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Basic Concepts in

Forest Valuation and Investment Analysis

Edition 1.0.2

by

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Preface

Purpose. This book was originally intended to supplement lectures in forestry economics at the undergraduate level. At Mississippi State University, for example, these materials are currently used in one of the eleven major topics included in a one-semester course titled 'Forest Resource Economics.' It is also intended, however, that the book will serve as a basic reference for foresters with experience in valuation concepts and terminology. It has proven to be a valuable resource in forest valuation workshops for practicing foresters, landowners, and others interested in forestry investments.

Characteristics. Several characteristics of the book and its contents reflect its purpose as a classroom/workshop *supplement* and a *basic* reference:

- ***No attempt is made to present all possible topics in forest valuation and investment analysis.*** Omitted, for example, are extensive discussions of such topics as choosing a discount rate and accounting for risk and uncertainty. These topics are important, of course, and may be covered in a classroom or workshop setting once the 'basics' are understood. A reference section *is* included, therefore, that has citations to articles and other information for these and other specific topics.

- ***Several topics have been omitted due to orientation.*** Formulas for gradient series and other complex cash flows, for example, are not presented due to their relatively limited application in forestry. Formulas for terminating periodic series are also omitted; in most applications, even in forest-related investments with long rotations, their actual usefulness is probably very limited if the single-sum formulas are well-understood (or if computer programs are used). Finally, this book does not include tables of compounding and discounting factors. Calculators with the y^x key are readily available, and interest rates today are often stated in non-integer form. A calculator with a y^x key is needed to work the book's examples and problems – a financial calculator may be used, of course, but is not required.

• ***The emphasis is very applied, and examples and problems are used to reinforce the concepts presented.*** Students are encouraged to put their pencils to paper in working examples and problems – solutions to all problems are included in the book's final "Section" (Section 9). Extra problem sets may be used by instructors, however, to build on the basics with applications that are most relevant to their students.

• ***Blank spaces in the book are for taking notes.*** In many places in the book, blank spaces are left intentially – primarily to encourage students and other readers to make notes for future reference.

In a publication of this length and type, many decisions are necessary about the subjects and examples to include, and about the appropriate depth of discussion and illustration. To help ensure that future versions of the book are as useful and relevant as possible, therefore, the authors sincerely invite students, instructors, and other readers to comment on aspects they find helpful as well as areas that should be added, deleted, or revised.

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Basics of Compound Interest

Section 1.

Basics of Compound Interest

1.1 Introduction

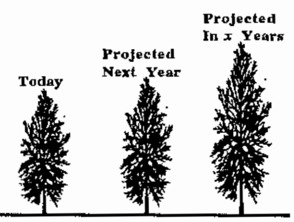
Why Bother?

Why should foresters and other natural resource managers bother learning the basics of compound interest? Why be concerned with the application of financial criteria like "present net worth" or "rate of return?" To begin understanding *why*, consider the number and variety of applications – all of the examples below can be addressed with compound interest techniques. In each example, volumes, dollar values, and population numbers are involved that occur at different points in time. ***Their time value must be considered.***

❖ *Applications – The List Is Endless*

One of the most important reasons to "bother" learning how to apply compound interest techniques in forestry is because there are so many potential applications:

- A white-tailed deer population is five times larger today than 20 years ago. What was the average annual rate of growth?
- Is the extra expense of genetically improved planting stock financially justified? What returns are expected from fertilization, herbicides, or other silvicultural treatments?
- What's the monetary value of a specific tract of timberland?
- How do you value *precommercial* timber, or merchantable timber that hasn't yet reached its greatest potential value?
- If a tract is leased to a club for hunting, or to a forest products company for growing timber, what is the value today of all payments to be received in the future?
- How can you compare relatively long-term projects and investments – like owning timberland – with alternatives that have a much shorter time frame?
- A timber stand is growing in volume at five percent per year. If the growth rate continues, what will be the total increase in volume after *x* years?



- Should you cut a specific tree or stand today or wait for the dollar value to increase? That is, will the expected increase be an attractive return on your investment?

The list of important applications is endless. It's endless because each forest stand is different (volumes, site quality, species, etc.), and each landowner or manager is different in terms of their objectives, expectations, and possible decisions. [*Given this inherent diversity, what would you conclude about the usefulness of generalizations and the need for accurate analyses that are tract- or landowner-specific?*]

You should note that some of the compound interest applications above do *not* involve money – percentage annual increases in timber volumes or wildlife populations, for example, are straightforward applications of the basic formula for compound interest. Many applications of compound interest techniques, of course, *do* involve money. Forest resources represent a capital investment and in many cases, landowners and managers are highly interested in the monetary consequences of their timber and wildlife decisions.

1.1 Introduction (continued)

❖ *Forests and The Time Value of Money*

Would you prefer to receive $100 today, or would you rather wait and receive the $100 five years from now? Most of us would choose to have the money as soon as possible, even if there is absolutely no risk or uncertainty involved. A dollar we receive or pay today is generally worth more to us than a dollar we're to receive or pay in the future – the dollar has "value" with respect to a specific point in time. The nearer to the present, the higher the dollar's "value."

[illegible]

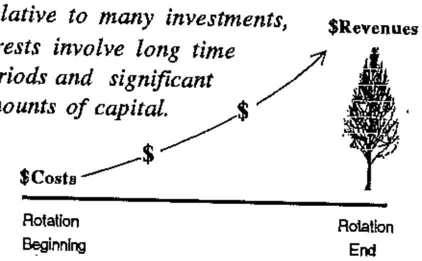
Compound interest allows us to account for the "value" of dollars that occur at different points in time. We can calculate dollars that are "equivalent" in value based on a reference year, and we can thus compare choices and make decisions about the use of funds that occur over time.

Two characteristics of forests and other natural resources make it extremely important for decision makers to be able to account for the "time value" of money:

- Decisions that affect forests and other natural resources almost always involve values that occur at different points in time. Also, the time periods involved are often much longer than with other investments.

- Second, the dollar values involved are often significant. Merchantable timber alone, for example, may represent a capital investment worth thousands of dollars per acre.

Relative to many investments, forests involve long time periods and significant amounts of capital.



❖ *Additional Reasons to "Bother" with Compound Interest*

Finally, there are other important reasons why we should understand compound interest and its use in today's society – reasons that have nothing to do with forest resources or potential timber investments. As consumers and producers in modern society, compound interest applications confront us daily:

- Mortgage payments
- Car payments
- Credit card accounts
- Personal investment decisions
- Others____________________________

Since banks and other financial institutions use the same formulas and methods that apply to forest resources, we discuss techniques and topics that apply to decisions about new cars and financial planning as well as managing forest-based assets.

1.1 Introduction (continued)

How Interest Compounds

Compound interest is quite simple to calculate, and as a general concept, is also easy to understand. Compound interest is basically *simple* interest that is charged for multiple periods of time, and where the interest is allowed to accumulate or *compound* after each period.

With *simple* interest applied to a loan, after the loan period one must pay the principal plus the interest due, and the interest due is simply the amount borrowed multiplied by the rate of interest (Figure 1).

