A RETIREMENT INCOME SIMULATION MODEL FOR FARM OPERATORS*

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INTRODUCTION

Retirement planning for farm families is complicated by the unique relationship between the farmer and his business. Farm operators combine their labor and management with owned or borrowed capital to generate income, a combination of labor and investment return. When earned income exceeds immediate consumption needs, the excess is often invested in the farm business. In fact, the high demand for capital reinvestment in the business enterprise may leave little opportunity for farm families to establish a savings or investment program designed to produce adequate income for their retirement needs.

At the time of retirement, many farm operators substantially reduce or end their active engagement in farming. When the operator's labor and management are removed from the business, some or all of the capital previously employed in the farming operation may become available to produce pure investment return in retirement. The retiring farmer faces a series of perplexing problems. Among the most important are (1) the decision to sell or keep the farm and (2) whether he sells or keeps the farm, he must decide how to allocate available capital among a portfolio of investments which will generate a stable flow of adequate income. Given uncertainty of future economic fluctuations, and the likelihood that he and/or his wife may live another 20 to 25 years, his needs will change over time. Compounding the problem, there is often a desire to select a strategy which will preserve or enlarge the size of the estate and facilitate the transfer of a large portion of it to the next generation.

The purpose of this paper is to present a stochastic simulation model which can be used in both research and extension applications to evaluate investment opportunities available to retiring farm operators who have not participated in pre-retirement planning. Following the discussion of model development, simulated outcomes of two hypothetical retirement strategies are presented to illustrate the model's potential usefulness.

MODEL DEVELOPMENT

Any technique used to analyze retirement investment portfolios must consider several things. These include (1) expected value of return from the portfolio in relation to the retiree's economic needs, (2) variability of real return associated with the portfolio, and (3) allocation of real returns and economic needs over the entire planning horizon or life expectancy of the couple. None of the classical theories of portfolio analysis satisfy all of these criteria. All consider expected return from the portfolio, but early work by Fisher [4] fails to account for risk. Markowitz [7] and Sharpe [9], while concentrating on risk and value of diversification, tend to confront investment as an end in itself and not as a means of allocating consumption of wealth over time. All seek to define the optional allocation of financial resources among competing investment alternatives. The classical objective function to be maximized is utility but, in actual planning situations,

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our inability to measure utility forces us to make a simplifying assumption about the nature of the individual's utility function. The most frequent assumption is a linear utility function with respect to money income. Thus, maximizing profit is equivalent to maximizing utility. In models of firm growth and allocation of resources among competing enterprises in commercial agriculture, this assumption has served the profession quite well. Yet, in planning for resource management in retirement, the assumption of profit maximization as the dominant goal is unrealistic.

Brucker, Baker and Erickson [2] have recently presented an optimizing model for retirement planning. It uses linear programming to allocate investments between farm and nonfarm assets in a way which maximizes the ending estate, or net asset values at the horizon, subject to an annual consumption requirement. In addition to a somewhat restrictive assumption of net asset value maximizing behavior, their analysis fails to consider variability of returns among alternative investments.

Lee and Brake [6] estimate average yearly return and standard deviation of return for a range of equity and fixed income assets. However, their retirement income budgeting procedure is somewhat tedious when evaluating a range of retirement investment strategies.

The stochastic simulation model reported here can consider both expected value and variance of returns for investment strategies in analyzing retiree needs over the retirement planning period. The model focuses on outcomes of selected investment and estate planning strategies, rather than concentrating on the most profitable way to manage resources in retirement.[1] The simulation model is an economic laboratory [8], in which experiments may be performed for individual retirement investment planning. By comparing the results of simulated alternatives, the retiree can decide which strategy comes closest to satisfying his needs.

The Retirement Investment Simulator (RIS)[2]

The Retirement Investment Simulator (RIS) projects performance of a portfolio of farm and nonfarm investments over a planning period determined by a couple's life expectancy. Figure 1 presents a schematic diagram of the functions performed by the model.

