Pacific Forest Research Centre

ECON

Financial Evaluation Module for Tree Growth Simulators

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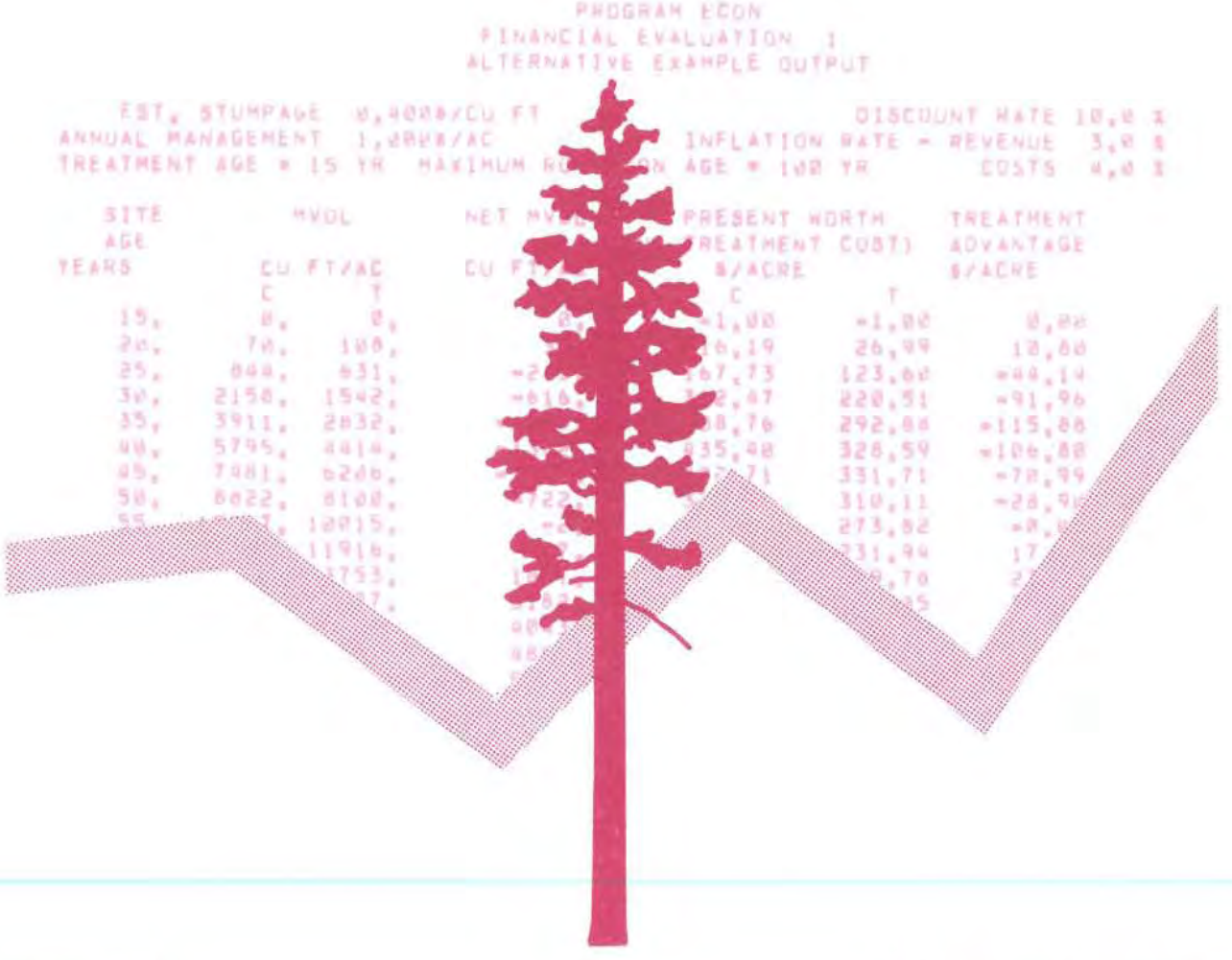

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ABSTRACT

Implementation of forest management regimes is generally based on favorable financial feasibility evaluation. ECON is a routine which can be used to test the physical outputs of tree growth simulation for financial feasibility. This routine is based on a modification of present net worth termed the "forestry fund" approach, which has the advantage of not requiring a priori assumptions concerning the cost of silvicultural treatments.

