Tools and Techniques of Forest Finance

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Abstract.--The financial analysis process combines costs, prices, and yields with economic assumptions to develop cash flow expectations. Economic criteria computed from these cash flows are used to compare forestry investments with other options. Omissions, errors in inputs, incorrect methods or assumptions, and misuse of financial results can lead to inappropriate management decisions. Effective use of financial analyses to support forest management decisions requires an understanding of the concepts and methods used. This manuscript reviews the elements of financial analysis for forest management investments.

Keywords: forest finance, rate of return, investments, taxes, present net worth, soil rent.

Financial analyses provide information to help managers determine cost effective ways to manage forests. Many landowners want to know how profitable forest management investments are for them.

Too often in the past, forestry has been disadvantaged as an investment opportunity because it was difficult to determine just how profitable it was. Investors often had no idea whether forestry investments were good or not so good. They could not look into the Wall Street Journal to see how trees did yesterday.

Even when financial analyses are used to support forest management decisions, they are often used incorrectly. Many foresters have limited experience with techniques of financial analysis and may feel very uncomfortable using discounted cash flow methods and terms like rate of return.

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Financial Analysis Techniques

Analytical Procedures

The basic method of computing financial returns has not changed much over the last several decades. Recently, however, new information and computerized tools have made it easier to figure profits. Several steps are needed to develop a financial analysis for forestry investments. Just like building a house, analysis requires materials, tools, and know-how to produce a finished product.

Step 1: Identify all feasible treatments, including "no treatments." In this step you should outline the different investment options under consideration. When do they start and when do they end?

Step 2: Determine expected timber yields. Most forestry investments involve production of timber. You should decide how much timber will be produced and when it will be cut. Also, if other outputs are generated by the forest, the yields of these must be specified.

Step 3: Estimate costs and benefits. In this step, you develop a detailed schedule of cash flows for each investment option. You must specify when costs are paid and when income is received. Both the timing and amount of costs and benefits are important.

Step 4: Compute financial returns. Cash flows are analyzed to find different financial criteria used for judging profitability. This step requires you to specify an appropriate discount rate to adjust cash flows for the time value of money.

Step 5: Test effects of assumptions. Costs, revenues, and yields are never known for certain. In this step, you should determine the effect of errors in your estimates of these parameters on financial returns.

Step 6: Compare investment returns. When you can't invest in every possible opportunity, you must compare the results of the financial analysis to .learn which options are better than others.

Step 7: Select the best option. The final step is to select from among the investment options. Profitability is only one of the important considerations; nonfinancial factors may also be important.

Although these steps appear to be straightforward, analyses can be complicated by many factors. Each investment is different, and no hard and fast rules apply to all cases. Proper data must be used to build a realistic picture of expected cash flows. Costs and revenues must be discounted with the appropriate formulas (Gunter and Haney 1978). Those results must then be used correctly to make appropriate decisions and avoid common mistakes. Reviews of the methods commonly used to assess forestry investments are well documented in the recent literature (Gunter and Haney 1984, Hanson 1981, Thompson 1976).

Types of Financial Analyses

There are several different ways to analyze investments. The goal,. however, is always to determine if financial returns are better or worse than other available investment options. Forestry must compete for any investor's money.

Foresters and landowners are typically concerned with two types of investment questions. In each case, the investor wants to compare forestry with other investment possibilities. The first type of question asks if growing and managing a particular forest is a profitable venture. The investor is comparing two alternatives--forestry versus some other investment.

Some common type I questions might be:

- How profitable is timber growing?
- Can I make money buying land and planting trees?
- Is forestry more or less profitable than bonds?

Questions of a second type assumes some commitment has already been-made to forest ownership and management. They ask if more intensive management of an existing forest is profitable. Marginal or incremental analyses are the financial tools designed to answer these questions. They determine the profitability of additional capital above that which already has been committed.

