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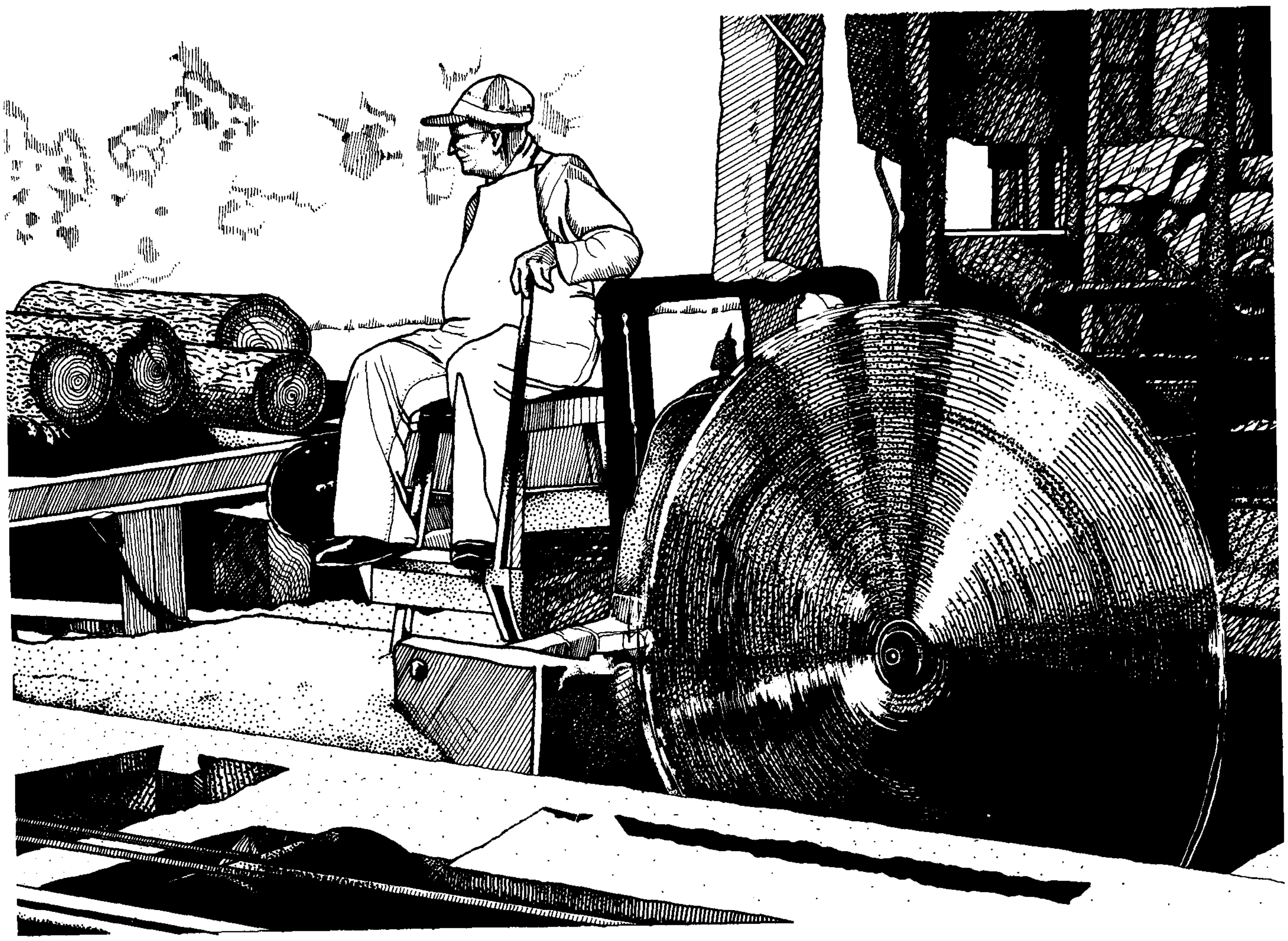

Abstract

Methods other than presented here should be used to assess projects for likely return on investment; but, payback is simple to calculate and can be used for calculations that will indicate the relative attractiveness of alternative improvement projects. This paper illustrates how payback ratios are calculated, how they can be used to rank alternative improvement projects, and how to calculate the benefit value of improvement projects.

Key Word: Economics, Feasibility analysis, Sawmill improvement projects, Payback analysis, Utilization economics.