For each year in the planning horizon, a couple's income needs are projected from input data indicating living expenses, social security benefits and private pension benefits in the first year of retirement. Living expenses and social security benefits are increased yearly by an inflation rate supplied by the user. Subtracting social security and private pension benefits from the consumption need yields an estimate of amount of funds necessarily extracted from the portfolio in that year. This can be accomplished either by consuming income returns or by liquidating assets and consuming part of the capital base. The remainder of the model is designed to evaluate how well a selected portfolio of assets can

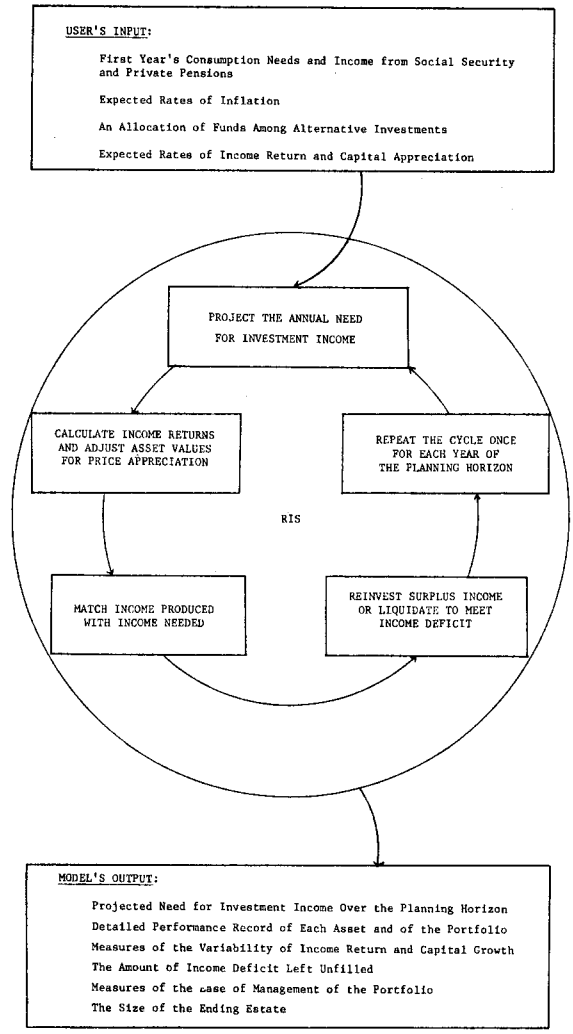

FIGURE 1. A SCHEMATIC DIAGRAM OF THE RETIREMENT INVESTMENT SIMULATOR (RIS)

[1] Boehlje [1], in an excellent delineation of research priorities for the entry-growth-exit process in agriculture, suggested this methodological approach.

[2] A detailed description of the model, including data input requirements, output tables, a program listing and suggestions for use and modification of the basic program, is being prepared [11] and may be obtained from the authors upon request.

meet the couple's annual investment income needs. It also estimates size of the estate which can be passed to the next generation.

The simulation model does not optimize the allocation of funds among alternative investments. The user may specify the amount invested in each type of asset, and average rates of income and price return expected from each.[3] If the user chooses not to specify expected rates of return and capital appreciation, the model bases its simulation analysis on fourteen years of price and income returns data for the investment categories presented in Table 1.[4]

Variability of income and price return has been accounted for, using a procedure reported by Clements, Mapp and Eidman [3]. Given (1) expected average rate of return supplied as input, (2) a matrix of coefficients derived from the historical variance and covariance matrix of returns from the selected investments, and (3) the assumption that annual rates of return will be normally distributed about average rates, the simulator generates for each type of asset a random series of annual rates of income and price return. These are normally distributed about the mean and "appropriately correlated" with rates generated for all other types of assets in that year.[5] Using the simulator, therefore, requires an assumption that performance of each investment will react to changes in that of all others in the way observed during the period which provided data for the variance-covariance matrix. However, this does not