RÉSUMÉ

La mise en oeuvre de régimes de gestion forestière se fonde généralement sur une évaluation favorable de la rentabilité. ECON est un système pouvant servir à vérifier les produits réels de la simulation de la croissance des arbres quant à la rentabilité. Il est fondé sur une modification de la valeur nette actuelle appelée l'accès aux "fonds forestiers", qui a l'avantage de ne pas exiger d'hypothèses a priori, concernant le coût des traitements sylvicoles.

INTRODUCTION

The development of simulation techniques and their application to forestry allows easier and more reliable growth prediction, and the analysis of the impact of forestry practices on growth. The Pacific Forest Research Centre is developing a Compatible System of Growth Simulators (CSGS), part of which is an individual tree growth model known as BUSH.

BUSH is a distance-dependent model (Hegyi 1976), which uses a spatial distribution of stems, site index and stocking percent to predict the growth of individual trees. The model may be used to analyze the growth effects of juvenile spacing, thinning and fertilization. While output of BUSH is in physical terms, implementation of forest management regimes is generally based on favorable financial feasibility indicators. ECON is proposed as a way of providing one such indicator.

ECON AS AN ECONOMIC EVALUATOR

Since electronic computers were first applied to forestry problems, a large number of financial evaluation routines have been developed (Hall 1962; Row 1963; Schweitzer et al. 1967; Schweitzer 1968; Forster 1968; Wikstrom and Alley 1968; Chappelle 1969; Goforth and Mills 1975; Harpole 1978). In general, these programs have utilized four criteria: 1) present net worth, 2) internal rate of return, 3) benefit-cost ratio, and 4) cash flow. Haley (1969) has reviewed the first three of these, and finds that each has its advantages. The computer programs, developed at various times, each have their special features. For instance, Schweitzer (1968) has a method for evaluating present net worth under uncertainty, while Goforth and Mills (1975) include a sensitivity analysis procedure in their model. The advantage of the routine developed by the Pacific Forest Research Centre is that it does not require an exact knowledge of silvicultural treatment cost.

Resource managers may find that the financial evaluator (ECON), used in conjunction with BUSH or some other tree growth simulator, will prove useful in evaluating investment opportunities and, owing to the rapidity of output, allow testing of a wide range of alternative treatments.

The financial evaluator (ECON) developed by the Pacific Forest Research Centre (Massie et al. 1977) utilizes a technique closely related to the forestry fund (Massie 1972). The similarity is that both the forestry fund and ECON use a truncated variation of present net worth for the evaluation of investment opportunities.

The evaluation criteria for the forestry fund is the net discounted revenue, not including the cost of undertaking the alternative, expected from the investment. It is the residual determined by discounting to the present future revenue and subtracting all discounted costs (usually annual), excepting the current cost of undertaking the alternative[1/]. In the forestry fund, the resulting figures are then ordered largest to smallest if the costs of undertaking the alternatives are estimated to be similar. Hence, the investment opportunities are ranked. If the costs of undertaking the alternatives vary, the estimated cost for each alternative is subtracted from the appropriate fund and the residuals are then ordered highest to lowest to denote the ranked investment opportunities.

