk-return preference curve is elicited by the farmer's response to a question in the

questionnaire.

9. *Revenue, expenses, and their respective probabilities.* The net cash revenue flows generated by the investment(s) are calculated as revenue minus expenses. In forecasting these cash flows for the purpose of investment analysis, we are assuming that any one of three potential outcomes could occur and that each outcome has different revenue and expenses. The three possible outcomes reflect a pessimistic, optimistic, and current evidence scenario and each will result in different values for the annual potential net cash flows. The optimistic scenario would be associated with the highest potential flow, the current evidence scenario would result in a flow similar to previously ones experienced by the farmer, and the pessimistic scenario would be associated with the lowest potential cash flow. The farmer must put himself into each scenario and forecast the potential annual revenue flows and expenses he thinks could occur each year over the life of the investment. He must then assign (to each scenario in each year) a percentage probability which indicates his

belief that a particular scenario will occur. For each year, the individual percentage probabilities for all three scenarios must total to 100 percent. The annual interest charges and depreciation allowance are deducted from the annual revenue and expenses for each scenario to calculate the annual income tax payment. Once this has been done and the tax has been deducted from the annual cash flows, each potential net cash revenue flow is weighted using the assigned probabilities and combined to determine the *expected* annual net cash revenue flow. Finally, the annual principal payments are deducted from the annual expected net cash revenue flows to determine the *expected annual net cash flows.* These are the cash flows which correspond to the values for the Y_i variable in equation (1) and are discounted to determine their present values.

Loan Repayment Schedules

The loan repayment schedules must be calculated for the initial purchase as well as for the purchases of replacement assets for 3-year and 5-year property over the life of the planning horizon. Due to assumed increases in nominal costs and interest rates, the repayment schedules will be different over the planning horizon for each replacement. These differences must be taken into account when calculating the expected net cash flows and the cash downpayments. Reports are generated by the simulation model for the initial loan, each replacement loan, and for all loans taken together. The loan repayment schedules used in this study and the annual principal and interest payments associated with the investment project assessed in this study are presented in Figures 3.2 through 3.5.

Annual Depreciation Allowance

One of the advantages of purchasing depreciable assets is the reduction in taxable income they afford over their useful life. Thus, the calculation of the annual depreciation allowance is important to assessing the merits of an investment and must be captured by the model. The depreciation allowances calculated in this study are based upon the Accelerated Cost Recovery percentages for 3-year, 5-year and 15-year property. The annual depreciation allowances for the investment project assessed in this study are reported in Figure 3.6.

YEAR	TOTAL PAYMENT	INTEREST PAYMENT	PRINCIPAL PAYMENT	REMAINING BALANCE
1	3286.85	2500.00	786.85	24213.14
2	3286.85	2421.31	865.54	23347.61
3	3286.85	2334.76	952.09	22395.52
4	3286.85	2239.55	1047.30	21348.21
5	3286.85	2134.82	1152.03	20196.18
6	3286.85	2019.62	1267.23	18928.95
7	3286.85	1892.90	1393.96	17534.99
8	3286.85	1753.50	1533.35	16001.64
9	3286.85	1600.16	1686.69	14314.95
10	3286.85	1431.50	1855.36	12459.60
11	3286.85	1245.96	2040.89	10418.71
12	3286.85	1041.87	2244.98	8173.73
13	3286.85	817.37	2469.48	5704.25
14	3286.85	570.42	2716.43	2987.82
15	3286.85	298.78	2988.07	-0.25

Figure 3.2: Loan Repayment Schedule for Original Loan Undertaken in Year 1

1ST 3-YEAR PROPERTY REPLACEMENT LOAN

YEAR	TOTAL PAYMENT	INTEREST PAYMENT	PRINCIPAL PAYMENT	REMAINING BALANCE
4	966.53	281.42	685.11	1630.14
5	966.53	198.14	768.38	861.76
6	966.53	104.75	861.78	-0.02

2ND 3-YEAR PROPERTY REPLACEMENT LOAN

YEAR	TOTAL PAYMENT	INTEREST PAYMENT	PRINCIPAL PAYMENT	REMAINING BALANCE
7	1155.82	377.13	778.69	1901.50
8	1155.82	267.56	888.26	1013.24
9	1155.82	142.57	1013.25	-0.01

3RD 3-YEAR PROPERTY REPLACEMENT LOAN

YEAR	TOTAL PAYMENT	INTEREST PAYMENT	PRINCIPAL PAYMENT	REMAINING BALANCE
10	1388.03	505.39	882.65	2220.01
11	1388.03	361.61	1026.42	1193.60
12	1388.03	194.42	1193.61	-0.02

4TH 3-YEAR PROPERTY REPLACEMENT LOAN

YEAR	TOTAL PAYMENT	INTEREST PAYMENT	PRINCIPAL PAYMENT	REMAINING BALANCE
13	1674.63	677.27	997.36	2594.36
14	1674.63	489.20	1185.43	1408.93
15	1674.63	265.67	1408.95	-0.02

Figure 3.3: Loan Repayment Schedules for Replacement Loans on 3-Year Property

1ST 5-YEAR PROPERTY REPLACEMENT LOAN

YEAR	TOTAL PAYMENT	INTEREST PAYMENT	PRINCIPAL PAYMENT	REMAINING BALANCE
6	732.85	342.07	390.78	2161.79
7	732.85	289.70	443.15	1718.64
8	732.85	230.31	502.53	1216.11
9	732.85	162.97	569.88	646.23
10	732.85	86.60	646.25	-0.02

2ND 5-YEAR PROPERTY REPLACEMENT LOAN

YEAR	TOTAL PAYMENT	INTEREST PAYMENT	PRINCIPAL PAYMENT	REMAINING BALANCE
11	1020.69	557.19	463.50	2794.29
12	1020.69	477.92	542.77	2251.52
13	1020.69	385.08	635.61	1615.91
14	1020.69	276.37	744.31	871.60
15	1020.69	149.07	871.62	-0.02

Figure 3.4: Loan Repayment Schedules for Replacement Loans on 5-Year Property

YEAR	TOTAL PAYMENT	INTEREST PAYMENT	PRINCIPAL PAYMENT
1	3286.85	2500.00	786.85
2	3286.85	2421.31	865.54
3	3286.85	2334.76	952.09
4	4253.38	2520.97	1732.41
5	4253.38	2332.97	1920.41
6	4986.22	2466.43	2519.79
7	5175.52	2559.72	2615.80
8	5175.52	2251.37	2924.15
9	5175.52	1905.71	3269.81
10	5407.73	2023.48	3384.25
11	5695.57	2164.76	3530.81
12	5695.57	1714.21	3981.37
13	5982.16	1879.72	4102.45
14	5982.16	1336.00	4646.17
15	5982.16	713.53	5268.64

Figure 3.5: Total Annual Principal and Interest Payments Over Life of Investment Project

YEAR	ALLOWANCE
1	2540.00
2	4080.00
3	3980.00
4	3487.03
5	4149.48
6	3908.82
7	3799.03
8	4516.28
9	4359.27
10	3729.26
11	4529.20
12	5021.74
13	4225.16
14	5302.47
15	5122.68

Figure 3.6: Annual Depreciation Allowances for Depreciable Assets Over Life of Investment Project

Potential Annual Net Cash Revenue Flows

The values for the potential annual net cash revenue flows discussed above are obtained using values for certain variables given by the questionnaire presented in Appendix A as well as values for other variables calculated within the simulation model. The equations used to calculate these values are as follows:

(2) $ANCFBT_{ij} = A_{ij} - B_{ij} - AINT_i$

(3) $TAX_{ij} = TXRATE*(ANCFBT_{ij} - ANDPAL_i)$

(4) $ANFAT_{ij} = ANCFBT_{ij} - TAX_{ij}$

These calculations reflect the farmer's projections of future revenues stored in matrix A and expenses stored in matrix B for each scenario. The scenarios are represented by the "j" subscript above, where j=1 represents the optimistic outlook, j=2 represents the current evidence outlook, and j=3 represents the pessimistic outlook. The "i" subscript on the other hand represents the year in question. The variable $AINT_i$ is the total interest charges being paid in a particular (ith) year and represents the total interest charges from all the loan repayment schedules for that year. The depreciation allowance for a specific year is symbolized by $ANDPAL_i$ and is also summed over all types of depreciable property. The amount of taxes paid in a particular year under a particular scenario is represented by TAX_{ij}. This value is then subtracted from $ANCFBT_{ij}$, the potential annual net cash revenue flow before taxes for each scenario in each year to arrive at the value for $ANCFAT_{ij}$ or the potential after-tax annual net revenue cash flow.