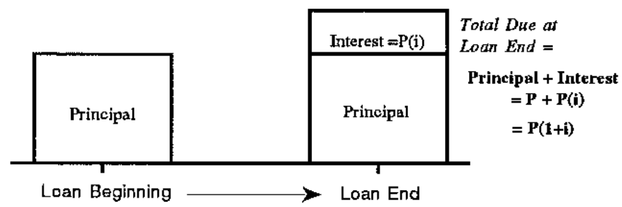
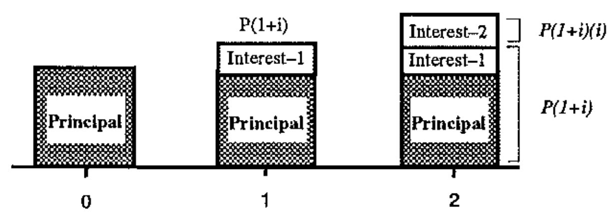


Figure 1. Simple Interest: *Total Due at Loan End =* $P(1+i)$

If the amount due (priucipal plus interest) is *not* paid after the first period, with *compound* interest, the rate is charged on the entire amount left uupaid for the next time period (Figure 2). This amount is essentially "borrowed" again, i.e., for another interest bearing period of time, aud interest is therefore paid ou interest (the interest due after the first period), as well as on the amount originally borrowed. The interest therefore *compounds.*



Total Due After Period 2 = **Principal + Interest–1 + Interest–2**

$= P(1+i) + \text{Interest–2}$

$= P(1+i) + P(1+i)(i)$

$= P(1+i)(1+i) = P(1+i)^2$

Figure 2. Compound Interest: *Total Due After n Periods =* $P(1+i)^n$

OF INTEREST: Interest is the price we pay to borrow money, or the price we charge others to borrow and use our funds. Today, interest is universally accepted as the price of capital, an asset necessary for production and consumption in modern society. It is interesting to note, however, that this has not always been the case in the past. As recently as 1950, for example, Pope Pius XII felt compelled to declare that *"bankers earn their living honestly."* This quote is in A History of Interest Rates by Sidney Homer (1977, Rutgers University Press). The book describes the Biblical condemnation of usury, centuries of controversy and debate, and the eventual acceptance by religious leaders of interest as a just compensation to lenders. Interest was originally accepted as a compensation for loss, however, rather than profit from the use of money–the word is derived from the Latin word *interesse*–"to be lost." The relatively recent acceptance of the charging of interest is indicated by the fact that not until 1836 did the Holy Office of the Catholic Church declare that *"all interest allowed by law may be taken by everyone."*

1.2 Two basic formulas

The pattern illustrated in Figure 2 for two periods of time can be extended for any number of interest bearing periods. For a loan with interest compounded annually, for example,

After *1* year ... Amount Due = (Principal)$(1+i)$
After *2* years... Amount Due = (Principal)$(1+i)^2$
After *3* years... Amount Due = (Principal)$(1+i)^3$

As stated in Figure 2, the general formula for compound interest is therefore:

Formula 1.1	*Future Value*
Future Value = (Present Value)$(1+i)^n$	

The general formula can be used to calculate the amount due on a loan, where interest is compounded for "n" periods of time, as in Figure 2. It can also be used to calculate the future value of a sum of money invested or deposited that will earn a specific rate of interest for "n" periods. *[Can you think of applications that don't involve money? What if "i" represents the rate of growth of a tree, population, etc.?]*

The *Present Value* term in Formula 1.1, therefore, may represent the amount borrowed, or it may represent the amount of money invested, deposited, or loaned to someone else. *[What is the Present Value if the formula is applied to a deer herd or a timber stand?]*

Future Value simply represents the amount of money, the number of people or animals, the quantity of timber, etc., at the *end* of the period of time considered.

[illegible]

Try to work each of the Examples below – they provide good experience in using the y^x key on your calculator. In later Sections of the book, "Problems" are also presented to reinforce concepts and techniques.

Example 1.1 — *Plant Expansion*

XYZ Company is considering a small expansion in their manufacturing facility, and a local bank has agreed to lend the company $200,000 at 10% interest, compounded annually for 5 years. If no intermediate payments are made, how much money will the firm owe the bank at the end of the loan period?

Future Value = $(\$200{,}000)(1+.10)^5$
= $(\$200{,}000)(1.10)^5$
= $322,102.00

Example 1.2 — *Stumpage Price Projection*

If stumpage prices in a given geographic area are expected to increase by 1.5% per year for the next 10 years, what are prices projected to be in 10 years if they are $180/MBF today?

Future Value = $(\$180.00)(1+.015)^{10}$
= $208.90/MBF

Example 1.3 — *Local Resources for Waterfowl*

Personnel at a wildlife refuge estimate that local resources can support an average population of 50,000 waterfowl per season. If expected growth in the population is 4% per year, will the resources be adequate to sustain 5 more years of growth? Last year's population was estimated at 40,000.

Future Value = $(40{,}000)(1+.04)^5$
= 48,666...less than capacity

What if the population grows at a compound rate of 5% per year?

Future Value = $(40{,}000)(1+.05)^5$
= 51,051...more than capacity

If the resources available to the waterfowl are expected to decrease by 10% within 10 years, would they be adequate for an average population growth of 0.5% per year?

Future Value = $(40{,}000)(1+.005)^{10}$
= 42,046...compared to resources for 50,000 - 10% = 45,000

1.2 Two basic formulas (continued)

The compound interest formula (1.1) may also be used to calculate "*present* value." The present value of a sum of money is the value today, or the value at the beginning of the time period being considered. It may be the principal on a loan, for example, or the amount spent on a piece of equipment or deposited in an interest bearing bank account.

To calculate the present valne of a sum, the compound interest formula is simply rearranged or "solved" for present value rather than future value:

Formula 1.2 — ***Present Value***

$$\textbf{Present Value} = (\textbf{Future Value})/(1+i)^n$$

Example 1.4 — ***Stand Volume 3 Years Ago***

If increment borings show that a given timber stand has recently been growing at a 5% annual rate, what was the stand volume 3 years ago? Assume the growth rate was constant at 5%; current stand volume is 8,200 board feet per acre.

Present Value $= 8{,}200 \div (1+.05)^3$
$= 7{,}083$ board feet/acre

Example 1.5 — ***Past Stumpage Values***

For tax purposes, the value of a tract of timberland must be estimated when it was inherited 14 years ago. Hardwood and pine sawtimber volumes were recorded, but there are no records of prevailing stumpage prices for the area 14 years ago. A recent study of forest products prices for the region concludes that on average (over the past 20 years), hardwood sawtimber prices have increased at an annual rate of 2.7% and pine sawtimber prices at an annual rate of 1.9%. Using these percentages, what would the estimated past values be if today's values for the stumpage are \$225/MBF for hardwood and \$245/MBF for pine?

Hardwood Price $= \$225 \div (1+.027)^{14} = \$154.95$/MBF

Softwood Price $= \$245 \div (1+.019)^{14} = \$188.25$/MBF

What simplifying assumptions does the above process involve? For example, what does this process assume about changes in timber quality?

Example 1.6 — ***Fertilization Investment***

Consider an investment in forest fertilization that will increase yield by 10 cords per acre in 12 years. If a cord of pulpwood is expected to be worth \$20 in 12 years, how much could you pay for fertilization today and earn 7 percent on the investment?

Present Value $= \$200.00 \div (1+.07)^{12}$
$= \$88.80$/acre

Example 1.7 — ***Timber Stand Improvement***

You are considering an investment of \$14 per acre in timber stand improvement. The stand will be harvested in 15 years. Using a 6 percent interest rate, how much additional harvest value must be generated to justify the investment?

Future Value $= (\$14.00)(1+.06)^{15}$
$= \$33.55$/acre

A Note on Using Financial Calculators:

Standard financial calculators often have the following keys that allow basic valuation problems to be solved quickly:

CMP	PV	FV	I	N	PMT
Compute	*Present Value*	*Future Value*	*Interest Rate*	*Number of Periods*	*Payment*

To solve Example 1.1 using such a calculator, input the known values, then compute FV:

200000 [PV]
10 [I]
5 [N]
[CMP] [FV] = *322102*

To solve Example 1.4:

8200 [FV]
5 [I]
3 [N]
[CMP] [PV] = *7083*

1.3 Basic terms and concepts

Formulas 1.1 and 1.2 may be used to calculate financial criteria for analyzing capital investment projects. There are other formulas, however, that may also be used in calculating present net values, benefit/cost ratios, and other financial criteria. These formulas are therefore the subject of Section 2.

