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NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

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NCRETURN COMPUTER PROGRAM FOR EVALUATING INVESTMENTS REVISED TO PROVIDE ADDITIONAL INFORMATION

ABSTRACT. — Reports a modified version of NCRETURN, a computer program for evaluating forestry investments. The revised version, RETURN, provides additional information about each investment, including future net worths and benefit-cost ratios, with no added input.

OXFORD: 651.1:U681.3. KEY WORDS: computer program, investment analysis, evaluation.

In 1967 we published a description of a computer program designed to evaluate long-term forestry investments.[1] This program, labeled NCRETURN, has since been revised to print out additional information so that a more thorough analysis of investments is possible. This note briefly describes the added output. A complete description of the original program and the input format (which is unchanged) is given in the 1967 publication.

An expanded output table from this revised program (now labeled RETURN) is shown in figure 1. (The illustrative table entries are the result of analyzing a hypothetical investment in producing 1 acre of red pine stumpage on a 55-year rotation.) The first four columns, which give the interest rate used for discounting and compounding, the discounted incomes and costs, and the net worth for a single rotation, are similar to the output provided by the original version of NCRETURN. The remaining six columns are new.

The "NET WORTH AT END OF ROTATION" of column 5 shows how much incomes would exceed costs (or, if negative, costs would exceed incomes) at the end of the rotation if all costs and all incomes were carried forward to that point in time at the compound interest rate shown in the first column. At a 5-percent (.0500) interest rate, the compounded net worth at the end of the rotation is $294.36. This tells us that if all of the incomes and costs specified in this investment analysis actually are realized, then by the end of the rotation we would have enough income to offset all costs, compounded at 5 percent,

[1] *Schweitzer, Dennis L., Lundgren, Allen L., and Wambach, Robert F. A computer program for evaluating long-term forestry investments. USDA Forest Serv. Res. Pap. NC-10, 34 p., illus. N. Cent. Forest Exp. Sta., St. Paul, Minn. 1967.*

.....ROTATION LENGTH = 55 YEARS.....   RL NO. 4 OF 7 - PROBLEM NO. 3

TABLE OF FINANCIAL OUTCOMES FOR INVESTMENT
(IN DOLLARS, EXCEPT BENEFIT-COST RATIOS)

DISCOUNT	SINGLE ROTATION			NET WORTH	BENEFIT-	COST-	INFINITE ROTATIONS		
RATE	DISCOUNTED INCOMES	DISCOUNTED COSTS	DISCOUNTED NET WORTH	AT END OF ROTATION	COST RATIO	BENEFIT RATIO	DISCOUNTED INCOMES	DISCOUNTED COSTS	DISCOUNTED NET WORTH
.0050	947.59	-129.61	817.98	1076.16	7.31	.14	3949.83	-540.25	3409.58
.0100	740.96	-123.00	617.96	1068.15	6.02	.17	1758.03	-291.84	1466.19
.0150	581.17	-117.45	463.72	1051.70	4.95	.20	1039.53	-210.08	829.45
.0200	457.29	-112.77	344.51	1023.80	4.05	.25	689.21	-169.97	519.24
.0250	360.98	-108.83	252.16	980.58	3.32	.30	485.94	-146.50	339.44
.0300	285.91	-105.48	180.43	916.95	2.71	.37	355.95	-131.32	224.62
.0350	227.22	-102.64	124.58	826.34	2.21	.45	267.55	-120.86	146.69
.0400	181.20	-100.22	80.99	700.23	1.81	.55	204.90	-113.33	91.58
.0450	145.02	-98.15	46.87	527.63	1.48	.68	159.16	-107.72	51.44
.0500	116.49	-96.38	20.11	294.36	1.21	.83	125.03	-103.44	21.59
IRR = .0548	94.92	-94.92	.00	.01	1.00	1.00	100.25	-100.25	.00
.0550	93.91	-94.85	-.94	-17.81	.99	1.01	99.13	-100.12	-.99
.0600	75.99	-93.53	-17.54	-432.27	.81	1.23	79.21	-97.48	-18.28
.0650	61.73	-92.39	-30.66	-979.02	.67	1.50	63.72	-95.37	-31.65
.0700	50.33	-91.39	-41.06	-1696.47	.55	1.82	51.58	-93.66	-42.08
.0750	41.19	-90.52	-49.33	-2633.65	.46	2.20	41.98	-92.25	-50.27

Figure 1.—*Output table from computer program RETURN (a revised version of NCRETURN) for an illustrative investment in growing red pine on a 55-year rotation.*

and still have $294 left over. Note that at the internal rate of return (IRR = .0548), discounted costs equal discounted incomes, so both discounted net worth at the beginning of the rotation and compounded net worth at the end of the rotation are zero. In both instances, costs and incomes can be compared because they are viewed at a common point in time.

Column 6 shows the benefit-cost ratio, another measure of investment profitability. To obtain this ratio, total discounted incomes have been divided by total discounted costs for each interest rate.[2] For an interest rate of 5 percent, the benefit-cost ratio in our example is $116.49 ÷ $96.38 = 1.21. This indicates that for every dollar of total discounted costs invested in this project, assuming an interest rate of 5 percent, we can expect a return of $1.21 in discounted incomes. Note that at the internal rate of return (IRR = .0548 in this example), discounted incomes equal discounted costs, so the benefit-cost ratio is 1.00. For a given interest rate, benefit-cost ratios from different investment alternatives can be compared to determine which alternative provides the most income per dollar invested.