Expected Net Cash Flows

The questionnaire illustrated in Appendix A requires the farmer to assign a probability of occurrence to each scenario, with the limitation that the total for the three scenarios must sum to 100 percent. These probability assignments influence the value that is actually *expected* to occur each year over the life of the project. For example, assume a farmer assigned a 90 percent probability to one potential net cash flow while each of the other two scenarios were assigned a 5 percent change of occurrence. Given this normal distribution, the expected value would be closely associated with the 90 percent chance of occurrence. The following formula illustrates the calculation required to determine the expected net cash revenue flow:

$$(5) \qquad EANFAT_i = W_{i1}*ANFAT_{i1} + W_{i2}*ANFAT_{i2} + W_{i3}*ANFAT_{i3}$$

where W_{ij} represents a matrix of probability weights for each scenario over the life of the planning horizon. The model simply takes the weights assigned by the farmer to scenario in a particular year and multiplies them by the calculated potential annual net cash revenue flow for the corresponding scenario in that year. The sum of these weighted potential cash flows is $EANFAT_i$, the expected net cash revenue flow for a particular year. To obtain the expected net cash flow for each year, the model uses the following general approach:

(6) $EANNCF_i = EANFAT_i - APRN_i$

where $EANNCF_i$ corresponds to the variable Y_i in equation (1). The annual expected net cash revenue flows reported in Figure 3.7 are generated by equation (5). From this value, the total principal payments on loans in each year are subtracted to obtain the expected net cash flow $EANNCF_i$ for each year. These annual values given by equation (6) are the additional net cash flows available to the farmer as a result of having made the investment under consideration.

Net Present Value

The investment decision suggested by this simultion model will be based upon the net present value of the cash flows associated with the investments being analyzed. The equation in the simulation model that is used to compute the net present value (NPV) is as follows:

(7) $$NPV = DNCF - DNPAY - TNOINT + [ERSLND - (.40*TXRATE*(ERSLND-PURLND))]*DISFAC_n$$

where DNPAY corresponds to C in equation (1). The entire last term within brackets in equation (7) corresponds to variable T in equa-

YEAR	EXPECTED NET CASH REVENUE FLOW	PRINCIPAL PAYMENTS	EXPECTED NET CASH FLOW
1	3260.00	786.85	2473.15
2	3704.01	865.54	2838.47
3	3743.93	952.09	2791.84
4	3481.03	1732.41	1748.62
5	3787.65	1920.41	1867.23
6	3627.38	2519.79	1107.59
7	3529.97	2615.80	914.17
8	3940.54	2924.15	1016.39
9	4160.54	3269.81	890.72
10	3914.70	3384.25	530.45
11	4008.73	3530.81	477.91
12	4469.78	3981.37	488.41
13	4146.50	4102.45	44.05
14	4823.61	4646.17	177.45
15	5245.52	5268.64	-23.12

Figure 3.7: Calculation of Annual Expected Net Cash Flows Over Life of Investment Project

tion (1). The variable TNOINT in equation (7) was captured in Y_1 in equation (1).

Equation (7) thus incorporates all of the informational needs discussed in the previous paragraphs. The expected annual net cash flows, after being discounted by the appropriate discount factor, are accumulated in the variable DNCF. This variable can simply be thought of as the total present value of all the annual net cash flows. This will hopefully be the largest value in equation (7), as it reflects the ability of the farmer to service new debt out of the net revenue generated by the investment.

The variable DNPAY in equation (7) represents the present value of the cash downpayments made on all loans associated with this project over the entire planning horizon. This includes the initial loan as well as each of the replacement loans to be taken out when replacing 3-year and 5-year property. The downpayments are discounted back to the present using the discount factor associated with the year the loan is taken out. The value of DNPAY will offset the value of DNCF somewhat when calculating the net present value (NPV) in equation (7).

The variable TNOINT, or total noninterest charges, is treated in a similar fashion. It represents the fees that are incurred for servicing a loan request and therefore also represents an outflow of cash from the firm.

The final term in equation (7) accounts for the net appreciation in land values. Land purchased at the beginning of the project is generally worth more by the end of the project's life. The difference between the beginning and ending values is subject to a capital gains tax. This tax is subtracted from the resale value of the land and this difference is then discounted with the use of the $DISFAC_n$, where n is the final year of the project. This present value represents an addition to DNCF because it also results in an inflow of fundsto the firm generated by the investment. The final result, net present value or NPV, must be positive for the investment to be considered economically feasible. A positive value for NPV indicates that, over the life of the project, the investment will generate more revenue than it will cost in the way of general operating expenses, cash downpayments on loans, and opportunity costs associated with making this versus some other investment. A negative net present value on the other hand indicates that the opposite is true and that the investment should not be made.

The determination of whether or not an investment is feasible from a cash flow standpoint involves more than simply observing the project's net present value. Even if an investment has a positive net present value, it could still be a poor investment from the standpoint of annual net cash flows generated. For example, an investment that has several years of negative net cash flows early in the project's life but enough positive net cash flows in later years to achieve a positive net present value, should be studied carefully before making a decision. During the years of negative net cash flows, the cash flow deficit will still have to be covered. This means the farmer must be able to obtain additional cash from other sources to cover these deficits if the project is to be considered feasible from a cash flow standpoint. The final result generated by this simulation model, therefore, should not be taken as a definite indication of whether the farmer should make the investment, but rather should be used in conjunction with an analysis of other factors including the existence of any negative net cash flows over the life of the project.

Assumptions

Several assumptions were made in this study to keep this model as simple and user-friendly as possible. One assumption is that forecasts of future revenue and expenses are made in nominal as opposed to real terms. This allows the user to think in terms of his actual costs and prices when he forecasts his potential future revenue and costs. Another assumption is the steady growth in costs of property and interest rates assumed in the case example examined in this study. Each was assumed to increase at 5 percent annually, but could be changed if so desired. This assumption is important since the accuracy of the cost of replacing 3-year and 5-year property and the debt financing that accompanies their purchase has a large effect on the ending net present value. An additional assumption concerns the resale value of 3-year, 5-year, and 15-year depreciable property. Due to theer depreciable nature, these assets are assume to have a $0 market value at the time of their replacement. Any money received from their sale or trade-in is thus negligible, especially after discounting. The final assumption involves the user's attitude toward risk. The use of a linear risk-return preference curve (i.e., constant aversion to risk) is assumed for ease of description and implementation. If the farmer exhibits an increasing aversion to risk, his risk-return preference curve would be nonlinear. This behavior towards risk can be incorporated into the model with relative ease if desired.

Uses of the Model

The computer simulation model developed in this study will be made available for use by the Agricultural Extension Service and to undergraduate students in the Department of Agricultural Economics. It is intended that the model be used by extension agents in providing services to their clients as well as in their educational programs. Instructors of specific agricultural economics classes (e.g., AGEC 330 at Texas A&M University) can use the model to (1) help clarify the procedures involved in net present value analysis and (2) illustrate the effects that changes in risk behavior have on the feasibility of an investment. Effects of changes in other variables such as revenue and expense forecasts, assigned probabilities, terms of the loan or expected rates of change in prices and interest rates could also be observed very easily and very quickly by changing the desired variable while holding the others constant. This could prove to be very helpful both to the student who could see practical applications of presented theories, and to the extension agent who could analyze a variety of potential investments for a client in a matter of minutes.

CHAPTER IV

APPLICATION TO STUDY OF BEHAVIOR TOWARD RISK

The purpose of this chapter is to apply the simulation model developed in this study to an examination of the effects that alternative forms of behavior toward risk have on the economic feasibility of an investment. Before presenting the simulation results provided by this model, the approach taken in this study to measure risk and the time dimension of risk should be explained.

Measurement of Risk

Risk refers to situations whose probability distribution of returns can be estimated. The tighter the probability distribution of potential future returns, the smaller the risk of the project as seen in Figure 4.1. One way to measure the tightness of these distributions is through the calculation of the *standard deviation.* This measure of dispersion gives an indication of how closely the distribution of returns remains around the expected value. The smaller the deviation, the tighter the distribution, and therefore the lower the riskiness of the project.