Some common type II questions might be:

- Which is more profitable, precommercial thinning
- or managing an unthinned stand?
- Should the company spend more on site preparation?.
- Are the benefits of planting genetically improved stock worth the costs?

Another item to be considered is whether to include income taxes. For many forestry projects, taxes represent the largest single cost paid throughout the investment, even in present value terms. Taxes should always be considered if income from the project is subject to tax. Taxes do not affect projects on public lands or investments by charities and other nonprofit organizations.

Financial analyses may include or exclude inflation. With inflation, the process is termed a nominal or current-dollar analysis and all costs and revenues are specified as actual dollars in the year they occur. Without inflation, the analysis is termed a real or constant-dollar analysis. Each cost and revenue must be adjusted to remove the effects of inflation. Price indexes such as the consumer or producer price indexes are often used to adjust values for the effects of inflation.

There are pros and cons to including inflation in financial return estimates (Flick 1976, Klemperer 1979, Hotvedt 1982). When inflation is included, costs and prices projected for 20 or 30 years may seem excessively high, and perhaps difficult to believe for some inexperienced investors. At 7 percent inflation, a price of $150 per MBF today grows to almost $1150 per MBF in the 30 years it takes to grow a sawlog.

If inflation is excluded, financial returns may appear abnormally low when compared with typical market interest rates. Market returns, like bond yields and bank interest rates, must then be adjusted for inflation before comparison with forestry returns. This adjustment may also mislead or confuse inexperienced investors.

Economic Risks

The future of say forest is uncertain and profits can be affected by three sources of economic risk--natural events, market variations, and policy changes (Haney 1983, Condrell 1983, Vasievich 1983). Part or all of the timber can be lost to insects, diseases, fire, storms, and other natural hazards. Trees may grow more slowly or quickly

than indicated by yield tables. Demand for timber may be lower than expected, leading to depressed prices. State and federal policies on timber taxes may change before timber is cut. All of these factors may cause profits to be higher or lower than anticipated.

Risk is common to every investment and investors are always wise to consider the chances that things will not work out as planned. Financial analyses require that we make assumptions about future costs, prices, and timber yields. Unfortunately, even with the very best techniques, we can not predict these values with complete accuracy.

One way to account for risk is to increase the discount rate by one or more points (Foster 1979b). Higher discount rates are used if the proposed investment is perceived to be more risky than the alternatives. This common technique is somewhat arbitrary. It acknowledges an uncertain future, but fails to systematically account for potential sources of risk. Using a higher discount rate requires the investment to return more than other options to be acceptable.

Several scenarios can be developed for each investment option if sources of risk can be isolated and probabilities can be assigned. Then each scenario can be analyzed independently and assigned a probability. This method, called decision tree analysis, focuses attention on the chances that certain outcomes will prevail.

In the extreme, detailed probability distributions of costs, revenues, and yields may be used for the analysis (Engelhard and Anderson 1983). A distribution of expected financial returns can be computed by analyzing many combinations of possible inputs. The results of this approach show the chances that profits will achieve any specified level.

Another technique, called sensitivity analysis, finds out how much costs, prices, or yields must change before returns drop below some minimum level (Schweitzer 1970, Rose and Gregersen 1980). Sensitivity analyses find such thresholds as the minimum yields or maximum cost needed to get a certain rate of return or a specific present value. This method is limited because each input is considered separately and all others are held constant.

Computer Tools for Financial Analysis

Recent computer advances have produced some very effective ways to analyze forestry and other investments (Brooks et al. 1984). Computers greatly reduce the time, cost, and mathematical drudgery associated with figuring profits on forestry.

Spreadsheet programs have become very popular for financial analyses. These general-purpose business programs are flexible and easy to use. They allow the user to construct detailed scenarios to describe the timing and magnitude of cash flows from forest management. Many spreadsheet programs feature built-in financial functions such as present value and rate of return. Standard templates may be developed for typical investments where data are entered into blank cells on the spreadsheet. Output reports may be customized to meet specific needs.