In ECON, one further step is required to handle stand treatment alternatives where one viable alternative is considered to be no treatment. In this situation, treatments are rated against a no treatment

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1/ The discount formulas used in ECON are:

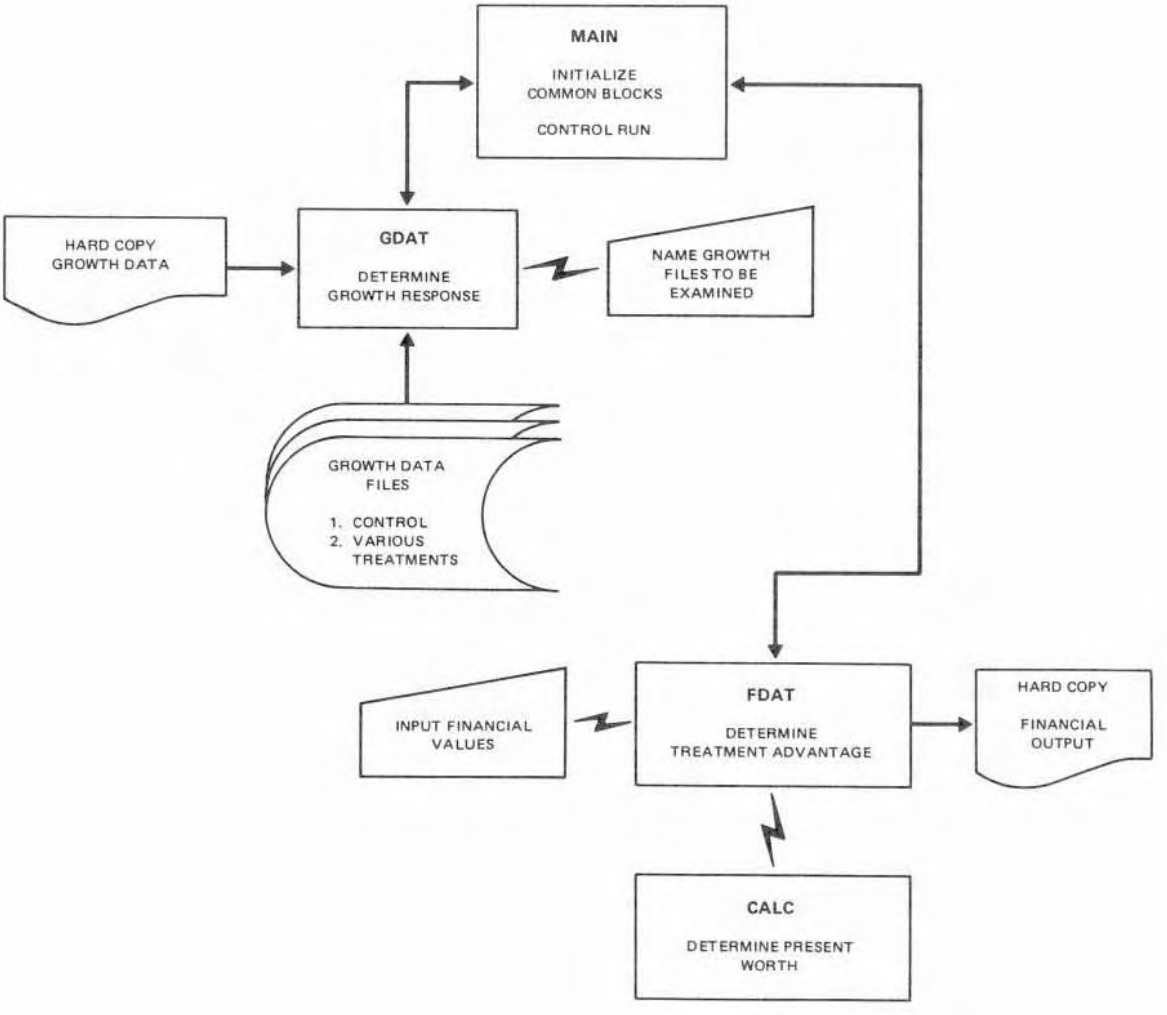
(1) Formula for inflation: $Vn = Vo\ (1.0K^n)$
where Vn = value of sum after n years
Vo = value of sum now
$1.0K^n$ = principle plus inflation on $1.00 for n years