Another measure of risk associated with an investment is the *coefficient of variation.* The coefficient of variation , or standard deviation divided by the expected value, allows the farmer to obtain a measure of risk associated with each dollar of expected return. The simulation model developed in this study uses the coefficient of variation as the measure of the annual risk associ-

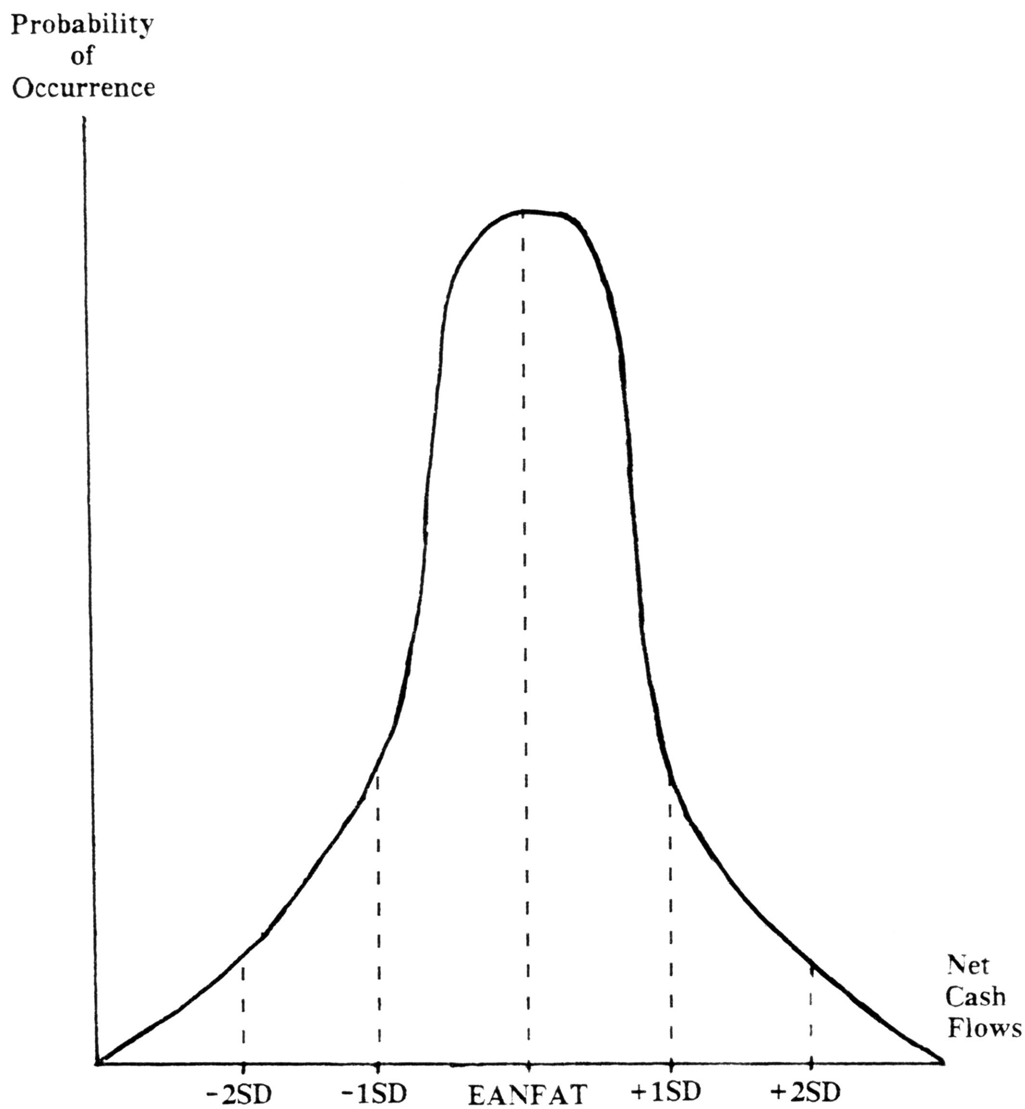

Figure 4.1: Distribution of Expected Net Cash Revenue Flows

ated with an investment's expected net cash flows.

Risk Over Time

Estimates of expected net cash flows will likely be far less accurate in the final years of a project than for the most recent years. This decrease in accuracy, and corresponding increase in riskiness over time, is an important consideration in the evaluation of a project's returns. The differences in the probability distributions of a project's returns can be seen in Figure 4.2. As the flatter distribution for year ten indicates, the standard deviation is larger, demonstrating a greater degree of risk. While increasing risk over time can be reflected in the model using the farmer's assignment of probabilities to the potential annual revenue and expenses associated with each scenario, the case example examined in this study assumes a constant distribution of potential net cash flows over the life of the project.

Effects of Behavior Toward Risk

As in any model of risk-adjusted investment analysis, incorporation of one's personal feelings towards risk into the analysis is the major focus. The approach taken to incorporating these feelings in this model is to parametrixcally modify a variable in the program called SLOPE. This variable represents the slope of the farmer's risk-return preference curve which determines the increase in the required rate of return associated with an increase in risk per dollar of expected return. The information recorded on

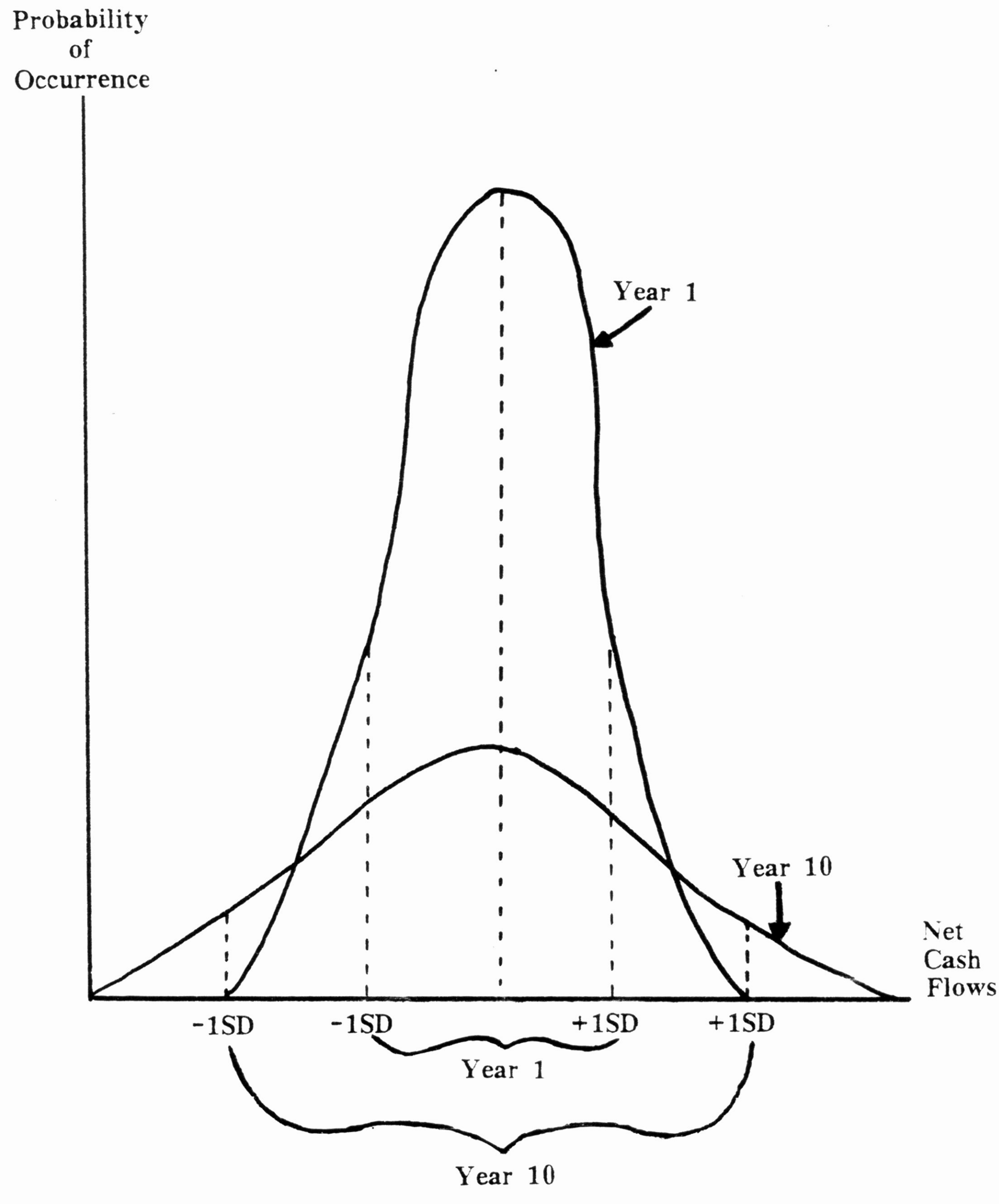

Figure 4.2: Distribution of Expected Net Cash Revenue Flows and Increasing Risk Over Time

the questionnaire in Appendix A provides the basis for testing the model and examining the importance of risk. In keeping with the focus of the project, the testing of the model focused on the change in the net present value associated with the change in the farmer's attitude toward risk. This was accomplished by keeping all other variables constant while altering the SLOPE variable. As the slope of the risk-return preference curve increases, the discount factor used to compute the present value of future net cash flows decreases.

The results of three runs simulations of the model presented in Figure 4.3 through Figure 4.5. The only variable that was changed in each simulation was the SLOPE variable. The simulation representing a risk-neutral farmer whose SLOPE variable was 0.0, resulted in a net present value of $1,784.96 as shown in Figure 4.3. The lowly-risk averse farmer requires a slightly higher The results from the simulation reflecting a value for the variable SLOPE of +.20 reported in Figure 4.4 shows that the net present value dropped from $1,784.96 to $297.07 as the slope of the curve increased from zero to +.20. Finally, when the value of SLOPE was increased to +.70 to observe the effects of the riskiness of this project when a farmer is highly risk-averse, Figure 4.5 shows that a net present value of -$1,048.62 was found. This latter result indicates that, for the highly risk-averse farmer, the analyzed investment would not be economically feasible and should not be made.