Several microcomputer programs have been developed specifically to evaluate forestry investments. The analyst must enter each cost and source of revenue. The program then takes over to compute various measures of profit. Standardized financial reports are produced. Some programs include built-in yield models to estimate timber volumes and figure financial returns in one program. These programs are easy to use, compute results accurately, and are very fast.

Information on microcomputer models with financial capabilities is available from the Forest Resources Systems Institute's Software Directory (Windon and Cooney 1984).

There are many highly specialized financial programs now operating on the large computers of forest products firms. These planning programs integrate many aspects of forestry investment analysis and manage information on large forests composed of many stands. They may project timber growth; schedule harvests and management treatments; account for costs, revenues, and taxes; figure profits; rank investment options; and project budgets. These highly complex and powerful programs fill a special need for managers of large and complex forest holdings. In the future, programs like these will be available on common microcomputers.

INPUTS TO FINANCIAL ANALYSES

Financial analyses require estimates of costs, prices, yields, and other economic parameters. These inputs are critical, and results may be very sensitive to errors.

Investment Period

The terms of many forestry investments are very long. For analytical purposes, a starting point and an ending point must be established. The beginning point is set as the time the decision is made to invest. This is usually the current year, regardless of when the forest was established.

There are three common choices for the time to end investment analyses. The first option is to end the analysis when the forest is harvested. The second end is when the land and/or timber is sold and ceases to produce income. The third option is to project the investment into perpetuity. Results for each option will differ.

Costs

Many different costs must be paid to manage forests. For most analyses, include all costs from the beginning to the end of the investment period. For marginal analyses, only the additional costs of treatment should be included.

There are several sources for information on forest management costs. Large land management organizations may have good records of average costs for different treatments. Costs can be taken from published reports such as Moak

Some cost categories to consider are:

Land costs	land purchase or rent, road construction, drainage, fencing, or other improvements.
Stand establishment	site preparation, planting, direct seeding, coppice regeneration costs, or opportunity costs of leaving seed trees.
Cultural costs	precommercial thinning, control of undesirable competition, release, fertilization, pest control, and prescribed burning.
Periodic costs	property (ad valorem) taxes, management fees, maintenance of roads, boundary lines., and fences.
Sale/harvesting costs	timber cruising, sale administration, commissions, harvesting and transportation costs.
Taxes	taxes on ordinary or capital gains income, business taxes, special permits, yield or severance taxes, or other forms of tax.

Two categories of costs are often treated incorrectly in forestry investment analyses. Opportunity costs are often forgotten and left out of analyses. When some potential revenue is foregone because an investment is made, the lost revenue should be included as an opportunity cost. Marginal analyses that compare treated and untreated stand management options usually include some opportunity costs.

Sunk costs are outlays paid before the beginning point of any investment. They are not relevant to current decisions or future returns and should always be excluded from consideration.

Revenues

Forestry incomes may come from several sources. Potential sources of benefit to considered include the following categories:

Sales of products	sales of stumpage, land sales, sales, leases, or royalties from minerals, and sales of other products such as stumps or pine straw.
Use fees	hunting permits and leases, recreation fees, grazing fees, and other types of ordinary income.
Other income	tax credits, depletion, amortization, and expense deductions, and cost sharing payments.

Yields

Projections of timber yields are very important and several aspects must be considered. Yield tables or stand projections are usually used to estimate future timber volumes and values (Alig et al. 1984). Careful attention should be given to the quantity and quality of different products available for harvest. Sawtimber is worth considerably more than pulpwood per cubic foot. Therefore, errors in estimates of the product mix can greatly affect expected revenues.

Timber yields are often overestimated. Available yield tables may not reflect average losses expected in normal forests from natural hazards. if areas in roads, streams, and other unproductive areas are not deleted, yield estimates are going to be too high. Also, since yields are particularly dependent an site quality, errors in this variable may translate into spurious yields. Other errors in timber value estimates may be caused by using different log rules for sawtimber volumes and stumpage prices.