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Many investment opportunities (computer processing controls, intensified maintenance programs, employee training programs, equipment modification, and other sawmill improvement projects) can improve sawmilling efficiencies. Both costs and anticipated efficiencies may be estimated to a reasonable degree of accuracy. But, what about the payback? Where will it come from, and what does the payback of investment say about returns on investment?

Methods other than those presented here should be used to assess projects for likely return on investment *(1-5)*;[2] but, payback is simple to calculate and can be used for calculations that will indicate the relative attractiveness of alternative improvement projects. This paper illustrates how payback ratios are calculated, how they can be used to rank alternative improvement projects, and how to calculate the benefit value of improvement projects that must be known in order to calculate payback.

Payback Calculations

Payback, or payback time, is calculated by cumulating yearly the sum of after-tax operating profits, plus depreciation, to the point at which accumulated profits equal original investment. For sawmill improvement projects, payback will be based on the cost of the improvement project and an assumed even flow (period to period) of increased after-tax profits associated with the project. Payback time, including a portion of a year, can be calculated by indicating exactly when profits offset investment. Payback indicates when a break even of profits with the cost of investment will be realized-important information for financial planning, but without meaning as a guide to profitability.

Payback expressed in ratio to the useful economic life of an investment (PL = payback/economic life) does provide a criterion for ranking alternative projects of equal economic life on the basis of relative profitability. In general, projects with economic lives of 6 months to 1 year will require a PL ratio of 0.88 or lower to yield a return on investment (ROI) of 15 percent or more (fig. 1). For projects with an economic life of 10 years, a payback ratio of 0.50 or lower would indicate an ROI of 15 percent or more.

As indicated, there is a need to adjust the PL ratio when comparing projects with economic lives that vary more than a year. This can be accomplished by expressing PL in ratio to a PL ratio that corresponds with a specified ROI, referred to as a PLX ratio. A PLX ratio that approximates a 15 percent ROI for projects with different economic lives can be calculated using the following equation:

$$\text{PLX} = 0.90 - (0.04 \times \text{Economic Life}) \quad (1)$$

A PL/PLX ratio of less than 1.0 will indicate an ROI greater than 15 percent, and conversely. Projects with the lowest PL/PLX ratios are likely to provide the most attractive ROI's compared to alternatives.

To illustrate the foregoing, assume we have two sawmill improvement projects to consider. The first is a proposed employee training program that will improve product grade recovery. The program will cost $6,000 with an estimated after-tax payback time of 0.38 year (table 1). The

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[2] Italicized numbers in parentheses refer to literature cited at end of this report.

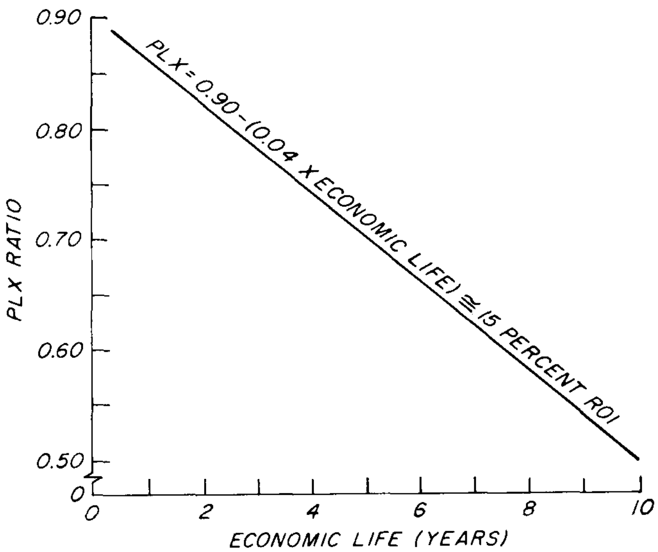

Figure 1.—Payback in ratio to project economic life (PL) where PL ratios approximate projects with 15 percent return on investment (PLX).
(M151941)

effectiveness of the training program is expected to last about one-half year, after which another training program will be necessary to maintain product grade recovery. The PL ratio is 0.76 (0.38/0.5).

The second proposed project is an increased maintenance program to reduce sawing variation. This project requires purchase of $90,000 of new maintenance and processing equipment. Estimated payback time is 1.45 years. Benefits from the new maintenance project, however, are expected to continue for about 2 years, after which time equipment items will again have to be replaced. The PL ratio is then 0.72 (1.45/2.0), implying (incorrectly) a better return on investment than the proposed employee training program.