Before proceeding, however, several concepts and terms that are basic to using the formulas should be reviewed:

❖ ***Compounding and Discounting***

When the compound interest formula is used to calculate a future value, a present value is multiplied by $(1+i)^n$ – an example of "compounding." To "compound" a number is therefore to calculate a future value with compound interest using the basic formula (1.1), or using other formulas for future value. "Discounting," meanwhile, is simply the reciprocal operation. To divide a number by $(1+i)^n$ is an example, and to calculate a present valne is therefore often referred to as "discounting." If the interest rate is positive, of course, numbers get larger and larger when they are "compounded" for longer periods of time, and they get successively smaller when "discounted" for longer periods.

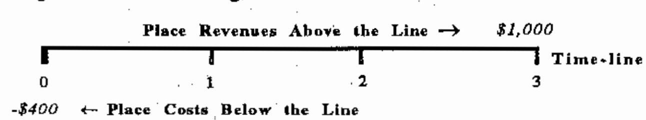
❖ ***Equivalence***

Money has a time value, and a dollar received today is not equivalent to a dollar to be received in the future. Compound interest may be used, however, to calculate sums of money that are termed "equivalent" in different time periods. For example, \$1.00 today may be referred to as "equivalent" to \$1.10 in one year if the annual interest rate is 10%, or \$1.07 if the interest rate is 7%. In general, equivalent present and future valnes are determined by compounding and discounting for a specific time with a specific rate of compound interest.

❖ ***Cash-flow Diagrams***

Once the costs and returns for a specific project are known or projected, a very useful device is to place the numbers on a "time-line" or "cash-flow" diagram. The diagram is simply a line representing the time period involved in the investment, with all of the costs and revenues placed on the line at the appropriate points (times). If the analysis involves both costs and revenues, costs are typically placed below the line and revenues above the line (Figure 3). If the analysis involves costs only, of course, it may be most convenient to place them above the time-line.

Figure 3. Cashflow diagram



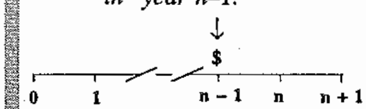
❖ ***End-of-year Assumption***

When compound interest is applied, the interest-bearing period must be specified exactly, and exact beginning and ending points must therefore be stated or understood. For example, to state that a specific revenue occurs in year 3 is ambiguous unless it is understood that "in year 3" means at a specific time in the third year. Unless stated otherwise, therefore, all of the examples and problems that follow assume that "in year n" means at the *end* of the n^{th} year.

On a cash-flow diagram, today (the present) is represented as year 0, and revenues or costs that are shown for future years are assumed to occur at the end of the specified year. To account for the time value of money between the present and year "n" therefore involves compounding or discounting for "n" compounding periods.

With the end-of-year assumption, if a sum is specified for the *beginning* of year "n," the sum should be considered as occurring at the *end* of period n-1 (and n-1 is therefore the appropriate number of periods for discounting).

A value specified for the beginning of year n should be treated as occurring "in" year n–1.



Section 2.

Formulas

Section 2.

Formulas

In Section 1, two basic formulas were derived for use with compound interest. They are repeated in Section 2 for emphasis, and also becanse they'll be used to derive additional equations – formnlas that allow efficient compounding and/or discounting of *series* of eqnal revenues or payments. After the basic, single-sum formulas, we present formulas for two types of series:

- Basic, Single-sum formulas
  ...Present and Future Value
- *Terminating Annual Series* Formulas
  ...Present and Fnture Value
- *Perpetual Series* Formulas
  ...Annnal and Periodic

NOTE: We chose not to include the formulas for terminating series that are *periodic*. The actual, marginal gain in efficiency by using terminating periodic series formulas is very small in most cases–if the single-sum formulas are well understood and efficiently applied. Formulas for gradient series and other 'complex' cash-flows have also been omitted due to their limited application in forestry problems.

Also included in this Section on **Formulas**, however, are techniques for *non-annual* compounding and discounting, and formulas for *installment payments*, "*effective*" interest rates, and "*sinking fund*" acconnts.

For convenience in working problems in later Sections, a "quick reference" or chart of the basic formulas and notation is on the last page of Section 2 (page 16), and also inside the book's back cover.

2.1 Basic, single-sum formulas

The formnlas derived in Section 1 were referred to as *the* **Future Value** formula (1.1) and *the* **Present Value** formula (1.2). They are actually the *basic* formnlas for calculating present and future values, however, and they are more appropriately referred to as the Present and Future Value, *single-sum* formulas. When using them, one applies them to individual, "single-snms" of money or other values – each cost, revenue, or other quantity is treated separately.

The basic, single-sum formnlas at right are presented as they were in Section 1, and are also presented using abbreviations for the variables. They are used in snbsection 2.2 to develop formulas for termiuating annual *series* of costs, revenues, or other numbers.

Formula 2.1	***Future Value, Single-Sum***

$$\textbf{Future Value} = (\textbf{Present Value})(1+i)^n$$

$$V_n = V_0(1+i)^n$$

Formula 2.2	***Present Value, Single-Sum***

$$\textbf{Present Value} = (\textbf{Future Value})/(1+i)^n$$

$$V_0 = V_n/(1+i)^n$$

In both formulas, the abbreviation V_n denotes a value in year n (a **Fnture Value**), and V_0 denotes a value in year 0 (a **Present Value**).

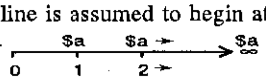
2.3 Perpetual series formulas

A *perpetual* series of costs or revenues has no end – the values are assumed to occur each year or each period *forever*. An example of where perpetual series occur is in determining the value of land – if land is being valued for property tax purposes or for growing timber, for example, a common approach is to estimate the present value of *all* future revenues and costs. The values expected in the future are discounted to the present using compound interest formulas (land "expectation" values are discussed in Section 3 – Financial Criteria).

Perpetual series may be **annual** or **periodic**, and we therefore present two formulas for present value. *[Why do we not have formulas for the* ***future*** *value of perpetual series?]*

❖ *Perpetual Annual Series*

A perpetual annual series timeline is assumed to begin at the end of year 1, and to continue each year forever.



If the present value of a *terminating* annual series (Formula 2.4) is examined closely, one sees that if "n" has an extremely high value, the terms within brackets are simplified: $(1+i)^n-1$ approaches $(1+i)^n$ as "n" approaches infinity. The terms therefore cancel out of the formula. Mathematically, we derive the present value of a *perpetual* annual series formula by taking the limit of Formula 2.4 as "n" approaches infinity:

$$V_0 = a \lim_{n \to \infty} \left[\frac{(1+i)^n - 1}{i\,(1+i)^n} \right] = \frac{a}{i}$$

Formula 2.5 — ***Present Value of a Perpetual Annual Series***

$$V_0 = \frac{a}{i}$$

Formula 2.5 can also be derived and understood intuitively. If you placed a sum of money (V_0) into an account or other investment that generates a return of i% per year, how much money would you receive at the end of each year, starting at the end of year 1? You would receive $V_0(i)$=\$a per year in perpetuity. This *is*, of course, the relationship derived above for the present value of a perpetual annual series (written in terms of "a" rather than "V_0").