(2) Formula for discounting : $Vo = \frac{Vn}{1.0p^n}$
where Vo = value of sum after discounting
Vn = value of sum to be discounted
$1.0p^n$ = principle plus discount on $1.00 for n years

(3) Formula for Net Discounted Annual Management Costs:
$$Vo = AC\left[\frac{1.0p^n - 1.0K^n}{(1.0p - 1.0K)\ 1.0p^n)}\right]$$
where AC = annual cost
$1.0p$ = principle plus discount of $1.00
$1.0K$ = principle plus inflation on $1.00
$1.0p$ = principle plus discount on $1.00 for n years
$1.0K$ = principle plus inflation on $1.00 for n years

FIGURE 1

'ECON' FLOWCHART



or control situation. That is, the present net worth of the stand **without treatment** is calculated and the difference between the forestry fund and the "untreated" present net worth is taken. This difference is called the treatment advantage, which is the amount of gross income generated by the treatment. If the treatment can be undertaken for less than the treatment advantage, that treatment could be considered financially feasible. All the various silvicultural treatments simulated by BUSH can also be ranked financially on the basis of the value of the treatment advantage, by ECON, given the necessary assumptions.

While ECON does not require exact knowledge of the treatment cost, it does require other assumptions in common with similar financial evaluation models. The key economic assumption, and one to which the results are highly sensitive, is that of an appropriate discount rate. The rate most appropriate to public investments (Manning 1977) is not necessarily that which is most appropriate to private industry. A closely related assumption is that the chosen discount rate will be constant over the life of the investment.

The model also requires the user to specify certain other assumptions. Price of output is one necessary specification, as are inflation rates for costs and output price. It must be recognized at this point that no explicit allowance for uncertainty is incorporated into the program. Finally, the user must specify all costs, other than the treatment cost.

ECON AS A PROGRAM

ECON is written in FORTRAN IV and is currently operational on the PFRC inhouse PDP 11/45 minicomputer. It requires an interactive terminal, either video or printing, an online mass storage device capable of maintaining data files or a method of bulk data entry and 24K bytes of core for the run module. Two data display options are available in the program, the hard copy listing of output and the file created for a plotting program. These require a lineprinter and online mass storage, respectively.

ECON is composed of a main program and three subroutines (Fig. 1). In the main program, all the common blocks are initialized and the prompts to control the run are initiated from here. Control passes from main to subroutine GDAT where two growth files from BUSH are combined and displayed. After visually inspecting the growth data (Table A1), the analyst can specify different growth files from BUSH, in which case new tables are derived under different assumptions, or he may accept the growth files and call the financial routine.

FDAT, the financial routine, asks for financial values and, when these are entered and confirmed, calls subroutine CALC to perform the actual calculations. Control then returns to FDAT for display (Table A2) and further financial evaluation. If no further financial evaluation is needed for this set of growth data, control returns to main.

INTERPRETING THE OUTPUT

An annotated test run of ECON is reproduced in the Appendix, along with sample output. Output for analysis consists of two tables, first (A1) a table of physical growth data, and second (A2) a financial analysis.

Table A1 is used simply to check whether there is sufficient physical growth response to continue analysis of the treatment. If there is not, the treatment is modified, and new growth data are generated. Response is evaluated by the difference in indicators (Merch. vol., DBH, Height). This evaluation is on a subjective basis, the pertinent indicator being based on management objectives.

The financial analysis portion of the module is called when physical response is judged to be at least adequate. The program requires the user to specify a number of parameters: treatment age, maximum rotation age, stumpage price, discount rate, revenue inflation rate, cost inflation rate and annual management cost. Sample output from the financial evaluation is shown in Table A2.

The operative column in the financial output is that called "Treatment Advantage". This is the difference in present worth (**not** net present worth) of the treated **vs.** control stands. It may be described as the amount available for the specified treatment.