The inverse relationship between the SLOPE variable and the

NET
PRESENT VALUE

1784.96

THE RESULTS OF THIS ANALYSIS INDICATE THAT THE PRESENT VALUE OF THE CASH FLOWS GENERATED BY THIS INVESTMENT EXCEED THE PRESENT VALUE OF THE COSTS ASSOCIATED WITH MAKING THE INVESTMENT. THE INVESTMENT IS ECONOMICALLY FEASIBLE ACCORDING TO THIS ANALYSIS.

Figure 4.3: Risk-Neutral Simulation

NET
PRESENT VALUE

297.07

THE RESULTS OF THIS ANALYSIS INDICATE THAT THE PRESENT VALUE OF THE CASH FLOWS GENERATED BY THIS INVESTMENT EXCEED THE PRESENT VALUE OF THE COSTS ASSOCIATED WITH MAKING THE INVESTMENT. THE INVESTMENT IS ECONOMICALLY FEASIBLE ACCORDING TO THIS ANALYSIS.

Figure 4.4: Lowly Risk-Averse Simulation

NET
PRESENT VALUE

-1048.62

THE RESULTS OF THIS ANALYSIS INDICATE THAT THE PRESENT VALUE OF THE CASH FLOWS GENERATED INVESTMENT ARE LESS THAN THE PRESENT VALUE OF THE COSTS ASSOCIATED WITH MAKING THIS INVESTMENT. THE INVESTMENT IS THEREFORE NOT ECONOMICALLY FEASIBLE ACCORDING TO THIS ANALYSIS.

Figure 4.5: Highly Risk-Averse Simulation

net present value can be explained with the clarification of the calculation and use of discount factors. A farmer who is more highly risk averse requires a higher rate of return on a risky investment. This increase in the required rate of return is measured using the SLOPE variable. The larger the value assigned to SLOPE, the higher the required rate of return. The annual discount factors are calculated by taking the reciprocal of the product of the annual required rates of return for the year being analyzed and all previous years. As the required rate of return increases, therefore, the discount factor decreases. When smaller annual discount factors are multiplied by the corresponding annual expected net cash flows, their present values become smaller.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this final chapter is to summarize the design and results of this study, set forth the conclusions drawn from these results and identify the limitations to be addressed in further studies.

Summary

This study involved the development of a simulation model for investment analysis which incorporates the farmer's attitude toward the riskiness of the investment project. The incorporation of his attitude toward risk was accomplished through the use of risk-adjusted discount factors in a simulation model of the widely-used net present value approach to investment analysis.

The potential benefactors of this study include: (1) Agricultural Extension Service Agents who can use the model to analyze the potential investment opportunities of their clientele and enable them to make more intelligent investment decisions, (2) instructors of farm financial management courses who can use this model as a teaching aid, and (3) students interested in observing a practical application of risk theory and investment analysis and the effects of risk attitudes on net present value analysis.

Conclusions

The results from a case example were presented and the differences in the results due solely to changes in the slope of the risk-return preference curve were discussed. One conclusion drawn from the analysis of these results is the importance that the incorporation of risk-adjusted discount factors plays in the evaluation of investment opportunities. This can be seen by the difference between the net present values found when the farmer's attitude toward risk was changed. Another conclusion is drawn from the observed sensitivity of the net present value analysis to the degree of risk aversion; namely, the higher the degree of risk aversion, the lower the net present value, and vice versa. These conclusions demonstrate the necessity of incorporating the farmer's attitude toward risk when analyzing risky investment opportunities.

Limitations of Analysis

As with any type of research where time constraints play a large factor, certain boundaries must be drawn in order to make the study feasible. One such boundary of this study is the dependence on the information that is supplied by the farmer. The information taken from the questionnaire is read into a data file and provides the basis for all subsequent calculations. Therefore, the accuracy of the farmer's estimates and his knowledge concerning probable future conditions greatly affects how realistic the analysis of the investment will be. Another limitation of the analysis is its partial budgeting nature. The model is designed specifically to analyze a particular investment or investment package and, as such, does not to take into account the profitability of other areas of his business. Another limitation stems from the nature of the field of agriculture and the uncertainty involved. As mentioned previously, agriculture and the success or failure of many of its participants, depends to a large extent on the weather and economic conditions which prevail. Therefore, the results of a particular analysis will depend in part on whether or not the economic and weather conditions occur as predicted or occur in an unpredicted fashion such as a drought or flood, or sudden rise or fall in interest rates. Any of these changes would alter the data used in the analysis, therefore making the results from the analysis unrealistic under these new circumstances. The analysis could be performed again, altering the data file to better represent current and perhaps newly forecasted conditions. The final limitation of this study is the assumption that the farmer's risk-return preference curve is a linear function. This assumption, however, can be easily changed by modifying the equation for the risk-return preference curve currently in the model.

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APPENDIX A

COMPUTER SIMULATION QUESTIONNAIRE

COMPUTER SIMULATION QUESTIONNAIRE

1. Please specify the investment(s) you will be making. (i.e., truck, tractor, land, etc.) and the purchase price of each.

   3 year property _____ $5000.00
   5 year property _____ $5000.00
   15 year property _____ $9000.00
   Land _____ $10,000.00

   What is your planning horizon 15 yrs.

2. Please indicate the terms of financing the investment(s).

   Amount of loan $25,000.00
   Length of time loan will be out 15 yrs.
   Payment frequency (monthly, annually) annually
   Rate being charged 10 %

3. What is the amount required for your cash downpayment?

   16 %

4. What percent of the purchase price of replacement assets do you expect to debt finance?

   89 %

5. What do you expect your total noninterest charges to be?

   $ 0

6. What is the amount you expect to receive for the resale at the end of the planning horizon of any land purchased?

   Resale of Land $25,000.00

7. What is your tax rate?

   25 %

8. In order to incorporate your personal feelings toward risk into the analysis, please answer the following question as accurately as possible. Assume the rate of return on an investment of zero risk is 8%. If there was a possible investment which had a risk of $.10 per dollar of expected return (i.e., you could receive as much as $1.10 or as little as $.90), what minimum rate of return would you require in order to make the investment worthwhile to you (i.e., 10%, 11%, etc.)?

I would require 10% in order to accept this risk

9. The next section of this questionnaire deals with your expectations for changes in revenue and expenses, as a direct result of the asset being considered. Please indicate on the appropriate chart attached the change in the amount of revenue (or expenses) you would expect to receive (or pay). These estimates should be made on a yearly basis over the life of the investment. For each of these years, there will be three possible outcomes considered, of which only one can occur. The three possible outcomes are: (1) optimistic, which means events will result in better conditions than predicted; (2) current evidence, which means that events (such as weather, economic and financial conditions) will occur much as the experts predict; and (3) pessimistic which means that events will result in worse conditions than predicted.

For each year and for each possible outcome, you will need to make your estimates for the change in revenue and expense, as a direct result of the investment. You will also need to indicate for each possible outcome your belief in its chance of occurrence. This will be in percentage terms and the total for a single year must be 100%.

EXPENSE										
	YEAR									
OUTCOME	1	2	3	4	5	6	7	8	9	10
Optimistic	\$ 7000^{00} 10 %	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10
Current Evidence	\$ 7000^{00} 80 %	7000^{00} 80	7000^{00} 80	7000^{00} 80	7000^{00} 80	7000^{00} 80	7000^{00} 80	7000^{00} 80	7000^{00} 80	7000^{00} 80
Pessimistic	\$ 7000^{00} 10 %	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10	7000^{00} 10
	100%									

EXPENSE CONTINUED

	YEAR									
OUTCOME	11	12	13	14	15	16	17	18	19	20
Optimistic	\$ 7000.00 10 %	7000.00 10	7000.00 10	7000.00 10	7000.00 10					
Current Evidence	\$ 7000.00 80 %	7000.00 80	7000.00 80	7000.00 80	7000.00 80					
Pessimistic	\$ 7000.00 10 %	7000.00 10	7000.00 10	7000.00 10	7000.00 10					
	100%									

REVENUE

	YEAR									
OUTCOME	1	2	3	4	5	6	7	8	9	10
Optimistic	$15,000.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
	10 %	10	10	10	10	10	10	10	10	10
Current Evidence	$13,000.00	13,000.00	13,000.00	13,000.00	13,000.00	13,000.00	13,000.00	13,000.00	13,000.00	13,000.00
	80 %	80	80	80	80	80	80	80	80	80
Pessimistic	$11,000.00	11,000.00	11,000.00	11,000.00	11,000.00	11,000.00	11,000.00	11,000.00	11,000.00	11,000.00
	10 %	10	10	10	10	10	10	10	10	10
	100%									