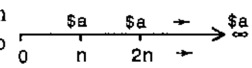
❖ *Perpetual Periodic Series*

The present value of a periodic series formula is derived using the formula for a *terminating* periodic series. Although we haven't derived or used this formula, one can see that it's simply a generalized form of the terminating annual series formula – generalized to allow "n" periods, each of which is "t" years in length. Notice, for example, that if t=1, the formula below is identical to Formula 2.4, the present value of a terminating *annual* series.

Present Value of a Terminating Periodic Series

$$V_0 = a \left[\frac{(1+i)^{nt} - 1}{[(1+i)^t - 1]\,(1+i)^{nt}} \right]$$

We derive the present value of a *perpetual* periodic series by taking the mathematical limit of the formula above as "n" approaches infinity. Terms in the numerator and denominator cancel out, and the result is greatly simplified. For consistency in notation, we allow "n" to represent the number of years per period.



Formula 2.6 — ***Present Value of a Perpetual Periodic Series***

$$V_0 = \frac{a}{(1+i)^n - 1}$$

2.3 Perpetual series formulas (continued)

Example 2.3 — *Property Taxes*

Mississippi taxes commercial forest land using a "Current Use Value" system. An average annual net return is estimated for growing timber (by site class), and this number is "capitalized" using a discount rate of 10%.

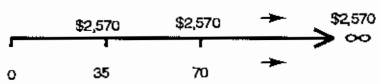
$$\text{Current Use Value} = \left[\frac{\text{Average Annual Net Returns}}{.10}\right]$$

Current Use Value is therefore consistent with determining the present value of a perpetual annual series. What is the Current Use Value of forest land in Mississippi if it has a net return of $19.50 per acre per year?

$$\text{Current Use Value} = \frac{\$19.50}{.10} = \$195.00/\text{acre}$$

Example 2.4 — *Forest Land Value*

If one expects a specific tract of land to produce net returns from timber of $2,570 per acre every 35 years, what would be the present value of the expected income stream at 6%?



$$V_0 = \frac{\$2{,}570}{(1.06)^{35} - 1} = \$384.38/\text{acre}$$

Example 2.5 — *Forest Land Value*

What would the forest land value in Example 2.4 be if the following changes are made to the cash-flow stream?

- Additional income of $2 per acre per year from hunting lease (to start at the end of year 1)
- The *first* $2,570 income from the forest occurs *now*.

$$V_0 = \frac{\$2{,}570}{(1.06)^{35} - 1} + \frac{\$2}{.06} + \$2{,}570$$

$$= \$2{,}987.71/\text{acre}$$

Problem 2.4

Expected hunting lease income on a tract is $4.00 per acre per year and expected property taxes are $3.10 per acre per year. Would the net annual income from this property be enough to offset periodic prescribed burning costs? Burning costs are $10.00/acre every 9 years. The discount rate is 7%. (Answer: See Section 9)

Problem 2.5

A state wildlife management agency allows residents to purchase a lifetime hunting and fishing permit for $200. If an annual permit currently costs $15 (and you assume the cost would remain $15), what would your discount rate have to be for you to consider this offer attractive strictly from a financial perspective? (Answer: 7.5% or less)

2.4 Non-annual compounding periods

When interest is compounded daily, monthly, quarterly, or on another basis that is non-annual, Formulas 2.1 to 2.4 need two modifications:

1) *use "i/m" for the interest rate*, where "m" is the number of compounding periods per year and "i" is the annual interest rate; and

2) *use "n*m" for the number of periods*, where "n" represents the number of years, and "m" is the number of periods per year.

Example 2.6	*Non-annual Compounding*

If \$100 is placed in an account that earns 6% interest, how much money will be in the account after 5 years if interest is compounded:

Annually... $V_5 = \$100(1.06)^5 = \underline{\$133.82}$

Quarterly... $V_5 = \$100(1+.06/4)^{5*4}$
$V_5 = \$100(1.015)^{20} = \underline{\$134.69}$

Monthly... ________________

__________ (\$134.89)

Daily... ________________

__________ (\$134.98)

In Example 2.6 and in Problem 2.6, the values obtained are influenced by the number of componnding periods per year. *[What is the pattern and why does it occur?]*

Problem 2.6

If a 5-year hunting lease specifies that you are to receive payments of \$2,000 for each of 5 years, what is the present value of the income if your discount rate is 11.5%? (Answer: \$7,299.76)

What is the present value of the income if you are to receive the payments quarterly (\$500/quarter) for 5 years? Assume the income is deposited into an account that earns an annual rate of 11.5% compounded quarterly. (Answer: \$7,525.44)

2.5 Installment payments

In the last part of Problem 2.6 on the preceding page, the present value of a series of lease payments is calculated. In this case, Formula 2.4 is used to calculate V_0, after the formula is modified for quarterly interest and quarterly payments. Formula 2.4 may also be solved for "a" directly, however, and the payment can be calculated as a fuuction of V_0, the amount borrowed:

Formula 2.7 *Annual Installment Payments*

$$a = V_0 \left[\frac{i\ (1+i)^n}{(1+i)^n - 1} \right]$$

When calculating *annual* iustallment payments, Fonnula 2.7 is used "as is." For monthly, quarterly, or other *non-annual* payments, the only modifications ueeded are to use the appropriate number of months or other periods, and the appropriate interest rate. Where APR represents the aunual percentage rate, the iustallment paymeut formula cau he restated as:

Formula 2.8 *Non-annual Installment Payments*

$$a = V_0 \left[\frac{\left(\frac{APR}{m}\right)\left(1+\frac{APR}{m}\right)^{n*m}}{\left(1+\frac{APR}{m}\right)^{n*m} - 1} \right]$$

As discussed ou page 12, iu Formula 2.8 "m" is the number of compoundiug periods per year (the number of payments per year), aud "n" is the number of years; "n*m" is therefore the total number of paymeuts iuvolved.

The annual percentage rate (APR) is sometimes stated as the monthly rate multiplied by 12. Credit card interest of 1.5% per month, for example, is an APR of 1.5*12 = 18%. As shown in Formula 2.8, however, if an APR is quoted, it should be divided by 12 to obtain the monthly rate. In general, APR is divided by "m" to obtain the appropriate rate applied to each of "m" periods per year.

Problem 2.7

What is the monthly payment necessary to repay a $100,000 real estate loan in 10 years? in 15 years? APR = 12% (Answers: $1,434.71 in 10 years, $1,200.17 in 15 years)

Problem 2.8

If you assume a monthly-payment loan on a tract of land, and the closing date for the transaction is March 31, who is responsible for the payment that is due on April 1? Why? HINT: Recall the end-of-year assumption discussed on page 6. Also note the cash-flow diagram at the top of Figure 4 on page 8.

2.6 Effective interest rates

When interest is compounded on a non-annual basis, the "APR" is not the actual or "effective" rate of interest that is paid. The effective interest rate is ***higher*** than the APR.

Consider the interest paid on credit cards at 1.5% per month, for example. If one pays 1.5% on a \$1 debt each month, the APR is 18%; after 12 compounding periods (after 1 year), however, the amount needed to pay off the debt would be $(\$1)(1.015)^{12} = \$1.1956182$. *The interest paid is actually over 19.5 cents per dollar per year* (rather than 18 cents).

In general, with "m" compounding periods per year, the effective rate of interest can be calculated from APR:

Formula 2.9	***Effective Rate of Interest***

$$\textbf{Effective Rate} = (1 + \text{APR}/m)^m - 1$$

[illegible]

Problem 2.9

The inaccuracy between APR and the effective rate of compound interest can be substantial. Formula 2.9 can be used to show that the effective rate is 19.56% on credit cards that quote APR = 18%, and 23.14% where APR = 21%, for example. *What is the effective rate of compound interest on finance company loans where APR = 28%? (Answer: 31.89%)*

"Effective" rates of interest may also be calculated for other types of loans. If "add-on" or "discount" rates are quoted, for example, the effective rate of compound interest charged may be calculated by putting the actual numbers (amount borrowed, number of payments, and the payment amount) into the installment payment formula (2.8) and solving for the rate of interest charged.