The PLX ratio for the first project (employee training program) is 0.88, and the PL/PLX ratio is 0.86 (0.76/0.88). The PLX ratio for the second project (improved maintenance) is 0.82, with a PL/PLX ratio of 0.88 (0.72/0.82). On the basis of the PL/PLX ratio, the true case is seen where the employee training project indicates a higher ROI than the maintenance project. Return on investment analysis will support this ranking.

Both examples indicate an initial cost, or investment. In either case, it is unlikely that initial costs will be capitalized and depreciated. Investment costs are defined as monies spent to provide means for generating future revenues. However, investment projects with less than 2 years economic life are likely to be expensed rather than capitalized, but should be treated as investment for decision purposes. On the other hand, there may be operating expenses associated with an improvement project, such as the addition of personnel to carry on a maintenance and quality control program. Such operating expenses are simply deducted from associated benefits. If there is no initial investment, payback analysis is not applicable.

As indicated, payback time and the PL and PL/PLX ratios provide cursory criteria for assessing investment opportunities. Their main advantage is that they are easily calculated and, if used correctly, can identify promising opportunities deserving more careful analysis.

Calculating Sawmill Improvement Program Benefits

The calculation of payback time requires calculating the change in operating profit expected to be associated with a sawmill improvement program project. This means that both the change in operating costs, fixed and variable, and any change in revenues need to be identified. In short, the change in operating profit associated with a project will be the difference between operating profit (ΔOP) before and after the activation of a project:

$$\Delta\overline{OP} = \underset{\text{(cubic feet)}}{\text{Logs processed}} \times \left[\begin{pmatrix}\text{Change in unit value due}\\ \text{to change in lumber}\\ \text{recovery factor (LRF)}\end{pmatrix} + \begin{pmatrix}\text{Change in unit value due}\\ \text{to change in average}\\ \text{value of lumber mix}\end{pmatrix} - \begin{pmatrix}\text{Change in unit cost due}\\ \text{to expected change in}\\ \text{volume of logs processed}\end{pmatrix}\right] - \begin{pmatrix}\text{Change in operating cost,}\\ \text{excluding taxes and}\\ \text{depreciation}\end{pmatrix}$$

To calculate the after-tax benefit of a project, simply multiply ΔOP times 1.0 − effective tax rate, or;

$$\text{Before-tax } \Delta\overline{OP} = Q[\Delta\overline{LRF}(P_\ell = P_r) + (\Delta\overline{P}_\ell * LRF') + \frac{\Delta\overline{Q}\%}{100}((\overline{P}'_\ell * LRF') + P_r(BFE - LRF') - AVC)] - \Delta\overline{OC} \quad (2)$$

$$\text{After-tax } \Delta\overline{OP} = (\text{before-tax } \Delta\overline{OP}) * (1.0 - \text{effective tax rate})$$

where

$\Delta\overline{OP}$ = total expected change in operating profit,
Q = average volume of logs processed before the SIP, expressed in thousands of cubic feet,
$\Delta\overline{LRF}$ = expected change in the lumber recovery factor (board feet of lumber recovered per cubic foot of wood input),
P_ℓ = average value of lumber expressed in dollars per 1,000 board feet,
P_r = value of 1,000 board feet of lumber if made into mill residue,
$\Delta\overline{P}_\ell$ = expected change in the value of lumber output due to change in grade and/or product mix expressed in dollars per 1,000 board feet,
LRF' = lumber recovery factor after improvement project ($LRF + \Delta\overline{LRF}$),
$\Delta\overline{Q}\%$ = expected percentage increase or decrease in volume of logs processed,
$\overline{P}'_\ell$ = average value of lumber after SIP, expressed in dollars per 1,000 board feet ($P_\ell + \Delta\overline{P}_\ell$),
BFE = nominal board feet of lumber equivalent to 1 net cubic foot of solid wood,
AVC = average variable cost expressed in dollars per 1,000 cubic feet of log volume, and
$\Delta\overline{OC}$ = total expected change in operating cost, before taxes and depreciation.

Projects to improve sawmilling can generally be categorized as employee training, maintenance, or process modification. Investing in any one of these may affect one or more production variables. In turn, the effect on each variable must be estimated to provide a basis for estimating the value of the benefits, i.e., the change in operating profit. Assistance in estimating the likely effects of a sawmill improvement program can be obtained from most industry consultants as well as the U.S. Forest Service's State and Private Forestry utilization specialists. Refer to figure 2 for a worksheet to calculate project benefits.