REVENUE CONTINUED

	YEAR									
OUTCOME	11	12	13	14	15	16	17	18	19	20
Optimistic	$15000.00 10 %	15,000.00 10	15,000.00 10	15,000.00 10	15,000.00 10					
Current Evidence	$13,000.00 80 %	13,000.00 80	13,000.00 80	13,000.00 80	13,000.00 80					
Pessimistic	$11,000.00 10 %	11,000.00 10	11,000.00 10	11,000.00 10	11,000.00 10					
	100%									

APPENDIX B

B.1: List of Variables

N	- length of planning horizon.
M1	- length of loan for 15-year property.
M3	- length of loan for initial 3-year property.
M31	- length of 1st replacement loan for 3-year property.
M32	- length of 2nd replacement loan for 3-year property.
M33	- length of 3rd replacement loan for 3-year property.
M34	- length of 4th replacement loan for 3-year property.
M5	- length of loan for initial 5-year property.
M51	- length of 1st replacement loan for 5-year property.
M52	- length of 2nd replacement loan for 5-year property.
AMTB1	- amount borrowed for loan on 15-year property.
AMTB3	- amount borrowed for loan on 3-year property.
AMTB5	- amount borrowed for loan on 5-year property.
AINT1	- annual interest charges for loan on 15-year property.
AINT3	- annual interest charges for initial loan on 3-year property.
AINT31	- annual interest charges for 1st replacement loan on 3-year property.
AINT32	- annual interest charges for 2nd replacement loan on 3-year property.
AINT33	- annual interest charges for 3rd replacement loan on 3-year property.
AINT34	- annual interest charges for 4th replacement loan on 3-year property.
AINT5	- annual interest charges for initial 5-year loan.
AINT51	- annual interest charges for 1st replacement on 5-year property.
AINT52	- annual interest charges for 2nd replacement loan on 5-year property.
APRN1	- annual principal payments for loan on 15-year property.
APRN3	- annual principal payments for initial loan on 3-year property.
APRN31	- annual principal payments for 1st replacement loan on 3-year property.
APRN32	- annual principal payments for 2nd replacement loan on 3-year property.
APRN33	- annual principal payments for 3rd replacement loan on 3-year property.
APRN34	- annual principal payments for 4th replacement loan on 3-year property.
APRN5	- annual principal payments for initial loan on 5-year property.
APRN51	- annual principal payments for 1st replacement loan on 5-year property.
APRN52	- annual principal payments for 2nd replacement loan on 5-year property.
RBALT1	- remaining balance on loan on 15-year property.
RBAL31	- remaining balance 1st replacement loan on 3-year property.

B.1: List of Variables Continued

RBAL32	- remaining balance on 2nd replacement loan on 3-year property.
RBAL33	- remaining balance on 3rd replacement loan on 3-year property.
RBAL34	- remaining balance on 4th replacement loan on 3-year property.
RBAL51	- remaining balance on 1st replacement loan on 5-year property.
RBAL52	- remaining balance on 2nd replacement loan on 5-year property.
TPI1	- total payment, initial loan
PI31	- total payment, 1st replacement loan, 3-year property.
PI32	- total payment, 2nd replacement loan, 3-year property.
PI33	- total payment, 3rd replacement loan, 3-year property.
PI34	- total payment, 4th replacement loan, 3-year property.
PI51	- total payment, 1st replacement loan, 5-year property.
PI52	- total payment, 2nd replacement loan, 5-year property.
TALP	- cumulative value for total annual loan payments.
AINT	- cumulative value for annual interest charges.
APRN	- cumulative value for annual principal payments.
TNOINT	- total noninterest charges.
DWNPAY	- cash downpayment on initial loan.
DNPY31	- cash downpayment on 1st replacement loan on 3-year property.
DNPY32	- cash downpayment on 2nd replacement loan on 3-year property.
DNPY33	- cash downpayment on 3rd replacement loan on 3-year property.
DNPY34	- cash downpayment on 4th replacement loan on 3-year property.
DNPY51	- cash downpayment on 1st replacement loan on 5-year property.
DNPY52	- cash downpayment on 2nd replacement loan on 5-year property.
DNPAY	- cumulative value of all cash downpayments.
DEPR3	- depreciation for 3-year property.
DEPR5	- depreciation for 5-year property.
DEPR15	- depreciation for 15-year property.
ANDPAL	- annual depreciation allowance.
C3YPP	- initial cost of 3-year property.
C5YPP	- initial cost of 5-year property.
C15YPP	- initial cost of 15-year property.
ERS3YP	- expected resale value of 3-year property.
ERS5YP	- expected resale value of 5-year property.
ERS15YP	- expected resale value of 15-year property.
ERSLND	- expected resale value of land property.
PURLND	- purchase price of land.
EANNCF	- expected annual net cash flow.

B.1: List of Variables Continued

RRR	- required rate of return.
RFR	- risk-free rate of return.
DISFAC	- discount factor.
SLOPE	- slope of investor's risk-return preference curve.
TXRATE	- investor's marginal income tax rate.
DNCF	- cumulative value for cash flows after discounting.
NPV	- net present value.
RATE1	- rate charged on initial loan.

B.2: Computer Simulation Model

```
      DIMENSION A(100,100),B(100,100),W(100,100)
      DIMENSION ANCFBT(100,100),TAX(100,100),ANFAT(100,100)
      DIMENSION RATE(100),AINT1(100),APRN1(100),RBALT1(100)
      DIMENSION AINT31(100),AINT32(100),AINT33(100),AINT34(100)
      DIMENSION APRN31(100),APRN32(100),APRN33(100),APRN34(100)
      DIMENSION RBAL31(100),RBAL32(100),RBAL33(100),RBAL34(100)
      DIMENSION AINT51(100),AINT52(100),APRN51(100)
      DIMENSION APRN52(100),RBAL51(100),RBAL52(100)
      DIMENSION APRN3(100),AINT3(100),APRN5(100),AINT5(100)
      DIMENSION APRN(100),AINT(100),ANDPAL(100),EANNCF(100)
      DIMENSION VAR(100),STDEV(100),COV(100),RRR(100),DISFAC(100)
      DIMENSION CRRR(100),TALP(100),EANFAT(100)
      DIMENSION DEPR3(100),DEPR5(100),DEPR15(100)
      REAL AMTB1,EPIF,TPI1,TPRNPY,AINT,APRN
      REAL RBALT1,DEPR3,DEPR5,DEPR15,C3YPP,C5YPP,C15YPP
      REAL TNOINT,DWNPAY,DNPAY,DNPY31,DNPY32,DNPY33
      REAL DNPY34,DNPY51,DNPY52,ERS3YP,ERS5YP
      REAL ERS15Y,ERSLND,PURLND,TXRATE
      REAL AINT1,AINT3,AINT5,APRN1,APRN3,APRN5
      REAL AINT31,AINT32,AINT33,AINT34,AINT51,AINT52
      REAL APRN31,APRN32,APRN33,APRN34,APRN51,APRN52
      REAL RBAL31,RBAL32,RBAL33,RBAL34,RBAL51,RBAL52
      REAL PI31,PI32,PI33,PI34,PI51,PI52,NPV
      REAL ANDPAL,EANNCF,VAR,STDEV,COV,RRR
      REAL DISFAC,DNCF,CRRR,RFR,SLOPE,TALP
      INTEGER I,J,M1,M3,N,M31,M32,M33,M34,M5,M51,M52
C
      READ(1,15)M1,M3,M5,AMTB1,C3YPP,C5YPP,C15YPP,RATE1
   15 FORMAT(10X,3I5,4F10.0,F5.0)
      READ(1,16)TNOINT,DWNPAY,N,SLOPE,AMTB3,AMTB5
   16 FORMAT(10X,2F10.0,I5,3F10.0)
      READ(1,17)((A(I,J),J=1,3),I=1,N)
   17 FORMAT(10X,3F10.0)
      READ(1,18)((B(I,J),J=1,3),I=1,N)
   18 FORMAT(10X,3F10.0)
      READ(1,181)((W(I,J),J=1,3),I=1,N)
  181 FORMAT(10X,3F10.0)
C
      READ(1,22)ERSLND,PURLND,TXRATE,RFR
   22 FORMAT(10X,4F10.0)
C
      WRITE(6,2340)M1,M3,M5,AMTB1,AMTB3,AMTB5
 2340 FORMAT(10X,'DATA FROM QUESTIONNAIRE'//10X,
     #'TERM OF INITIAL LOAN',18X,I5/10X,
     #'TERM OF 3-YEAR REPLACEMENT LOAN',7X,I5/10X,
     #'TERM OF 5-YEAR REPLACEMENT LOAN',7X,I5/10X,
     #'AMOUNT INITIALLY BORROWED',8X,F10.2/10X,
     #'AMOUNT OF 3-YEAR REPLACEMENT LOAN',F10.2/10X,
     #'AMOUNT OF 5-YEAR REPLACEMENT LOAN',F10.2)
```