2.7 Sinking fund accounts

As a final note to this Section on *Formulas*, "sinking funds" should be considered. The basic concept of such a "fund" or account is that a specific sum of money needs to be accumulated in year "n." Perhaps, for example, we know that a piece of equipment will need to be replaced in "n" years, and we want to determine the yearly or monthly amount that should be set aside in an account so that those funds are available when needed.

Sinking fund accounts are similar to making payments to your own fund – payments that will earn interest and will therefore be compounded over time. The formnla is a rearrangement of Formula 2.3, the *Future Value of an Annual Series*. The sinking fund formula is obtained by rearranging Formula 2.3 to calculate "a" given V_n:

Formula 2.10 — ***Sinking Fund Formula***

$$a = V_n \left[\frac{i}{(1+i)^n - 1} \right]$$

For monthly or other non-annual series, the formula should be modified to use the appropriate interest rate and number of periods (as discussed in subsectiou 2.4, page 12).

Example 2.7 — ***New Computer Equipment***

A woodyard manager would like to upgrade the company's computer system next year, and would like to know the amount that would need to be set aside at the end of each month to accumulate $12,000 in 12 months. The company's checking account interest rate can be used – 5.5% compounded monthly.

Amount to Deposit Each Month

$$= \$12{,}000 \left[\frac{.055/12}{(1+.055/12)^{12} - 1} \right] = \$975.04$$

Problem 2.10

A forestry consultant would like to set aside funds to replace two pickup trucks four years from now. With the trade-in allowance expected, the consultant would like to have $25,000 available for the purchase. How much money will need to be set aside each month if the account earns a 4.5% annual rate, compounded monthly? (Answer: $476.34)

NOTE: For convenience in working forest valuation and investment analysis problems, a chart of the basic formulas and notation is printed on the next page, and also inside the book's back cover.

2.8 A quick reference to formulas and notation

Use the chart below as a quick reference to find the appropriate formula for the following cash-flow types: *Single-sums, Terminating Annual Series, and Perpetual Series–Annual and Periodic.*

Note: *If you have a* ***terminating*** *series that is* ***periodic*** *(non-annual), use the single-sum formulas to calculate present and/or future values for each number in the series separately.*

Single-sum? Yes ➤ *Are you calculating Future Value or Present Value?* ➤

Future Value *of a Single-sum*

$$V_n = V_0\ (1+i)^n$$

Present Value *of a Single-sum*

$$V_0 = \frac{V_n}{(1+i)^n}$$

Terminating Annual Series? Yes ➤ *Are you calculating Future Value or Present Value?* ➤

Future Value *of a Terminating Annual Series*

$$V_n = a \left[\frac{(1+i)^n - 1}{i}\right]$$

Present Value *of a Terminating Annual Series*

$$V_0 = a \left[\frac{(1+i)^n - 1}{i\ (1+i)^n}\right]$$

Perpetual Series? Yes ➤ *Is the perpetual series Annual or Periodic?* ➤

Present Value *of a Perpetual Annual Series*

$$V_0 = \frac{a}{i}$$

Present Value *of a Perpetual Periodic Series*

$$V_0 = \frac{a}{(1+i)^n - 1}$$

Other Formulas

Section 3.

Financial Criteria and Analysis

Section 3.

Financial Criteria and Analysis

3.1 Financial criteria

Compound interest formulas can be used to put all of the monetary benefits and costs of a specific capital project on an "equal footing." The formulas simply ensure that the time value of money is considered before sums of money are added, subtracted, or compared with other sums. Individual projects may then be assessed agaiust the costs of capital or compared with alternative uses for capital.

Several formal criteria are common in evaluating potential capital investmeuts. They are "formal" in the sense that they are calculated in a specific way. The criteria presented here are *Present Net Worth, Equivalent Annual Income, Benefit/Cost Ratio, Rate of Return, Payback Period,* and *Land Expectation Value*. Following these discussions, a separate subsection includes *Examples and Problems*.

NOTE: The "composite" or "realizable" rate of return is introduced but is not presented in detail. References on this criterion *are* included in Section 8 under the "Financial Criteria" heading.

❖ *Present Net Worth*

Present Net Worth (PNW) is very commonly used to evaluate potential capital investments. PNW is the present value of all revenues *minus* the present value of all costs (Figure 5). PNW is thus *present* because all reveuues and costs are discounted to the present with compound interest, and the criterion is *net* because the costs are subtracted from the revenues.

Other names for PNW are *Net Present Worth, Present Net Value,* and *Net Present Value.*

As stated in Figure 5, a project is acceptable if its PNW is greater than or equal to zero. Other things equal, of course, a large PNW is "better" than a PNW relatively close to zero. The criterion does not, however, indicate the relative *scale* of a project. For a specific project, for example, if a result of PNW = $100 is obtained, the result does not indicate whether the project involves a few hundred dollars or several million dollars. It merely indicates that the project is expected to yield a rate of returu greater than the interest rate used in the present value calculation.

Figure 5. Present Net Worth

To Calculate the Present Net Worth of a Project:

(1) Discount all of the project's *revenues* to the present, ➤ [Present Value of All Revenues]

(2) Discount all of the project's *costs* to the present, and ➤ – [Present Value of All Costs]

(3) Subtract the total present value of costs from the total present value of revenues ➤ PNW

Decision Rule: *The project is acceptable if PNW ≥ 0.*

3.1 Financial criteria (continued)

❖ *Equivalent Annual Income*

Projects of unequal duration can be compared by converting each project's PNW to an Equivalent Annual Income (EAI). To calculate EAI for a specific project, first calculate the project's PNW, then multiply the PNW by the installment payment factor in Formula 2.7 (see Figure 6).

Calculating an EAI is therefore analogous to responding to the question: "*If an amount equal to PNW is borrowed, what annual amount would be necessary to repay the loan?*"

EAI is thus the *annual* amount that (if received) would be *equivalent* to a project's PNW. Other names for EAI are *Annual Equivalent* and *Equal Annual Equivalent.*

Since PNW is expressed as an annual equivalent, EAI allows competing projects of different lives to be compared. Project A, for example, may have an EAI of $500 for each of 10 years, while project B has an EAI of $450 for each of 12 years. In many cases, EAI is provided as information in addition to PNW; the concept of an annual income is perhaps more readily understood than the more abstract concept of present net worth.

Figure 6. Equivalent Annual Income

[illegible]

❖ *Benefit/Cost Ratios*

Benefit/Cost (B/C) ratios are obtained by *dividing* the total present value of revenues by the total present value of costs (Figure 7). The present value computations for B/C ratios are therefore exactly the same as for the PNW criterion; with the B/C ratio, however, a *ratio* is calculated rather than a present value *difference.*

As shown in Figure 7, for a project to be acceptable, the B/C ratio should be greater than or equal to one. B/C ratios are often used by government agencies, but the criterion is not as commonly used as PNW and rate of return in evaluating capital investment projects in the private sector.

Figure 7. Benefit/Cost Ratios

(1) Discount all of the project's *revenues* to the present. ➤

$B = \left[\text{Present Value of All Revenues} \right]$

(2) Discount all of the project's *costs* to the present. ➤

$C = \left[\text{Present Value of All Costs} \right]$

(3) Divide the total present value of revenues by the total present value of costs. ➤

B/C Ratio = B ÷ C

Decision Rule:
The project is acceptable if B/C ≥ 1.