Management Schedule

Financial analyses require a schedule of management treatments to build a list of cash flows. You must specify when stand treatments and harvests are to be done in order to determine future costs and revenues.

Land Costs

A common question asked about forestry investment analyses is whether to include land costs. The answer depends on the circumstances of each investment case. Generally, land costs should be included if land must be bought or leased for the investment. Land costs should also be included if selling the land and investing the proceeds represents a viable option for the landowner.

Discount Rate

Financial analyses require several economic assumptions to account for changes in the value of money over time. A discount rate is used to adjust cash f lows for the time value of money (Guttenberg 1950, Row et.al. 1981, O'Toole, 1981, Foster, 1979a). The appropriate discount rate may be interpreted as the cost of capital or the rate of return that could be earned on the best alternative investment with a similar length and similar risk. This rate is often called the marginally acceptable rate of return or the hurdle rate. It is the minimum rate of return that the investor would accept for a successful investment project. It also is the interest rate paid on borrowed funds needed to finance the project. In most cases, the discount rate is specified in advance by the investor. If analyses are done on an after-tax basis, the discount rate should be adjusted to reflect the after-tax cost of capital or alternative return.

For forestry investments, I consider a before-tax discount rate of from 4 to 6 percent real (i.e. above inflation) to be appropriate.

Inflation Rate

Inflation increases future costs and revenues. If the results of -the analysis are to be compared with typical market interest rates or bond yields, then a long-term average inflation rate must be factored into the analysis. The average historical rate of inflation has been about 4.4 percent since 1950 and about 7.5 percent since 1970 based on the consumer price index.

Real Cost and Price Changes

Expected future costs and revenues are also influenced by relative changes in value. The market prices for some timber products, particularly softwood sawtimber, have increased more rapidly than inflation in the past and this trend is expected to continue in the future (Adams and Haynes 1985). This is not a universal effect, and prices in some areas are stronger than in other locations. Real price increases should be factored into analyses when and where they are expected. The appropriate rate of real price increase expected depends greatly on future timber supplies and demands within each timbershed. Estimates should be based on actual conditions in each region.

Income Taxes

Income taxes are important investment costs, but including taxes in analyses is often confusing. Federal tax legislation has changed the way some landowners compute timber taxes. For most landowners, all reforestation costs and some other costs must be capitalized and then recovered through depletion when timber is cut. Small landowners have the option to take an investment tax credit and then amortize reforestation costs over a 7-year period. This procedure, authorized by Public Law 96-451, can actually cause the rate of return for some forestry investments to be higher after taxes. This is caused by the early tax credits associated with the rapid write-off of establishment costs. Despite a higher rate of return, the present net worth is lower after taxes.

MEASURES OF FINANCIAL PERFORMANCE

Present Net Worth

Present net worth is the most reliable of all investment performance criteria. This measure, the difference between discounted revenues and discounted costs, is also sometimes called net present value.

Internal Rate of Return

The internal rate of return is perhaps the most revealing of all investment criteria. Internal rate of return indicates how fast profits are accrued on invested capital. It also assumes that all intermediate revenues are reinvested in a similar investment. Internal rate of return is often used to compare forestry with other investment

options. Although it is useful for such comparisons, internal rate of return is sometimes misleading and should be used with caution (Gansner and Larsen 1969).

There is no direct way to compute internal rate of return. Internal rate of return is defined mathematically as the discount rate that makes the present value of all costs just equal to the present value of all revenues. At this rate, the present net worth is zero. The usual way to determine rate of return is to graph the present net worth against several discount rates. Other ways are to use iterative algorithms such as the secant or Newton-Raphson methods to solve the present value equation.

Benefit/Cost Ratio

The benefit/cost ratio is a simple and powerful index of profitability. This ratio is computed as the present value of all benefits (numerator) divided by the present value of costs (denominator).