B.2: Computer Simulation Model Continued

```
      WRITE(6,2341)C3YPP,C5YPP,C15YPP,RATE1,TNOINT
 2341 FORMAT(10X,'COST OF 3-YEAR REPLACEMENT ASSET',1X,F10.2/
     #10X,'COST OF 5-YEAR REPLACEMENT ASSET',1X,F10.2/10X,
     #'COST OF 15-YEAR REPLACEMENT ASSET',F10.2/10X,
     #'INITIAL INTEREST RATE',12X,F10.2/10X,
     #'TOTAL NONINTEREST CHARGES',8X,F10.2)
      WRITE(6,2342)N, SLOPE
 2342 FORMAT(10X,'LENGTH OF PLANNING HORIZON',14X,I3/10X,
     #'SLOPE OF RISK-RETURN PREFERENCE CURVE',F6.2)
C
      M31=M3+3
      M32=M31+3
      M33=M32+3
      M34=M33+3
      M51=M5+5
      M52=M51+5
C
      DO 7733 I=1,N
      APRN31(I)=0.0
      APRN32(I)=0.0
      APRN33(I)=0.0
      APRN34(I)=0.0
      APRN51(I)=0.0
      APRN52(I)=0.0
      AINT31(I)=0.0
      AINT32(I)=0.0
      AINT33(I)=0.0
      AINT34(I)=0.0
      AINT51(I)=0.0
      AINT52(I)=0.0
 7733 CONTINUE
C
      AMTB31 = AMTB3*(1.05)**3
      AMTB32 = AMTB3*(1.05)**6
      AMTB33 = AMTB3*(1.05)**9
      AMTB34 = AMTB3*(1.05)**12
      AMTB51 = AMTB5*(1.05)**5
      AMTB52 = AMTB5*(1.05)**10
      DNPY31 = C3YPP*(1.05)**3 - AMTB31
      DNPY32 = C3YPP*(1.05)**6 - AMTB32
      DNPY33 = C3YPP*(1.05)**9 - AMTB33
      DNPY34 = C3YPP*(1.05)**12 - AMTB34
      DNPY51 = C5YPP*(1.05)**5 - AMTB51
      DNPY52 = C5YPP*(1.05)**10 - AMTB52
      RATE(1)=RATE1
      DO 2641 I=2,N
      RATE(I)=RATE(1)*(1.0+.05)**I
```

B.2 Computer Simulation Model Continued

```
 2641 CONTINUE
C
C************************************************************
C     CALCULATE LOAN REPAYMENT SCHEDULE
C     FOR ALL ASSETS PURCHASED IN YEAR 1
C***********************************************************
      EPIF=(1.0-(1.0/(1.0+RATE(1))**M1))/RATE(1)
      TPI1=AMTB1/EPIF
C*******************************************************
C     CALCULATE PERIODIC INTEREST AND PRINCIPAL
C     PAYMENTS FOR YEAR 1 LOAN
C********************************************************
      TPRNPY=0.0
      I=1
  100 AINT1(I)=RATE(1)*(AMTB1-TPRNPY)
      APRN1(I)=TPI1-AINT1(I)
      TPRNPY=TPRNPY+APRN1(I)
      RBALT1(I)=AMTB1-TPRNPY
      I=I+1
      IF(I.GT.M1) GO TO 101
      GO TO 100
  101 CONTINUE
C*********************************************************
C     WRITE LOAN REPAYMENT SCHEDULE
C     FOR YEAR 1 LOAN
C********************************************************
      WRITE(6,9999)
 9999 FORMAT(1H1)
      WRITE(6,1)
    1 FORMAT(21X,'YEAR 1 LOAN REPAYMENT SCHEDULE'////
     223X,'TOTAL',6X,'INTEREST',5X,'PRINCIPAL',4X,'REMAINING'/
     314X,'YEAR',4X,'PAYMENT',5X,'PAYMENT',
     47X,'PAYMENT',6X,'BALANCE'//)
      DO 102 I=1,M1
      WRITE(6,12) I,TPI1,AINT1(I),APRN1(I),RBALT1(I)
   12 FORMAT(13X,I3,2X,F11.2,2X,F11.2,2X,F11.2,3X,F11.2)
  102 CONTINUE
      WRITE(6,9999)
      IF(C3YPP.GT.0.0) GO TO 6643
      GO TO 6776
 6643 IF(N.GT.3) GO TO 1021
      GO TO 5555
 1021 CONTINUE
C********************************************************
C     CALCULATE LOAN REPAYMENT SCHEDULE
C     FOR 1ST REPLACEMENT OF 3-YEAR PROPERTY
C*********************************************************
      EPIF=(1.0-(1.0/(1.0+RATE(4))**M3))/RATE(4)
      PI31=AMTB31/EPIF
```

B.2 Computer Simulation Model Continued

```
C*********************************************************
C     CALCULATE PERIODIC INTEREST AND PRINCIPAL
C     PAYMENTS FOR 1ST REPLACEMENT LOAN FOR
C     3-YEAR PROPERTY
C**********************************************************
      TPRNPY=0.0
      I=4
      J=4
 1001 AINT31(I)=RATE(4)*(AMTB31-TPRNPY)
      APRN31(I)=PI31-AINT31(I)
      TPRNPY=TPRNPY+APRN31(I)
      RBAL31(I)=AMTB31-TPRNPY
      I=I+1
      IF(I.GT.M31) GO TO 1011
      GO TO 1001
 1011 CONTINUE
C*********************************************************
C     WRITE LOAN REPAYMENT SCHEDULE FOR
C     1ST REPLACEMENT OF 3-YEAR PROPERTY
C*********************************************************
      WRITE(6,11)
   11 FORMAT(21X,'1ST 3 YEAR PROPERTY REPLACEMENT LOAN'/29X,
     2'REPAYMENT SCHEDULE'////23X,'TOTAL',6X,'INTEREST',5X,
     3'PRINCIPAL',4X,'REMAINING'/14X,'YEAR',4X,'PAYMENT',5X,
     4'PAYMENT',7X,'PAYMENT',6X,'BALANCE'//)
      DO 1020 I=J,M31
      WRITE(6,13) I,PI31,AINT31(I),APRN31(I),RBAL31(I)
   13 FORMAT(13X,I3,2X,F11.2,2X,F11.2,2X,F11.2,2X,F11.2)
 1020 CONTINUE
      WRITE(6,9999)
      IF(N.GT.7) GO TO 2021
      GO TO 5555
 2021 CONTINUE
C**********************************************************
C     CALCULATE LOAN REPAYMENT SCHEDULE
C     FOR 2ND REPLACEMENT OF 3-YEAR PROPERTY
C**********************************************************
      EPIF=(1.0-(1.0/(1.0+RATE(7))**M3))/RATE(7)
      PI32=AMTB32/EPIF
C***********************************************************
C     CALCULATE PERIODIC INTEREST AND PRINCIPAL
C     PAYMENTS FOR 2ND REPLACEMENT LOAN FOR
C     3-YEAR PROPERTY
C**********************************************************
      TPRNPY=0.0
      I=7
      J=7
 2001 AINT32(I)=RATE(7)*(AMTB32-TPRNPY)
      APRN32(I)=PI32-AINT32(I)
```

B.2 Computer Simulation Model Continued

```
      TPRNPY=TPRNPY+APRN32(I)
      RBAL32(I)=AMTB32-TPRNPY
      I=I+1
      IF(I.GT.M32) GO TO 2011
      GO TO 2001
 2011 CONTINUE
C*********************************************************
C     WRITE LOAN REPAYMENT SCHEDULE FOR
C     2ND REPLACEMENT OF 3-YEAR PROPERTY
C**********************************************************
      WRITE(6,21)
   21 FORMAT(21X,'2ND 3 YEAR PROPERTY REPLACEMENT LOAN'/29X,
     2'REPAYMENT SCHEDULE'////23X,'TOTAL',6X,'INTEREST',5X,
     3'PRINCIPAL',4X,'REMAINING'/14X,'YEAR',4X,'PAYMENT',5X,
     4'PAYMENT',7X,'PAYMENT',6X,'BALANCE'//)
      DO 2020 I=J,M32
      WRITE(6,212) I,PI32,AINT32(I),APRN32(I),RBAL32(I)
  212 FORMAT(13X,I3,2X,F11.2,2X,F11.2,2X,F11.2,2X,F11.2)
 2020 CONTINUE
      WRITE(6,9999)
      IF(N.GT.10) GO TO 3021
      GO TO 5555
 3021 CONTINUE
C************************************************************
C     CALCULATE LOAN REPAYMENT SCHEDULE
C     FOR 3RD REPLACEMENT OF 3-YEAR PROPERTY
C************************************************************
      EPIF=(1.0-(1.0/(1.0+RATE(10))**M3))/RATE(10)
      PI33=AMTB33/EPIF
C************************************************************
C     CALCULATE PERIODIC INTEREST AND PRINCIPAL
C     PAYMENTS FOR 3RD REPLACEMENT LOAN FOR
C     3-YEAR PROPERTY
C************************************************************
      TPRNPY=0.0
      I=10
      J=10
 3001 AINT33(I)=RATE(10)*(AMTB33-TPRNPY)
      APRN33(I)=PI33-AINT33(I)
      TPRNPY=TPRNPY+APRN33(I)
      RBAL33(I)=AMTB33-TPRNPY
      I=I+1
      IF(I.GT.M33) GO TO 3011
      GO TO 3001
 3011 CONTINUE
C*************************************************************
C     WRITE LOAN REPAYMENT SCHEDULE FOR
C     3RD REPLACEMENT OF 3-YEAR PROPERTY
C**************************************************************
```