3.1 Financial criteria (continued)

❖ *Rate of Return*

The rate of return (ROR) of a project is the rate of compound interest that is "earned" by the capital invested; it is the average rate of capital appreciation during the life of the project.

ROR is calculated by finding the compound interest rate that equates the total present value of costs with the total present value of revenues (see Figure 8). Other names for ROR are *Internal Rate of Return* and *Return on Investment.*

The ROR criterion is very often used in project analysis. In fact, surveys of U.S. corporations over the last 20 years have consistently shown that ROR is the preferred choice of corporate managers for accept/reject investment decisions*. In calculating and using ROR, however, caution is necessary in some cases.

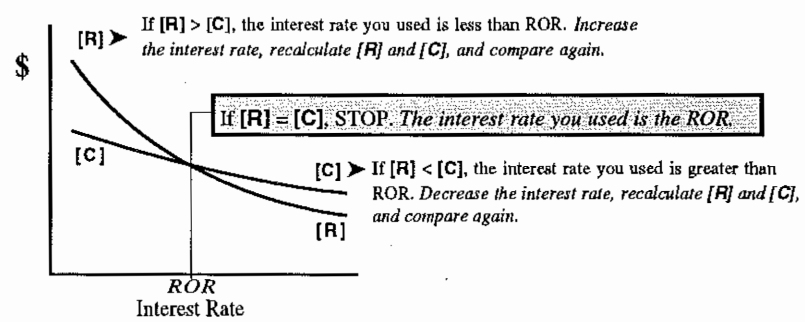
Some Cautions in Using ROR:

- For the criterion to be meaningful, there must be an initial cost, or the costs toward the beginning of the investment must be substantial enough that an average rate of capital appreciation is meaningful.
- If an analysis has revenues but costs are excluded entirely, the average rate of capital appreciation is infinite; also if costs are understated or very insignificant, the ROR will be extremely high.
- ROR does not indicate the scale of an investment.
- In some cases there may be multiple ROR's – more than one interest rate at which the present value of revenues and the present value of costs are equal.

Figure 8. Rate of Return

To Calculate the Rate of Return of a Project:
(1) Assume an initial interest rate and calculate the total present value of revenues **[R]** and the total present value of costs **[C]**.

(2) Compare **[R]** and **[C]**. Through the iterative process illustrated at right, identify the ROR – the interest rate where **[R]** equals **[C]**.



Decision Rule: *The project is acceptable if ROR ≥ the guiding rate of interest.*

*Bailes, J.C., J.F. Nielson, and S. Wendell. 1979. Capital budgeting in the forest products industry. Management Accounting 61(1):46-51, 57.

*Cubbage, F.W., and C.H. Redmond. 1985. A survey of capital budgeting in forest industry. In: Trends in Growing and Marketing Southern Timber, Proc. Symp. of the 1985 Southern Forest Economics Workers, p.190-200.

*Fremgen, J.M. 1973. Capital budgeting practices: A survey. Management Accounting 14(11):19-25.

*Gittman, L.J., and J.R. Forrester, Jr. 1977. A survey of capital budgeting techniques used by major U.S. firms. Financial Management 6(3):66-71.

*Petty, J.W., D.F. Scott, Jr., and M.M. Bird. 1975. The capital expenditure decision-making process of large corporations. The Engineering Economist 20(3):159-172.

Composite Rate of Return

The "composite" or "realizable" rate of return has been proposed as an improvement over the "internal" rate of return described above. The composite rate is calculated by: (1) compounding all intermediate cash flows to the end of the investment period (using an interest rate that reflects the actual or "realizable" potential for reinvestment), and then (2) determining the interest rate that will equate the initial costs with the compounded value of the project's cash flows. The criterion is not presented here in detail because it's not universally accepted as a useful and valid criterion for investment analysis. Articles describing the criterion and its advantages and disadvantages are included in Section 8, References, under the "Financial Criteria" heading.

3.1 Financial criteria (continued)

❖ *Rate of Return* (continued)

If a project involves only one cost and one revenue, ROR can be calculated directly, i.e., without going through the iterative process summarized in Figure 8. Where the initial cost is V_0 and the project's revenue is V_n, the basic present value of a single-sum formula $[V_0=V_n/(1+i)^n]$ can be solved for "i," the interest rate that equates V_0, the present value of costs, with $V_n/(1+i)^n$, the present value of revenue:

Formula 3.1	*ROR for One Cost & One Revenue*

$$i = \left(\frac{V_n}{V_0}\right)^{1/n} - 1$$

There are many examples of capital investments with only one cost and one revenue. Assets like real estate, for example, may be bought and sold later for a higher price, and the ROR can be calculated directly with Formula 3.1 (see Example 3.2 on the next page).

❖ *Payback Period*

The period of time it takes for an investment to "pay back" the initial costs is also a very commonly used criterion in project analysis. The criterion does not account for the time value of money, of course, since compound interest is not involved.

Payback period is included here because it is so frequently used, and because it does have at least one useful application. If projects are being evaluated and the financial criteria that *do* involve compound interest are essentially equal, the project with the shortest payback period is generally preferred since a shorter time period generally implies lower risk.

More information on the advantages and disadvantages of ROR, PNW, EAI, and other criteria is available in texts on financial analysis and engineering economy. No attempt is made here to list all of these or to advance one criterion as superior to the others in all situations.

Since this is a basic reference, the primary emphasis is on calculating the criteria and using them in basic accept/reject decisions. *All of the compound interest based criteria discussed here yield the same answer to the question of whether or not an investment is acceptable.* They do *not*, however, always yield the same investment rankings. For evaluation of mutually exclusive projects, the PNW criterion is generally recommended, but according to the surveys cited above ROR is also more frequently used in ranking competing projects.

❖ *Land Expectation Value*

Land Expectation Value (LEV) is an estimate of the value of a tract of land for growing timber. It is the present net value of *all* revenues and costs associated with growing timber on the land (not just those associated with one rotation or other time period). LEV is thus a special case of PNW – it is PNW where *all* revenues and costs are considered. LEV can be interpreted as the maximum price you can pay for a tract of land for growing timber – if you expect to earn a rate of return greater than or equal to the discount rate used to calculate LEV.

If you estimate the present net *value* of all cash flows *expected* from growing timber on a specific tract of *land*, the expected value of the land has been estimated (hence the name "Land Expectation Value"). The LEV criterion is also called "soil expectation value" and "bare land value" since many applications assume the cash flow stream begins with bare land. Also, LEV is sometimes called the "Faustmann formula." The technique was first published in 1849 by Martin Faustmann, a German forester who developed the formula to place values on bare forest land for tax purposes.

To calculate LEV for even-aged management on bare land:

- Determine all of the costs and revenues associated with the *first* rotation. These values should include initial costs of planting, site preparation, etc., as well as *all* subsequent costs and revenues.
- Place the costs and revenues on a time-line and compound all of them to the end of the rotation. Subtract the costs from the revenues.
- Use the present value of a perpetual periodic series formula to calculate the present value of an infinite series of identical rotations. (Divide by $(1+i)^n-1$ where n is the rotation length.)

$$\frac{\boxed{\text{Compounded Revenues} - \text{Compounded Costs (compounded to the end of the 1st rotation)}}}{(1+i)^n - 1}$$

LEV is the theoretically correct criterion for determining the optimal management regime and rotation age for a given species on a specific site. The optimal management strategy and age for final harvest is the combination that yields the highest value for LEV (there is an application of optimal rotation age in Section 5).

References on the theory and application of LEV are included in Section 8 under the "Financial Criteria" heading.