Interpretation of the benefit/cost ratio is straightforward. Projects with higher ratios are favored over projects with lower ratios. Projects with ratios less than 1 are unacceptable. The benefit/cost ratio depends on the discount rate, and higher rates produce lower benefit/cost ratios for most forestry projects. The ratio is always greater than I for discount rates less than the internal rate of return and always less than 1 for discount rates greater than the internal rate of return.

Payout Period

This criterion indicates how long it takes to recover the initial investment capital. The payout period can be found as the year when accumulated revenues exceed accumulated costs, without discounting. Establishment of a new forest usually requires a large initial cost and little income is generated until timber is cut. For these cases, the payout period usually does not occur until the first thinning or until sufficient timber has been sold.

Annual Equivalent Values

It is sometimes desirable to have a measure of annual profit from an investment. The present net value can be converted to a yearly amount using annuity formulas. Annual equivalent value is useful for comparing timber investments with other options that pay an annual return such as agricultural crops. It is also sometimes used to compare investments with different lengths.

Soil Expectation Value

Soil expectation value is an investment measure specific to land management activities. This measure equals the present value per acre of a forest investment extending into perpetuity and starting with bare land. This value is the maximum that could be paid for bare land and just earn the discount rate. Soil expectation value can be determined before or after tax. The maximum annual rent can be determined as the soil expectation value multiply by the interest rate.

Other Criteria

Several other financial criteria are often used for forestry investments. The composite rate of return (Marty 1970, Schallau and Wirth, 1980) is similar to the internal rate of return, but has one important difference. This rate of return assumes that early revenues are reinvested at the discount rate, rather than the internal rate of the forestry investment. The composite rate of return is also called the reinvestment rate adjusted rate of return.

Some individuals use a variety of accounting procedures to compute a production cost per unit of output to measure efficiency. In economic terms, the figure is ambiguous and misleading because costs and harvests are separated by many years. There is no standard way to compute an average cost of production per unit of forestry output and such measures should be avoided.

Comparing Investment Options

The purpose of financial analysis is to offer the investor a way to select the most appropriate options. Some landowners are only interested in selecting projects that produce the greatest profit. Other landowners may be willing to trade away some financial gain to achieve other nonmarket benefits. The process of selecting investment projects is called capital budgeting.

Project Selection

Perhaps one of the most confusing aspects of financial analysis involves deciding when one investment is to be preferred over another. Generally, the purpose of screening projects is to find the mix of investments that leads to the greatest gain. Present net worth is usually the deciding factor, but other factors may be important. Timing of cash flows, tax credits or liabilities, or compatibility with other investments also affect investment choices.

If capital is unlimited, then project selection is relatively easy. Select all projects that have a positive present net worth or a benefit/cost ratio above 1.

The process is different and more difficult when capital is limited, as is normally the case. Projects are first ranked by some criterion, then projects are selected from the top of the list until available capital is exhausted. This method works fine as long as the projects are all mutually exclusive and the choice of projects depends only on profitability. Linear programming or other methods are used when additional. constraints are placed on the selection process (Murphy 1976).

Choice of the criterion used to compare two or more investment projects is important (Fortson 1972). Generally, present net worth and benefit/cost ratio are preferred criteria for screening of investments. Rate of return is unreliable for ranking a list of potential investments and may lead to a less profitable mix.

POTENTIAL ERRORS AND LIMITATIONS

The results of financial analyses depend on the inputs used to compute measures of economic performance. Analyses can be biased toward higher or lower profits by adjusting inputs. Because many factors affect estimates of cash flow, particular attention must be paid to possible sources of error.

Errors of Omission

Perhaps the most significant and common flaw in financial analyses occurs when some significant cost or revenue is left out. This error invariably leads to incorrect estimates of present net worth and other criteria.

Errors in Inputs

When inputs are too high or too low, then results will be incorrect. Look for possible errors in costs, revenues, yields, rates of real price increases, inflation rate, or in the timing of cash flows.