B.2 Computer Simulation Model Continued

```
      WRITE(6,31)
   31 FORMAT(21X,'3RD 3 YEAR PROPERTY REPLACEMENT LOAN'/29X,
     2'REPAYMENT SCHEDULE'////23X,'TOTAL',6X,'INTEREST',5X,
     3'PRINCIPAL',4X,'REMAINING'/14X,'YEAR',4X,'PAYMENT',5X,
     4'PAYMENT',7X,'PAYMENT',6X,'BALANCE'//)
      DO 3020 I=J,M33
      WRITE(6,313) I,PI33,AINT33(I),APRN33(I),RBAL33(I)
  313 FORMAT(13X,I3,2X,F11.2,2X,F11.2,2X,F11.2,2X,F11.2)
 3020 CONTINUE
      WRITE(6,9999)
      IF(N.GT.13) GO TO 4021
      GO TO 5555
 4021 CONTINUE
C************************************************************
C     CALCULATE LOAN REPAYMENT SCHEDULE
C     FOR 4TH REPLACEMENT OF 3-YEAR PROPERTY
C**********************************************************
      EPIF=(1.0-(1.0/(1.0+RATE(13))**M3))/RATE(13)
      PI34=AMTB34/EPIF
C***********************************************************
C     CALCULATE PERIODIC INTEREST AND PRINCIPAL
C     PAYMENTS FOR 4TH REPLACEMENT LOAN FOR
C     3-YEAR PROPERTY
C************************************************************
      TPRNPY=0.0
      I=13
      J=13
 4001 AINT34(I)=RATE(13)*(AMTB34-TPRNPY)
      APRN34(I)=PI34-AINT34(I)
      TPRNPY=TPRNPY+APRN34(I)
      RBAL34(I)=AMTB34-TPRNPY
      I=I+1
      IF(I.GT.M34) GO TO 4011
      GO TO 4001
 4011 CONTINUE
C***********************************************************
C     WRITE LOAN REPAYMENT SCHEDULE FOR
C     4TH REPLACEMENT OF 3-YEAR PROPERTY
C**********************************************************
      WRITE(6,41)
   41 FORMAT(21X,'4TH 3 YEAR PROPERTY REPLACEMENT LOAN'/29X,
     2'REPAYMENT SCHEDULE'////23X,'TOTAL',6X,'INTEREST',5X,
     3'PRINCIPAL',4X,'REMAINING'/14X,'YEAR',4X,'PAYMENT',5X,
     4'PAYMENT',7X,'PAYMENT',6X,'BALANCE'//)
      DO 4020 I=J,M34
      WRITE(6,414) I,PI34,AINT34(I),APRN34(I),RBAL34(I)
  414 FORMAT(13X,I3,2X,F11.2,2X,F11.2,2X,F11.2,2X,F11.2)
 4020 CONTINUE
```

B.2 Computer Simulation Model Continued

```
 5555 CONTINUE
 6776 CONTINUE
      WRITE(6,9999)
      IF(C5YPP.GT.0.0) GO TO 6644
      GO TO 6777
 6644 CONTINUE
      IF(N.GT.5) GO TO 5021
      GO TO 6021
 5021 CONTINUE
C*************************************************************
C     CALCULATE LOAN REPAYMENT SCHEDULE
C     FOR 1ST REPLACEMENT OF 5-YEAR PROPERTY
C*************************************************************
      EPIF=(1.0-(1.0/(1.0+RATE(6))**M5))/RATE(6)
      PI51=AMTB51/EPIF
C***************************************************************
C     CALCULATE PERIODIC INTEREST AND PRINCIPAL
C     PAYMENTS FOR 1ST REPLACEMENT LOAN FOR
C     5-YEAR PROPERTY
C***************************************************************
      TPRNPY=0.0
      I=6
 5001 AINT51(I)=RATE(6)*(AMTB51-TPRNPY)
      APRN51(I)=PI51-AINT51(I)
      TPRNPY=TPRNPY+APRN51(I)
      RBAL51(I)=AMTB51-TPRNPY
      I=I+1
      IF(I.GT.M51) GO TO 5011
      GO TO 5001
 5011 CONTINUE
C**************************************************************
C     WRITE LOAN REPAYMENT SCHEDULE FOR
C     1ST REPLACEMENT OF 5-YEAR PROPERTY
C************************************************************
      I=6
      J=6
      WRITE(6,51)
   51 FORMAT(21X,'1ST 5 YEAR PROPERTY REPLACEMENT LOAN'/29X,
     2'REPAYMENT SCHEDULE'////23X,'TOTAL',6X,'INTEREST',5X,
     3'PRINCIPAL',4X,'REMAINING'/14X,'YEAR',4X,'PAYMENT',5X,
     4'PAYMENT',7X,'PAYMENT',6X,'BALANCE'//)
      DO 5020 I=J,M51
      WRITE(6,515) I,PI51,AINT51(I),APRN51(I),RBAL51(I)
  515 FORMAT(13X,I3,2X,F11.2,2X,F11.2,2X,F11.2,2X,F11.2)
 5020 CONTINUE
      WRITE(6,9999)
      IF(N.GT.10) GO TO 6021
      GO TO 6666
 6021 CONTINUE
```

B.2 Computer Simulation Model Continued

```
C**********************************************************
C     CALCULATE LOAN REPAYMENT SCHEDULE
C     FOR 2ND REPLACEMENT OF 5-YEAR PROPERTY
C**********************************************************
      EPIF=(1.0-(1.0/(1.0+RATE(11))**M5))/RATE(11)
      PI52=AMTB52/EPIF
C************************************************************
C     CALCULATE PERIODIC INTEREST AND PRINCIPAL
C     PAYMENTS FOR 2ND REPLACEMENT LOAN FOR
C     5-YEAR PROPERTY
C*************************************************************
      TPRNPY=0.0
      I=11
 6001 AINT52(I)=RATE(11)*(AMTB52-TPRNPY)
      APRN52(I)=PI52-AINT52(I)
      TPRNPY=TPRNPY+APRN52(I)
      RBAL52(I)=AMTB52-TPRNPY
      I=I+1
      IF(I.GT.M52) GO TO 6011
      GO TO 6001
 6011 CONTINUE
C************************************************************
C     WRITE LOAN REPAYMENT SCHEDULE FOR
C     2ND REPLACEMENT OF 5-YEAR PROPERTY
C************************************************************
      I=11
      J=11
      WRITE(6,61)
   61 FORMAT(21X,'2ND 5 YEAR PROPERTY REPLACEMENT LOAN'/29X,
     2'REPAYMENT SCHEDULE'////23X,'TOTAL',6X,'INTEREST',5X,
     3'PRINCIPAL',4X,'REMAINING'/14X,'YEAR',4X,'PAYMENT',5X,
     4'PAYMENT',7X,'PAYMENT',6X,'BALANCE'//)
      DO 6020 I=J,M52
      WRITE(6,616) I,PI52,AINT52(I),APRN52(I),RBAL52(I)
  616 FORMAT(13X,I3,2X,F11.2,2X,F11.2,2X,F11.2,2X,F11.2)
 6020 CONTINUE
 6666 CONTINUE
 6777 CONTINUE
      WRITE(6,9999)
      DO 9824 I=1,N
      APRN3(I)= APRN31(I)+APRN32(I)+APRN33(I)+APRN34(I)
      AINT3(I)= AINT31(I)+AINT32(I)+AINT33(I)+AINT34(I)
      APRN5(I)= APRN51(I)+APRN52(I)
      AINT5(I)= AINT51(I)+AINT52(I)
 9824 CONTINUE
```