3.1 Financial criteria (continued)

❖ ***Examples and Problems***

Example 3.1 — *PNW, EAI, B/C, and ROR*

The added costs and benefits of relocating a wood-based production facility are being considered. From the present location, the move would involve net, initial costs of approximately $6 million, but would result in an estimated net savings in operation and transportation costs of $600,000 per year. If the producer uses a 7-year planning horizon and estimates the plant will have a market value of $5.5 million after 7 years, is the move financially acceptable? The guiding rate of interest is 9%.

$$\textbf{PNW} = \$5{,}500{,}000/1.09^7 + \$600{,}000\left[\frac{1.09^7-1}{.09(1.09)^7}\right] - \$6{,}000{,}000$$
$$= \$6{,}028{,}460 - \$6{,}000{,}000 = \mathit{\$28{,}460}$$

$$\textbf{EAI} = \$28{,}460\left[\frac{.09(1.09)^7}{1.09^7-1}\right] = \mathit{\$5{,}654.73}$$

$$\textbf{B/C} = \$6{,}028{,}460/\$6{,}000000 = \mathit{1.005}$$

Payback Period = *7 years*

ROR – the rate must be greater than 9% because the PNW calculated above was positive (present value of revenues > present value of costs). Using 9.5% and recalculating yields -

PV Revenues = $5,883,594.90
PV Costs = $6,000,000

Since the present value of revenues is less than the present value of costs at 9.5%, the ROR is less than 9.5%. From the above information, therefore, *9.0%<ROR<9.5%*; further iterations would yield an estimate of *9.1%*.

Example 3.2 — *ROR – One Cost & One Revenue*

What is the compound rate of return on a $14,000 investment that is worth $20,000 after 5 years?

$$\textbf{ROR} = (\$20{,}000/\$14{,}000)^{1/5} - 1 = \mathit{7.4\%}$$

Example 3.3 — *Deer Harvest Rates*

Deer harvests in a specific region increased from 110,000 in 1985 to 250,000 in 1993. What was the compound annual rate of growth in harvests during this 8-year period? What would the projected harvest be in the year 2000 if past trends continue?

$$\textbf{Past Rate} = (250{,}000/110{,}000)^{1/8} - 1 = \mathit{10.8\%}$$
$$\textbf{Projected to 2000} = 250{,}000(1.108)^7 = 512{,}529$$

Example 3.4 — *The "Rule of 72"*

How long will it take for your money to double in an investment that yields a 14% compound rate of return?

In this case, $V_n = 2^*V_0$, so $(1+i)^n = 2$ can be solved for "n:"

$$(1 + .14)^n = 2$$
$$(n)\ln(1.14) = \ln(2)$$
$$(\mathbf{n}) = \ln(2)/\ln(1.14) = \mathit{5.29\ years}$$

In general, the length of time for a sum to double can be estimated using the ***"Rule of 72"*** *– dividing the number 72 by the interest rate above yields an estimate of 72/14 = 5.14 years, etc.*

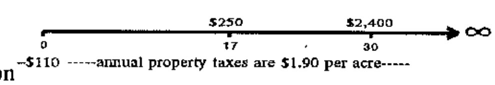
The "rule" can also be used to estimate "i," however. For a sum to double in 6 years, for example, it would take about 72/6 = 12% compound interest. The exact rate can be solved directly: $(1+i)^6 = 2$ implies that $i = 2^{1/6} - 1 = 12.25\%$.

Example 3.5 — *Land Expectation Value*

Calculate the LEV for a tract of timberland with the following assumptions:

- Establishment Cost = $110/acre
- Thinning income at age 17 = $250/acre
- Final harvest income at age 30 = $2,400/acre
- Annual property taxes = $1.90/acre
- Discount rate = 8%

The costs and revenues on the timeline are compounded to final harvest (year 30); the net value is then treated as a perpetual periodic series.



Revenues Compounded to Year 30:

$$\$250(1.08)^{13} + \$2{,}400$$
$$= \mathbf{\$3{,}079.91}$$

Costs Compounded to Year 30:

$$\$110(1.08)^{30} + \$1.90\left[\frac{1.08^{30}-1}{.08}\right]$$
$$= \mathbf{\$1{,}322.13}$$

$$\textbf{LEV} = \frac{\$3{,}079.91 - 1{,}322.13 = \mathbf{\$1{,}757.78}}{(1.08)^{30} - 1} = \mathbf{\$193.96/acre}$$

❖ ***Examples and Problems*** (continued)

Reminder: You may find it helpful to
- Draw a cash-flow diagram to illustrate values
- Use the chart of formulas inside the book's back cover
- Check your solutions with those in Section 9

Problem 3.1

Changes in a logger's equipment mix are estimated to save \$25,000 per year in total costs of operation. Over a 10-year planning horizon, what rate of return would the producer earn if \$100,000 in "upfront" costs are necessary for new materials and employee training? Would the proposed changes be acceptable if the logger's guiding rate of return is 9%? Would PNW be positive at 9%?
(Answer: ROR = 21.4%)

Problem 3.2

A tract of cut-over timberland is for sale that adjoins your property. The estimated cost of reforesting the tract to bottomland hardwoods is \$150/acre, and the expected yields are \$500/acre at age 25, \$1,000/acre at age 35, and \$4,000/acre at final harvest in year 50. You expect that hunting lease income will offset the property taxes. Based on these estimates, what can you offer as a price for the bare land if you expect to earn a 7% rate of return on your investment? (Answer: LEV = \$177.61)

Problem 3.3

To assure a steady supply of wood products at acceptable costs, a furniture manufacturer is considering purchasing a nearby hardwood lumber and dimension mill. The facility would cost \$15 million, but would save the firm an estimated \$1.4 million per year in the net cost of acquiring wood-based raw materials. If the firm uses a guiding rate of return of 10%, what would the market value of the lumber and dimension mill have to be after a 12-year period to justify its acquisition by the company? That is, what would this value have to be to assure that for the overall investment PNW ≥ 0, EAI ≥ 0, B/C ≥ 1, and ROR ≥ 10%?
(Answer: \$17,138,428)

Problem 3.4

Timber and wildlife management practices that would cost \$1,700 today are expected to result in increased revenues of \$400 eight years from now and \$3,300 fifteen years from now. Is the investment justified if the landowner's expected rate of return is 6.5%? (Answer: PNW = -\$175.18)

3.2 Analysis concepts

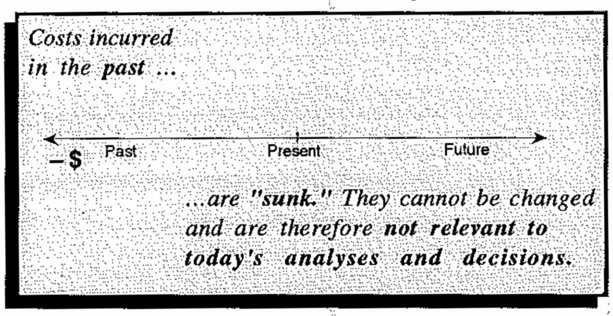
Accurate project analysis and assessment involves correct use of the formulas in Section 2 and correct calculation aud application of the financial criteria in Section 3. More issues are often involved, however, than simply using the financial information for a project in a way that is "mechanically" correct.

Two important issues – taxes and inflation – have not been considered in the examples and problems thus far. These topics are extremely important to accurate project analysis and are therefore the subject of Section 4. Other aspects of financial project analysis are also important, however:

❖ *Sunk Costs*

Project analysis is often called "marginal analysis" since only the *added* costs and *added* benefits of a poteutial investment are considered. Costs that have already been incurred, meanwhile, are "sunk" in the sense that they have already been made and cannot be changed.