Use of Inappropriate Discount Rate

Errors occur when the wrong rate is used for discounting cash flows. This can occur if a nominal rate is used for a real analysis or vice versa. Sometimes a rate is used which corresponds to an alternative investment option with substantially higher or lower risk. In some cases, the discount rate reflects the return from projects of much shorter duration than timber production.

Forestry is a long-term investment with delayed revenues. Therefore, a discount rate that is too high will underestimate profitability. Low discount rates make forestry projects appear more profitable than they may actually be.

Computational Errors

The many discounting operations needed to figure present value for complicated cash flows can cause trouble. Even experienced analysts sometimes incorrectly compute capitalization formulas or miss some arithmetic operations. Errors may also occur when incorrect formulas are used to discount future values.

Multiple Rates of Return

One problem that can occur for some investments is that the cash flow sequence may produce more than one legitimate internal rate of return. Multiple rates are more common for certain forestry cases such as when timberland is purchased and clearcut soon after. The occurrence of multiple rates of return can be detected by examining the sequence of undiscounted net revenues. If the sign (plus or minus) changes more than once over the investment period, then more than one rate of return may exist. This problem can also be found by plotting the present net worth against discount rate. Every place this curve crosses zero on the present net worth scale is a mathematically defined rate of return.

Incorrect Comparisons of Investments

Too often, forestry investments are not compared properly with other options. Comparing investments of different length, using internal rate of return to rank options, and comparing after-tax options with alternate before-tax options are a few common errors.

SUMMARY

Financial analyses of forestry investments are not difficult, but considerable skill is needed to select the proper inputs, analyze the data, and interpret the results. The process involves constructing a scenario of expected cash flows and discounting to adjust for the time value of money. The primary purpose of investment analyses is to compare options available to the investor. Common measures of investment performance, such as present net worth, rate of return, and benefit/cost ratio are used to select from among competing projects.

Foresters should become more comfortable with these methods. Perhaps then forestry can more effectively compete for the scarce capital that investors have to spend.

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Glossary

Benefit — Any positive value flowing from a forest management treatment. Financial or market benefits are those that can be quantified in monetary terms. For the purpose of analysis, only those benefits that can be defined in market terms will be considered in benefit/cost analysis. Non-market benefits will be quantified to the extent possible, but not valued in monetary terms.

Benefit/cost analysis — B/C analysis involves the comparison of forest management costs and benefits occurring over an extended period of time by discounting with an appropriate interest rate to adjust for the time-value of money. Various financial indicators are produced, including benefit/cost ratio, net present value, and rate of return. The purpose of B/C analysis is to compare the financial performance of alternative management treatments.

Cost — Any expenditure or outlay required to achieve a specific forest management objective. Costs may be payments to implement forest management guidelines as direct expenditures or foregone revenues (opportunity costs).

Economic analysis — Economic analysis (as used in this work plan) refers to evaluations of aggregate economic effects of guideline implementation on selected economic sectors. Economic analysis considers how a specific program alternative (e.g. guideline implementation) is likely to affect business performance, including production, distribution, and consumption of goods and services.

Management scenario — A sequence of activities necessary to implement a specific forest management regime. Scenarios are specified by the quantity and timing of treatments that generate costs and production of goods and services. Comparisons are usually made between management regimes that include the recommended treatments (such as integrated guidelines) and regimes that do not. Base management scenarios do not include recommended treatments and incremental or treatment scenarios include the recommended treatments. Marginal analyses evaluate the financial effects of the difference between the base and incremental scenarios.

Marginal analysis — An economic analysis that compares two mutually exclusive forest management scenarios – a scenario without the recommended treatment (the base scenario) and one with the recommended treatment. Only differences in costs and benefits between the two scenarios are used for comparison. The result of the analysis shows the effects of the treatment itself, rather than the complete management investment.