The cost-benefit ratio, the reciprocal of the benefit-cost ratio, is given in column 7. For a 5-percent interest rate, the cost-benefit ratio is $96.38 ÷ $116.49 = $0.83. This indicates that every dollar of total discounted income received from growing red pine will require an investment of $0.83 in discounted costs. In other words, it shows the investment required per dollar of discounted income. Cost-benefit ratios from alternative production opportunities can be compared to determine which opportunity requires the least investment per dollar of income produced.

The last three columns of output show the discounted incomes, costs, and net worths for an infinite series of equal-length rotations, each with costs and incomes identical to the first. These are obtained by multiplying the corresponding item in columns 2 to 4 by a special interest rate multiplier $((1+i)^n \div ((1+i)^n - 1))$, with interest rate i and rotation age n, called a land expectation value multiplier.[3] The discounted net worth for an infinite series of identical rotations shown here is the well-known soil or land expectation value in forestry. It is particularly useful in comparing investment periods of different lengths.

Besides these changes, a table has been added to the output to summarize the Internal Rate of Return (IRR) calculated for each rotation age (fig. 2). This table, showing the IRR for each rotation age specified for the problem, is useful in comparing rates of return for alternative rotation ages. It is also useful in determining the payback period for specified alternative interest rates.

SUMMARY TABLE OF IRR FOR PROBLEM 3	
ROTATION AGE	IRR
25	.0166
35	.0332
45	.0521
55	.0548
65	.0556
75	.0557
85	.0555

Figure 2. — *Summary table of internal rates of return from computer program RETURN over a range of rotation ages for an illustrative investment in growing red pine.*

The payback period is the minimum period of time in the life of an investment required to recover all investment costs up to that time. Although the concept usually has been used without allowance for a rate of return on invested capital, it can be modified

[2] *This is in line with: Chappelle, Daniel E. A computer program for evaluating forestry opportunities under three investment criteria. USDA Forest Serv. Res. Pap. PNW-78, 64 p., illus. Pac. N. W. Forest Range Exp. Sta., Portland, Oregon. 1969.*

[3] *For an example and more detailed explanation see: Lundgren, Allen L. Estimating investment returns from growing red pine. USDA Forest Serv. Res. Pap. NC-2, 48 p., illus. N. Cent. Forest Exp. Sta., St. Paul, Minn. 1966.*

to include the time to recover the cost of an investment plus interest.[4] By plotting IRR over rotation age (fig. 3), and interpolating between points, one can estimate quickly the minimum rotation age required to recover the invested capital plus interest for any specified rate. To illustrate, we would estimate the payback period for our example to be from 25 to 30 years for a 2-percent interest rate, from 30 to 35 years for a 3-percent rate, from 35 to 40 years for a 4-percent rate, and just under 45 years for a 5-percent rate. No rotation age will recover more than 5.6 percent on invested funds. Although it is a weak investment criterion by itself, the payback period suggests the relative flexibility of an investment by indicating how long funds must be kept tied up in an investment before they all can be recovered.

In addition to the modifications described above, an IMPACT subroutine can be added to the RETURN program. This subroutine provides an additional table of output for each specified rotation age and interest rate. This information enables the analyst to judge the relative importance of each item of cost and income in the analysis. A detailed description of this subroutine is given elsewhere.[5]

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[4] *Weingartner, H. Martin. Some new views on the payback period and capital budgeting decisions. Manage. Sci. 15(12): B594-607. 1969.*

[5] *Schweitzer, Dennis L. The impact of estimation errors on evaluations of timber production opportunities. USDA Forest Serv. Res. Pap. NC-43, 18 p., illus. N. Cent. Forest Exp. Sta., St. Paul, Minn. 1970.*

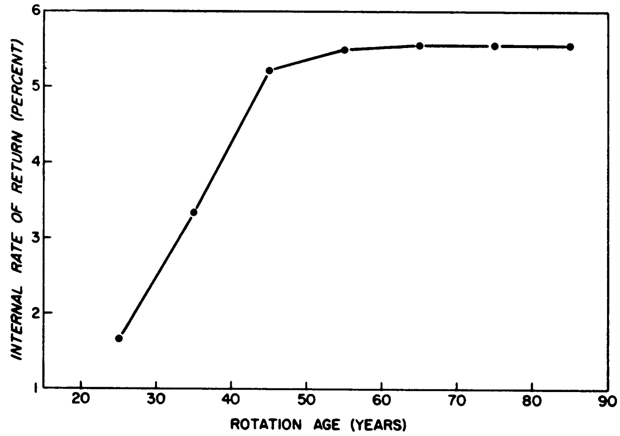

Figure 3. — *Illustrative plot of internal rates of return over alternative rotation ages to estimate payback periods for specified interest rates.*

Copies of the program listing for RETURN with or without the IMPACT subroutine are available from the North Central Forest Experiment Station upon request.

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