In the example given in Table A2, there are several alternative interpretations, depending on whether rotation is set on an economic basis, or on some other (e.g. culmination of mean annual increment) basis. If economic rotation is based on maximum present worth, in the example given, at rotation (50

years) no treatment would be recommended as there is a negative (–$34.33) treatment advantage. If rotation is on some other basis, treatment would be feasible if treatment advantage exceeds treatment cost.

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APPENDIX. ANNOTATED TEST RUN OF ECON

Terminal Output

```
    RUN ECON$
TREATMENT NAME =A24


TEST DATA


UNITS - ENGLISH = 1, METRIC = 2
1


CONTROL DATA =D#:FILE
3TEST.BSE
BASE DATA IN TEST.BSE                    Y OR N
Y
TREATED DATA =D#:FILE
3TEST.TRT
TREATED DATA IN TEST.TRT                   Y OR N
Y
```

Annotation

Conventions
Y = yes
N = no
Underlined portions of the input routine are program prompts or replies.

(1) Initiate a run

(2) Title for this pair of data files

(3) Specify English or metric units

(4) Name the device no. and file name for control or base data and then the same information is requested for the treated data. If an error is made, answer N at the appropriate place and the query will be repeated. If both files are correctly specified, the program reads and combines the data from both files and then produces the growth data table (Table A1).

```
HARD COPY? Y=6, N=0
0


FINANCIAL EVALUATION -- Y OR N
Y


PLOT OUTPUT - Y OR N
N


TREATMENT AGE =XXX
15
MAXIMUM ROTATION AGE =XXX
100
STUMPAGE PER VOLUME =XX.XXX
.25
DISCOUNT RATE =XX. %
8.
INFLATION RATE REVENUE =XX. %
3.
INFLATION RATE COSTS =XX. %
3.
ANNUAL MANAGEMENT COST =$XX.XX
1.00
                TREATMENT AGE  15
        MAXIMUM ROTATION AGE 100
         STUMPAGE PER VOLUME  0.250
                DISCOUNT RATE 8.
        INFLATION RATE REVENUE 3.
           INFLATION RATE COST 3.
      ANNUAL MANAGEMENT COST  1.00


CORRECT ? Y OR N
Y
```

(5) If you are using a CRT terminal or just wish additional copies of TABLE A1 specify 6. If not specify 0.

(6) If the particular data pair does not show enough growth response to warrant financial evaluation, specify N and the program returns to Step (2).

(7) A Y answer creates an output file with the same name as the run title for use by an inhouse plotting routine.

(8) If a financial evaluation is requested, the program asks for the seven variables necessary for the calculations and then lists all the values for a final check.

(9) If one or more of the values is incorrect, specify N and return to step (8), otherwise specify Y and TABLE A2 is produced.