TABLE 1. INCOME RETURNS AND PRICE RETURNS (PERCENT) TO SELECTED INVESTMENTS

	Farm Real Estate[a]		Utility Stocks[b]		Industrial Stocks[b]		Income Mutual[c] Funds		Growth Mutual[c] Funds		Bonds (Price Returns)[b,d]			
													Government	
Year	Income Returns	Price Returns	Income Returns	Price Returns	Income Returns	Price Returns	Income Returns	Price Returns	Income Returns	Price Returns	Corporate	Municipal	Long Term	Short Term
1959	1.8	3.0	3.92	6.14	3.11	-3.29	4.4	4.34	1.4	19.19	-0.33	3.18	1.26	1.29
1960	2.9	1.5	3.89	28.47	3.36	17.77	4.8	-4.43	1.5	6.24	0.61	3.75	1.04	2.15
1961	4.0	5.7	3.24	-1.73	2.90	-6.36	4.2	12.53	1.1	26.81	0.99	3.99	-0.61	0.63
1962	4.2	5.5	3.46	9.85	3.32	11.98	4.8	-8.70	1.5	-18.7	0.62	-0.71	-0.83	-0.79
1963	4.0	6.5	3.29	7.57	3.12	17.44	4.1	10.97	1.4	19.14	-1.67	0.02	-1.66	-0.92
1964	3.3	4.9	3.27	8.83	2.96	8.46	3.9	9.72	1.3	11.47	-1.32	-0.81	-0.71	-4.48
1965	5.0	6.9	3.24	-10.3	2.94	-2.57	3.7	10.29	1.2	29.00	-8.33	-7.32	-5.17	0.97
1966	5.2	7.5	3.90	-0.16	3.32	8.89	4.3	-9.85	1.4	-3.07	-5.01	-1.95	-2.41	0.86
1967	3.6	7.0	4.19	-2.47	3.07	8.39	4.0	16.57	1.2	40.00	-6.53	-7.02	-4.85	-2.33
1968	3.4	5.6	4.50	-5.69	2.91	-0.28	3.7	10.84	1.1	9.46	-10.2	-15.4	-9.53	-3.19
1969	4.5	3.5	4.92	-13.0	3.07	-14.8	4.9	-20.5	1.6	15.66	-10.3	-15.4	-9.53	-2.46
1970	3.8	4.3	5.81	8.90	3.62	18.74	5.2	-0.32	2.1	-12.8	5.62	10.63	9.48	6.23
1971	3.7	8.2	5.45	-4.10	2.94	12.36	4.9	8.67	1.5	19.87	1.31	5.50	2.98	-1.66
1972	4.2	13.6	5.83	-6.03	2.61	-0.01	4.9	3.64	1.2	11.12	-3.05	1.15	-4.91	-3.36
Mean (1959-72)	3.83	5.98	4.21	1.88	3.09	5.48	4.41	3.13	1.39	12.39	-2.69	-1.46	-1.82	-0.50
Standard Deviation (1959-1972)	.8570	2.869	.9514	10.67	.2515	10.17	.4991	10.57	.2586	15.92	4.766	7.530	4.971	2.785

[a]Agricultural Finance Statistics, ERS, USDA.

[b]Standard and Poor's Trade and Securities Statistics, Security Price Index Record, 1974 Edition.

[c]Investment Companies 1974, Mutual Funds and Other Types, Wiesenberger Services, Inc.

[d]Corporate and Municipal Bond price returns are calculated by assuming a 4% coupon rate and a 20-year maturity; Government Bonds assuming a 3% coupon rate and a 15 and 3½-year maturity respectively.

[3]Income and price returns are separated in this analysis to more accurately identify consumable and nonconsumable gains in an asset's market value. Price returns (capital gains) add to the retiree's stock of wealth, but cannot be allocated to consumption until the asset is sold. This is particularly important in the case of farm real estate which cannot be easily liquidated in small units. Income returns (profits, rents, interest and dividends) can be spent without liquidating the investment [6, p. 5].

[4]The income and price returns in Table 1 are estimated for broad classifications of investments. An individual investor may find these uncomfortably vague. However, if he has or is willing to estimate income and price returns for individual investment alternatives, these data can be substituted into the model in place of the historical data.