To illustrate, we will examine our previous examples more closely, where current and projected operating conditions for a hypothetical sawmill were assumed. The "current status," before the considered project assumes an average annual production output of 35 million board feet (MMfbm) of lumber, and average lumber recovery factor (LRF)[3] of 8.35. This gives an average realization of $106 per 1,000 board feet (Mfbm) for lumber output, and an average realization of $25 per unit for residues. The anticipated effects of the two SIP projects are given in table 2.

By using equation (2) the change in operating profit, payback time, and payback ratio for each example can be quickly calculated assuming:

1 unit of residues = 72 ft³ of solid wood
1 Mfbm log scale = 190 ft³ of solid wood
1 Mfbm lumber tally = 56.625 ft³ of solid wood
BFE = 17.66 fbm/ft³ of solid wood

where the initial conditions of the mill are

$LRF = 8.35$
$Q = 22{,}061.7$ Mfbm log scale $= 4{,}191.7$ thousand ft³
$P_r = \$25$ per unit $\simeq \$19.66$ per Mfbm
$AVC = \$140$ per Mfbm log scale $= \$736.84$ per 1,000 ft³
$P_\ell = \$106$ per Mfbm

Project 1.—Employee training project

$$\begin{aligned}\Delta\overline{OP} &= Q[-0.15(\$106 - \$19.66) + \$2.50(8.20)]\\ &= Q[-\$12.95 + \$20.50] = Q[\$7.55]\\ &= 4{,}191.7 \times \$7.55\\ &= \$31{,}647.34 \text{ per year (before tax)}\\ &\sim \$15{,}823.67 \text{ (after 50 pct tax)}\end{aligned}$$

Payback time = $6,000/$15,823 = 0.38 year
PL ratio = 0.38/0.5 = 0.76
PL/PLX ratio = 0.76/0.88 = 0.86

Project 2.—Increased maintenance project

$$\begin{aligned}\Delta\overline{OP} &= Q[0.40(\$106 - \$19.66) - 0.01(\$106 \times 8.75 + \$19.66 \times 8.91 - \$736.84)] - \$5{,}000\\ &= Q[\$34.54 - \$3.66] - \$5{,}000\\ &= 4{,}191.7 \times \$30.88 - \$5{,}000\\ &= \$124{,}439.7 \text{ per year (before tax)}\\ &\sim \$62{,}219.85 \text{ (after 50 pct tax)}\end{aligned}$$

Payback time = $90,000/$62,219.85 = 1.45 year
PL ratio = 1.45/2.0 = 0.72
PL/PLX ratio = 0.72/0.82 = 0.88

[3] LRF: board feet of lumber recovered per cubic foot of wood input.

Table 1.—Example improvement projects, investment costs, economic lives, payback, and related ratios

Project	Investment cost	Economic life	Payback time[1]	Ratios PL[2]	PL/PLX[3]
	$	*Yr*	*Yr*		
Employee training	6,000	0.5	0.38	0.76	0.86
Increased maintenance	90,000	2.0	1.45	0.72	0.88

[1] Payback time is years required to accumulate after-tax profits associated with a project, to equal the project's investment cost.
[2] PL is payback time divided by economic life of the project.
[3] PL/PLX is PL divided by PLX, where PLX is a PL ratio that corresponds with a specified rate of return (ROI) for a project of "X" number of years, e.g. PLX = 0.90 − (0.04 × economic life) = 15 percent after-tax ROI.

Table 2.—Anticipated effects of two sawmill improvement projects

Improvement project	Estimated effects $\Delta\overline{LRF}$	$\Delta\overline{P}_l$	$\Delta\overline{Q}$%	$\Delta\overline{OC}$	Economic	investment cost
	Fbm/ft³	*$/Mfbm*	*Pct*	*$/yr*	*Yr*	*$*
Employee training (to improve grade recovery)	−0.15	2.50	0	0	0.5	6,000
Increased maintenance (to reduce sawing tolerance)	0.40	0	-1	5,000	2.0	90,000

Summary

Payback time, not including return to investment monies, indicates a break even of benefits gained from investment with the cost of investment. Consequently, payback time tells nothing about likely return to investment-only how long before initial investment monies are recovered. For this reason, payback time must be expressed as a ratio to the useful economic life of an investment project to provide a criterion for ranking alternative projects. Payback to economic life ratios are simple to calculate, and provide an index for ranking alternative projects on the basis of relative investment attractiveness.