B.2 Computer Simulation Model Continued

```
C*****************************************************************
C     CALCULATE ANNUAL INTEREST AND PRINCIPAL PAYMENTS
C*****************************************************************
      WRITE(6,26)
   26 FORMAT(20X,'LOAN REPAYMENT SCHEDULE'////23X,'TOTAL',6X,
     2'INTEREST',5X,'PRINCIPAL',4X/14X,'YEAR',4X,'PAYMENT',5X,
     3'PAYMENT',7X,'PAYMENT'//)
      DO 7679 I=1,N
      APRN(I)=APRN3(I)+APRN5(I)+APRN1(I)
      AINT(I)=AINT3(I)+AINT5(I)+AINT1(I)
      TALP(I) = APRN(I) + AINT(I)
      WRITE(6,111)I,TALP(I),AINT(I),APRN(I)
  111 FORMAT(13X,I3,2X,F11.2,1X,F11.2,3X,F11.2)
 7679 CONTINUE
      WRITE(6,9999)
C*****************************************************************
C     CALCULATE ANNUAL DEPRECIATION ALLOWANCES
C*****************************************************************
      DEPR3(1)=.25*C3YPP
      DEPR3(2)=.38*C3YPP
      DEPR3(3)=.37*C3YPP
      DEPR5(1)=.15*C5YPP
      DEPR5(2)=.22*C5YPP
      DEPR5(3)=.21*C5YPP
      DEPR5(4)=DEPR5(3)
      DEPR5(5)=DEPR5(3)
      DEPR15(1)=.06*C15YPP
      DEPR15(2)=.12*C15YPP
      DEPR15(3)=.12*C15YPP
      DEPR15(4)=.11*C15YPP
      DEPR15(5)=.10*C15YPP
      DEPR15(6)=.09*C15YPP
      DEPR15(7)=.08*C15YPP
      DEPR15(8)=.07*C15YPP
      DEPR15(9)=.06*C15YPP
      DEPR15(10)= .05*C15YPP
      DEPR15(11)= .04*C15YPP
      DEPR15(12)= .04*C15YPP
      DEPR15(13)= .03*C15YPP
      DEPR15(14)= .02*C15YPP
      DEPR15(15)= .01*C15YPP
C*****************************************************************
C     CALCULATE ANNUAL DEPRECIATION ALLOWANCE
C*****************************************************************
      ANDPAL(1)=DEPR3(1)+DEPR5(1)+DEPR15(1)
      ANDPAL(2)=DEPR3(2)+DEPR5(2)+DEPR15(2)
      ANDPAL(3)=DEPR3(3)+DEPR5(3)+DEPR15(3)
      ANDPAL(4)=DEPR3(1)*(1.05)**3+DEPR5(4)+DEPR15(4)
      ANDPAL(5)=DEPR3(2)*(1.05)**3+DEPR5(5)+DEPR15(5)
```

B.2 Computer Simulation Model Continued

```
      ANDPAL(6)=DEPR3(3)*(1.05)**3+DEPR5(1)*(1.05)**5+DEPR15(6)
      ANDPAL(7)=DEPR3(1)*(1.05)**6+DEPR5(2)*(1.05)**5+DEPR15(7)
      ANDPAL(8)=DEPR3(2)*(1.05)**6+DEPR5(3)*(1.05)**5+DEPR15(8)
      ANDPAL(9)=DEPR3(3)*(1.05)**6+DEPR5(4)*(1.05)**5+DEPR15(9)
      ANDPAL(10)= DEPR3(1)*(1.05)**9+DEPR5(5)*(1.05)**5+DEPR15(10)
      ANDPAL(11)= DEPR3(2)*(1.05)**9+DEPR5(1)*(1.05)**10+DEPR15(11)
      ANDPAL(12)= DEPR3(3)*(1.05)**9+DEPR5(2)*(1.05)**10+DEPR15(12)
      ANDPAL(13)= DEPR3(1)*(1.05)**12+DEPR5(3)*(1.05)**10+DEPR15(13)
      ANDPAL(14)= DEPR3(2)*(1.05)**12+DEPR5(4)*(1.05)**10+DEPR15(14)
      ANDPAL(15)= DEPR3(3)*(1.05)**12+DEPR5(5)*(1.05)**10+DEPR15(15)
      WRITE(6,27)
   27 FORMAT(21X,'DEPRECIATION ALLOWANCE'////14X,'YEAR',
     28X,'ALLOWANCE'//)
      DO 2222 I=1,N
      WRITE(6,23)I,ANDPAL(I)
   23 FORMAT(13X,I3,8X,F10.2)
 2222 CONTINUE
C*************************************************************
C     CALCULATE POTENTIAL ANNUAL NET CASH FLOWS
C*************************************************************
      DO 1405 I=1,N
      DO 1406 J=1,3
      ANCFBT(I,J)=A(I,J)-B(I,J)-AINT(I)
      TAX(I,J)=TXRATE*(ANCFBT(I,J)-ANDPAL(I))
      ANFAT(I,J)=ANCFBT(I,J)-TAX(I,J)
 1406 CONTINUE
 1405 CONTINUE
C**************************************************************
C     CALCULATE EXPECTED NET CASH REVENUE FLOWS
C*************************************************************
      DO 1407 I=1,N
      DO 1408 J=1,3
      EANFAT(I)=W(I,1)*ANFAT(I,1)+W(I,2)*ANFAT(I,2)+W(I,3)*
     #ANFAT(I,3)
C
      VAR(I)=W(I,1)*((EANFAT(I)-ANFAT(I,1)))**2
     #+W(I,2)*((EANFAT(I)-ANFAT(I,2)))**2+W(I,3)*((EANFAT(I)-
     #ANFAT(I,3)))**2
C
      STDEV(I)=VAR(I)**.5
      COV(I)=STDEV(I)/EANFAT(I)
C****************************************************************
C     CALCULATE EXPECTED NET CASH FLOWS
C**************************************************************
      EANNCF(I)=EANFAT(I)-APRN(I)
C*****************************************************************
C     CALCULATE REQUIRED RATE OF RETURN
C*****************************************************************
      RRR(I)=RFR+SLOPE*(COV(I))
```

B.2 Computer Simulation Model Continued

```
 1408 CONTINUE
 1407 CONTINUE
      WRITE(6,9999)
      WRITE(6,28)
   28 FORMAT(29X,'EXPECTED NET CASH FLOW'////21X,
     2'EXPECTED NET CASH',4X,'PRINCIPAL',4X,'EXPECTED NET'/14X,'YEAR',
     35X,'REVENUE',2X,'FLOW',6X,'PAYMENTS',6X,'CASH  FLOW'//)
      DO 2223 I=1,N
      WRITE(6,24)I,EANFAT(I),APRN(I),EANNCF(I)
   24 FORMAT(14X,I3,6X,F11.2,5X,F11.2,4X,F11.2)
 2223 CONTINUE
C************************************************************
C     CALCULATE ANNUAL DISCOUNT FACTORS
C***********************************************************
      I=1
      IF(I.EQ.1) DISFAC(1)=1.0/(1.0+RRR(I))
      CRRR(I)=(1.0+RRR(I))
      GO TO 9437
 9438 CRRR(I)=CRRR(I-1)*(1.0+RRR(I))
      DISFAC(I)=1.0/CRRR(I)
 9437 I=I+1
      IF(I.GT.N) GO TO 9439
      GO TO 9438
C*************************************************************
C     CALCULATE NET PRESENT VALUE
C*************************************************************
 9439 DNCF=0.0
      I=1
 1543 DNCF=DNCF+EANNCF(I)*DISFAC(I)
      I=I+1
      IF(I.GE.N) GO TO 1544
      GO TO 1543
 1544 CONTINUE
      DNPAY=DWNPAY+(DNPY31*DISFAC(3))+(DNPY32*DISFAC(6))+
     2(DNPY33*DISFAC(9))+(DNPY34*DISFAC(12))+(DNPY51*DISFAC(5))+
     3(DNPY52*DISFAC(10))
C
      NPV=DNCF-DNPAY-TNOINT+(ERSLND-(.40*TXRATE*(ERSLND-
     #PURLND)))*DISFAC(N)
      WRITE(6,9999)
      WRITE(6,29)
   29 FORMAT(/////38X,'NET'/33X,
     2'PRESENT VALUE'//)
      WRITE(6,25)NPV
   25 FORMAT(35X,F10.2)
C
      IF(NPV.GT.0.0) GO TO 7840
      GO TO 7841
 7840 WRITE(6,7842)
```

B.2 Computer Simulation Model Continued

```
 7842 FORMAT(/////10X,'THE RESULTS OF THIS ANALYSIS INDICATE THAT'/
     210X,'THE PRESENT VALUE OF THE CASH FLOWS GENERATED BY THIS'/
     310X,'INVESTMENT EXCEED THE PRESENT VALUE OF THE COSTS ASSOCIATED'/
     410X,'WITH MAKING THE INVESTMENT.  THE INVESTMENT IS ECONOMICALLY'/
     510X,'FEASIBLE ACCORDING TO THIS ANALYSIS.'//)
      WRITE(6,9999)
      GO TO 7843
 7841 WRITE(6,7844)
 7844 FORMAT(/////10X,'THE RESULTS OF THIS ANALYSIS INDICATE THAT'/
     210X,'THE PRESENT VALUE OF THE CASH FLOWS GENERATED INVESTMENT'/
     310X,'ARE LESS THAN THE PRESENT VALUE OF THE COSTS ASSOCIATED'/
     410X,'WITH MAKING THIS INVESTMENT.  THE INVESTMENT IS THEREFORE'/
     510X,'NOT ECONOMICALLY FEASIBLE ACCORDING TO THIS ANALYSIS.'//)
      WRITE(6,9999)
 7843 CONTINUE
      RETURN
      END
//$DATA
```