[5]The random series of returns, generated by the model for individual investment alternatives, possesses means and standard deviations not significantly different from the historical series. In addition, the term "appropriately correlated" implies that correlation coefficients between investment alternatives are not significantly different from those of the historical series.

imply that variations in performance will occur within the same pattern of economic trends observed over the historical period.

The outcome of a selected investment strategy depends in part upon the set of randomly selected rates of return. To more accurately evaluate a strategy, simulation of the entire planning horizon is replicated a number of times. This permits an analysis of expected outcomes and a discussion of variability associated with each retirement income strategy. Thus, the retiree may observe year-to-year variations in income return and capital appreciation, plus effects of these variations on the stability of the ending estate value.

Having projected both income needed from investments and that provided by the chosen portfolio in a given year, the model matches one against the other. A part of any surplus income is reinvested in an asset of the user's choice. Similarly, an income deficit is met by liquidating assets and allocating the proceeds to consumption. In each year of the planning horizon, the model forces the couple's consumption needs to be met. The following year is entered with (1) an adjusted portfolio accounting for price appreciation, reinvestment of excess funds and liquidation to meet consumption needs, and (2) a minimum consumption need increased to account for inflation.

The retirement income simulator produces a schedule of a couple's consumption needs. This changes over time due to inflation. A report on the simulated performance of each asset is also produced. This shows both consumable income produced and changes in asset value. Summary tables demonstrate the performance of the total portfolio in meeting income needs. They provide measures of variability of return and capital growth, and indicate size of the ending estate.

AN APPLICATION OF THE MODEL

To illustrate the model's potential, two retirement investment strategies are simulated for an hypothetical farm situation. The net worth of our case farmer at retirement is assumed to be $145,800. The land resource accounts for $100,800 of the total. The remainder originates from the sale of farm chattels and is considered available for off-farm investment. Consumption requirements are assumed to be $4,000 above social security benefits. These are increased at an annual rate of six percent to account for inflation.

The two simulated investment strategies are quite different. Strategy 1 is to sell the farm real estate, pay appropriate capital gain taxes, and invest all capital in a portfolio of long-term bonds and corporate stocks producing high dividends and low capital growth rates. Strategy 2 is to maintain ownership of the farm real estate, rent cropland on a cash rent basis and invest proceeds from the sale of livestock and machinery in growth mutual funds. Each strategy is simulated for a twenty-year period and replicated fifteen times.[6]

Results of the two simulated strategies are summarized in Table 2.

Strategy 1, which involves selling the farm real estate and investing in income stocks and long-term bonds, results in an average rate of income return of slightly more than six percent. The standard deviation of income return is 0.544 percent, resulting in a coefficient of variation (standard deviation divided by the mean) of 0.09. The range in ending value of the estate for strategy 1 is $22,070 to $303,128, with an average of $130,201. Size of ending estate is much more variable than the rate of income return. With a standard deviation of $70,289, the coefficient of variation for size of ending estate is 0.54. Strategy 1 requires numerous liquidations of assets to meet retirement income needs, due to the declining real value of income-producing capital base.

Retirement income strategy 2, which involves keeping farm real estate and investing surplus income in growth mutual funds, is considerably more successful in meeting retirement income needs and enlarging the ending value of the estate. Average rates of income return are lower under strategy 2, averaging only 3.3 percent per year. Variability of income return is, as expected, much greater. The standard deviation of income return is 0.60, the coefficient of variation being 0.185, approximately twice the size of that of strategy 1. Price returns, however, are much greater under strategy 2 and account for the difference in size of ending estate.

The ending value of the estate ranges from $350,726 to $826,903, with a mean of $616,014. Standard deviation is $141,148. Relative variability in the ending value of the estate, measured by the coefficient of variation of 0.23, is less for strategy 2 than for strategy 1. This result may seem unexpected, but is easily explained. Under strategy 1, outright sale

[6] Results of fifteen replications are presented simply to illustrate the nature and variability of results generated by the model. The appropriate number of replications for a simulation analysis may vary, depending upon precision desired on the estimates, the power designed on one or more tests, precision desired on confidence intervals or on more pragmatic considerations, such as costs. For a more detailed discussion of factors affecting the sample size, see Folks [5] or Naylor, et al. [8].