Payback to economic life ratios for projects of equal economic lives are valid if based on initial costs (investment) which are expected to yield even flows of subsequent benefits. For sawmill improvement projects, the flow of benefits will result from associated changes in operating profits (revenues less operating costs).

Literature Cited

1. Grant, E. L.; Ireson, W. G. Principles of engineering economy. 5th ed. Ronald Press, New York; 1970.

2. Harpole, G. B. How to estimate investment break-even points for sawmill improvement projects. For. Prod. J. 27(4):54-56; 1977.

3. Harpole, G. B. A cash flow computer program to analyze investment opportunities in wood products manufacturing. USDA For. Serv. Res. Pap. 305. For. Prod. Lab., Madison, Wis.; 1978.

4. Harpole, G. B.; Hallock, H. Investment opportunity: Best opening face sawing. USDA For. Serv. Res. Pap. FPL 291. For. Prod. Lab., Madison, Wis.; 1977.

5. Ince, P. J.; Steele, P. H. EVALUE: A computer program for evaluating investments in forest products industries. USDA For. Serv. Gen. Tech. Rep. FPL-30. For. Prod. Lab., Madison, Wis.; 1980.

$$\Delta\overline{OP} = \begin{array}{c}\text{Logs processed}\\ \text{(cubic feet)}\end{array} \times \left[\left(\begin{array}{l}\text{Change in unit value due}\\ \text{to change in lumber}\\ \text{recovery factor (LRF)}\end{array}\right) + \left(\begin{array}{l}\text{Change in unit value due}\\ \text{to change in average}\\ \text{value of lumber mix}\end{array}\right)\right.$$

$$\left. - \left(\begin{array}{l}\text{Change in unit cost due}\\ \text{to expected change in}\\ \text{volume of logs processed}\end{array}\right)\right] - \left(\begin{array}{l}\text{Change in operating cost,}\\ \text{excluding taxes and}\\ \text{depreciation}\end{array}\right)$$

$$A\overline{OP} = Q\,[(\Delta\overline{LRF}(P_\ell = P_r)) + (\Delta\bar{P}_\ell * LRF') + \frac{\Delta\bar{Q}\%}{100}((\bar{P}'_\ell * LRF') + P_r(BFE - LRF') - AVC)] - \Delta\overline{OC}$$

$$\Delta\overline{OP} = \underline{\quad}\,[(\underline{\quad}\,(\underline{\quad} - \underline{\quad})) + (\underline{\quad} \times \underline{\quad}) + \underline{\quad}\,((\underline{\quad} \times \underline{\quad}) + \underline{\quad}\,(\underline{\quad} - \underline{\quad}) - \underline{\quad})] - \underline{\quad}$$

where

$\Delta\overline{OP}$ = total expected change in the profit, = ________

Q = average monthly volume of logs processed expressed in thousands of cubic feet, = ________

$\Delta\overline{LRF}$ = expected change in the lumber recovery factor,* = ________

P_ℓ = average value of lumber expressed in dollars per 1,000 board feet, = ________

P_r = equivalent residue value of 1,000 board feet of lumber, = ________

$\Delta\bar{P}_\ell$ = expected change in the value of lumber products expressed in dollars per 1,000 board feet, = ________

LRF' = lumber recovery factor after improvement project ($LRF + \Delta\overline{LRF}$), = ________

$\Delta\bar{Q}\%$ = expected percentage increase or decrease in volume of logs processed, and = ________

$\bar{P}'_\ell$ = average value of lumber after improvement project, expressed in dollars per 1,000 board feet ($P_\ell + \Delta\bar{P}_\ell$). = ________

BFE = the number of nominal board feet of lumber equivalent to 1 net cubic foot of solid wood, and = ________

AVC = average variable cost expressed in dollars per 1,000 cubic feet of log volume. = ________

$\Delta\overline{OC}$ = expected change in operating cost, before taxes and depreciation. = ________

*Lumber recovery factor, or the board feet of lumber recovered per cubic foot of log input.

Figure 2.—Worksheet for calculating project benefits (project benefits = change in operating profits).

Harpole, George B. Payback as an Investment Criterion for Sawmill Improvement Projects. USDA For. Serv. Gen. Tech. Rep. FPL-34. For. Prod. Lab., Madison, Wis.; 1983

Describes and illustrates how payback ratios are calculated, how they can be used to rank alternative improvement projects, and how to calculate the benefit value of improvement projects.

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