TABLE A1

PROGRAM ECON
GROWTH DATA
ALTERNATIVE TEST DATA

C = CONTROL DATATEST.BSE
T= TREATMENT DATA TEST.TRT

SITE AGE	STAND		MAI CU FT		# OF TREES ACRE		MERCH VOL CU FT/AC		AV DBH INCHES		AV MHT FEET	
	C	T	C	T	C	T	C	T	C	T	C	T
5.	5.	5.	0.	0.	800.	800.	0.	0.	0.1	0.1	0.0	0.0
10.	10.	10.	3.	3.	800.	800.	0.	0.	1.0	1.0	2.0	2.0
15.	15.	15.	14.	5.	800.	197.	0.	0.	2.1	2.5	11.0	14.9
20.	20.	20.	37.	16.	800.	197.	70.	108.	3.2	4.2	21.8	28.1
25.	25.	25.	69.	35.	800.	197.	8[illegible].	631.	4.3	5.9	33.3	42.2
30.	30.	30.	106.	59.	800.	197.	2158.	1542.	5.2	7.6	44.5	56.2
35.	35.	35.	141.	87.	715.	197.	3911.	2832.	6.3	9.3	56.1	69.4
40.	40.	40.	165.	116.	592.	197.	5795.	4414.	7.6	10.7	68.1	81.4
45.	45.	45.	180.	144.	496.	197.	7481.	6206.	8.8	12.1	78.7	92.2
50.	50.	50.	187.	168.	427.	197.	8822.	8100.	9.8	13.3	88.0	101.6
55.	55.	55.	191.	189.	373.	197.	10017.	10015.	10.7	14.3	96.9	109.8
60.	60.	60.	192.	206.	331.	197.	11069.	11916.	11.6	15.2	104.2	116.7
65.	65.	65.	19[illegible].	220.	299.	197.	11942.	13753.	12.5	16.0	110.0	122.7
70.	70.	70.	183.	231.	267.	197.	12345.	15527.	13.2	16.8	114.7	127.7
75.	75.	75.	182.	239.	245.	197.	13182.	17225.	14.1	17.4	119.6	131.9
80.	80.	80.	182.	245.	229.	197.	14045.	18847.	14.9	18.1	123.8	135.4
85.	85.	85.	177.	249.	213.	197.	14512.	20373.	15.6	18.6	126.5	138.4
90.	90.	9[illegible].	172.	252.	197.	197.	14908.	21813.	16.3	19.2	129.2	140.8
95.	95.	95.	169.	249.	187.	187.	15464.	22815.	17.0	20.2	131.3	143.8
100.	100.	100.	166.	241.	181.	181.	15959.	23277.	17.6	20.5	132.[illegible]	145.6

TABLE A2

PROGRAM ECON
FINANCIAL EVALUATION 1
ALTERNATIVE TEST DATA

EST. STUMPAGE 0.2500 CU FT — DISCOUNT RATE 8.0 %
ANNUAL MANAGEMENT 1.000$/AC — INFLATION RATE - REVENUE 3.0 %
TREATMENT AGE = 15 YR MAXIMUM ROTATION AGE = 100 YR — COSTS 3.0 %

SITE AGE YEARS	MVOL CU FT/AC C	MVOL CU FT/AC T	NET MVOL CU FT/AC	PRESENT WORTH (NO TREATMENT COST) $/ACRE C	PRESENT WORTH (NO TREATMENT COST) $/ACRE T	TREATMENT ADVANTAGE $/ACRE
15.	0.	0.	0.	-1.00	-1.00	0.00
20.	70.	108.	38.	9.66	17.06	7.40
25.	844.	631.	-213.	123.72	90.63	-33.10
30.	2158.	1542.	-616.	254.79	179.11	-75.68
35.	3911.	2832.	-1079.	366.63	262.09	-104.54
40.	5795.	4414.	-1382.	429.06	323.45	-105.61
45.	7481.	6206.	-1276.	435.98	359.04	-76.94
50.	8822.	8100.	-722.	403.54	369.21	-34.33
55.	10017.	10015.	2.	359.03	358.94	-0.09
60.	11069.	11916.	847.	310.19	335.28	25.09
65.	11942.	13753.	1811.	260.93	303.24	42.31
70.	12345.	15527.	3182.	209.08	267.74	58.66
75.	13182.	17225.	4043.	172.91	231.71	58.81
80.	14045.	18847.	4802.	142.11	197.22	55.11
85.	14512.	20373.	5861.	112.13	165.20	53.07
90.	14908.	21813.	6905.	87.07	136.40	49.33
95.	15464.	22815.	7351.	67.62	109.05	41.44
100.	15959.	23277.	7317.	51.45	83.87	32.54

HARD COPY? Y=6, N=0
0

FINANCIAL RE-EVALUATION -- Y OR N
N

ANOTHER RUN -- Y OR N
N

(10) see step (5).

(11) A Y answer returns control to step (8) and another set of financial values can be entered.

(12) A Y answer returns control to step (2) to repeat the whole cycle.

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