TABLE 2. AVERAGE RATE OF INCOME RETURN AND VALUE OF ENDING ESTATE FOR ALTERNATIVE RETIREMENT INCOME STRATEGIES

Replication[a]	Retirement Income Strategy 1 Sell Farm Real Estate and Invest in Income Stocks and Long Term Bonds		Retirement Income Strategy 2 Keep Farm Real Estate and Invest in Growth Mutual Funds	
	Average Rate of Income Return(%)	Size of Ending Estate($)	Average Rate of Income Return(%)	Size of Ending Estate($)
1	6.052	112,294	3.140	619,937
2	5.808	110,167	3.129	577,651
3	6.123	140,679	3.439	775,971
4	5.886	92,826	3.115	808,694
5	5.993	136,061	3.430	541,630
6	6.041	22,070	3.481	706,515
7	5.720	160,842	2.956	826,903
8	6.059	89,302	3.194	554,384
9	6.096	212,190	3.320	389,171
10	6.152	303,128	3.146	350,726
11	6.216	66,823	3.016	689,595
12	6.289	33,569	3.555	650,612
13	6.219	163,985	3.373	487,592
14	5.978	166,678	3.019	691,120
15	5.809	142,402	3.206	569,711
Mean	6.029	130,201	3.325	616,014
Std. Dev.	0.544[b]	70,289	0.599[b]	141,148
Coeff. of Var.	0.090	0.540	0.185	0.229
Ave. No. of Liquidations	2.0		1.0	
Est. after Tax Net Worth		113,219		425,100

[a]Each replication involves simulation of a retirement investment strategy over the entire 20-year planning horizon. Because of the volume of number generated, only averages for each replication are presented.

[b]Standard deviation of income return is computed for each replication of the simulation experiment in the conventional manner. This figure, however, represents an average standard deviation across replications.

of farm real estate results in payment of sizeable capital gains taxes. Income-type corporate stocks, comprising a large part of the portfolio in strategy 1, exhibit low and extremely variable rates of capital growth. The smaller capital base gives the retired farm family less cushion to meet consumption needs when portfolio value varies due to adverse economic conditions. Frequent liquidations to meet current consumption needs result in more relative variability in ending value of estate under strategy 1 than strategy 2.

In addition to generating income, the retired farm operator is frequently interested in passing the family's wealth at maximum value to the next generation. The bottom row of Table 2 presents estimates of the ending estate after settlement costs

are paid for both individuals. Estimates are made under the assumption that assets owned by the husband are passed to the wife at his death in year seventeen, then to the children at hear death in year twenty. Careful planning to reduce estate settlement costs may result in an even greater relative advantage of strategy 2 over strategy 1. However, a complete evaluation of estate transfer considerations was not within the scope of this analysis.

CONCLUDING COMMENT

The retirement income simulation model is designed to meet three criteria established earlier by considering (1) amount of return from a portfolio, (2) variability of return associated with it, and (3) allocation of returns over time in relation to changing economic needs of a retired family. The model has been used to evaluate retirement investment strategies for three representative case farm situations. For each, three methods of handling farm real estate are considered, including (1) keep farm real estate as an investment and rent the land on a cash basis, (2) sell the farm for cash and invest in nonfarm assets, and (3) sell the farm on an installment land contract and invest in nonfarm assets. For each real estate strategy, three types of nonfarm asset portfolios are being considered: (1) a portfolio consisting of assets yielding high income and low capital growth rates, (2) a balanced portfolio of income and growth assets, and (3) a portfolio consisting of assets producing high capital growth rates and low income returns [10].

With further modification to more realistically account for taxation and transactions costs, the model can be used to evaluate consequences of specific investment and estate transfer strategies in the disinvestment stage of the farm firm life cycle. The model appears to be sufficiently flexible and economical to serve as forerunner to the basic element of an extension workshop for individual retirement investment planning.

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