"Sunk" costs are outside the realm of current decisions, and therefore should *not* be included in calculating PNW, ROR, or other financial criteria for a specific project. If you own a certain property or production facility, for example, the *past costs of the asset are irrelevant to decisions about future uses of the property*. The current value of the property, equip-ment, or other asset may be relevant, but the price paid for the asset in the past is irrelevant (other than in a historical rate of return context).



❖ *Uncertainty*

Rarely are all of the physical and financial values of a project known with certainty. Cost savings, future yields and revenues, sales and profit increases, etc., are typically estimated based ou the best information available at the time a potential project is evaluated.

Various techniques to account for uncertainty have been advanced in financial analysis and engineering economy texts and articles. See "Risk and Uncertainty" in Section 8 for references from the forestry and natural resources literature. The references include articles on techniques such as calculating "certainty equivalents," and they also include articles on whether or not you should account for risk by adjusting the discount rate upward for riskier projects.

A frequently applied means of considering the potential impacts of uncertainty is "*sensitivity analysis*" – an orderly or systematic examination of how different assumptious influence PNW, ROR, or other criteria, and therefore how they may influence the accept/reject decision for a project. You may feel there is a great deal of uncertainty in projecting timber prices at the end of a rotation that is several decades long, for example. You may also find, however, that because they are discounted for long periods, considering wide ranges of future prices in your analysis has relatively little impact on PNW or other financial criteria.

For an example application of sensitivity analysis, see sub-section 5.1 "Sensitivity analy-sis of reforestation costs."

A Specific Example of a Sunk Cost:

Last year you spent $80 per acre for site preparation and planting. You're now considering the need for a herbicide application that will increase seedling survival...

- The $80 per acre you've already spent cannot be changed and is therefore *not* relevant to your herbicide decision.
- *What is relevant?* The physical characteristics of the site and the current biological opportunities for release are quite relevant to your analysis and decision – you now have an asset that has attributes related to the site prep and planting. The actual expenses you incurred to achieve the attributes of your stand, however, cannot be changed and are *not* relevant.

3.2 Analysis concepts (continued)

❖*Discount Rates*

In several previous examples and problems, the term "*guiding rate of return*" was used instead of "discount rate." Other very common terms used to represent a rate of compound interest are "*alternative rate of return*," and "*hurdle rate*."

The appropriate rate of interest to use in forestry and natural resources analyses often depends on who owns the laud or other resource:

- **Public Agencies.** Discount rates for public agencies are often specified by law. The federal government, for example, requires that agencies use a "real" rate (uninflated) of 10% unless a special rate, formula, or other guideline is set by law. The USDA Forest Service currently uses a "real" rate of 4% for long-term investments (generally more than 10 years), and 10% for other, shorter-term investments. For further information, see the article by Row, Kaiser, and Sessions, and the USDA Forest Service Economic Analysis Manual reference under the "Discount Rates" heading in Section 8.

- **Corporations.** Publicly-held corporations usually define discount rates as a weighted average cost of capital (the cost of debt capital and the cost of equity capital weighted by the firm's percentage of debt and equity). Privately-held companies typically specify a discount rate by considering alternative uses for the capital (the "alternative" rate), or by the interest rate paid on borrowed capital.

- **Private Individuals.** Individuals may specify their discount rate by considering alternative uses for their capital – alternative rates may thus be the rate they expect to earn on other investments, or they may be the rates they are paying on borrowed capital. Each landowner is different, however, and discussion may be needed to elicit an individual landowner's preferences for money today versus money in the future. While many factors may influence an individual's rate of time preference for money, the most important one is probably their current wealth – the amount of money and other assets they already have available for current and expected needs.

Inflation and Taxes

Because of their importance in investment analysis, inflation and taxes are discussed in Section 4. It should be noted here, however, that it is extremely important in specifying a discount rate that the rate be consistent with other aspects of the analysis – *consistent in whether or not inflation and taxes are included.* [Would you expect the 4% rate specified above for long-term Forest Service investments to be consistent with a before-tax or an after-tax analysis?]

There are four options for the discount rate to use, depending on whether or not inflation and taxes are considered:

	Considering Taxes	*Not* Considering Taxes
With **Inflation**	**Nominal, After-tax** Discount Rate	**Nominal, Before-tax** Discount Rate
Excluding **Inflation**	**Real, After-tax** Discount Rate	**Real, Before-tax** Discount Rate

Terms like "nominal" and "real" and techniques for determining after-tax discount rates and other values are discussed in Section 4.

3.2 Analysis concepts (continued)

❖*Opportunity Costs*

Economic resources have value because they can be used to produce goods and services. When an economic resource is put to a particular use, it competes with alternative uses. This means the price bid for a resource must be at least as much as the resource's value in the alternative use. This alternative use is commonly called an *"opportunity cost"* – it represents opportunities (revenues or other benefits) foregone.

Two examples of opportunity cost:

- A simple illustration is a miser who has $1,000 in cash. The local bank pays 4 percent on savings accounts, but instead of using the bank the miser stores the money under his mattress for a year. For the year, the miser is foregoing the opportunity to earn: (.04)($1,000) = $40. *The $40 is the opportunity cost of hoarding the $1,000 rather than investing it in a savings account.*

- If you pay $450 cash for a rifle or shotgun, use the gun for 6 years, and then sell it for $450, would your 6 years of use be *free*? The use was free *only* if you had no alternative uses for those funds – in such a case, your "alternative rate of return" would be 0 percent. If you do have alternatives, then there is an opportunity cost associated with owning the gun. If a bank would pay you 3 percent annual interest, for example, you could have earned (.03)($450) = $13.50 each year. If you borrow money, it obviously isn't "free" because you pay interest for the right to borrow it. Neither is it "free" to use your own funds or other resources – by using them you forego opportunities to earn interest or to benefit from other uses and potential investments.

There are many examples of opportunity costs in forestry investment analysis. A very important example is the opportunity cost of **forest land**; the remainder of this subsection demonstrates the importance and proper inclnsion of land costs in an investment analysis.

When should the opportunity cost of land be included as a production cost in timberland investments?

- *If timberland has an alternative use, the potential income from that alternative use should be included as a production cost in investment analyses.* (A potential case where the opportunity cost associated with land should be omitted from the analysis is where the land *must* be devoted to forest production due to legal restrictions, provisions of inheritance, etc.)

- In "marginal" analyses such as for fertilization or potential thinnings, only the additional costs specifically associated with the activity are relevant – in such cases land opportunity cost should *not* be included.

In the following two Examples, the potential impact of land opportunity cost is shown. Example 3.6 omits land cost entirely, and in Example 3.7 the same values are used, but PNW is calculated with the assumption that the land alone has a value of $150 per acre.

Example 3.6 — ***PNW Without Land Cost***

What is the present net worth of growing trees on 40 acres of land under the following assumptions? (Values below are on a per acre basis.)

Year 0, Site Prep and Regeneration Cost: $160.00
Year 16, Thinning Income: 5 cords at $19.50 =$97.50
Year 22, Thinning Income: 8 cords at $19.50=$156.00
Year 27, Final Harvest: 66 cords at $19.50 =$1,287.00
Years 1–27, Annual Costs: $2.50
Alternative Rate of Return = 4%

The present value of the two costs is $200.82, and the present value of the three reveuues is $564.25. Therefore:

PNW = $564.25 – $200.82 = **$363.43**

3.2 Analysis concepts (continued)

❖*Opportunity Costs* (continued)

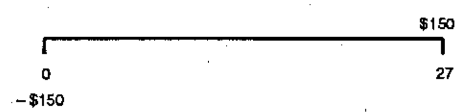
What if the landowner in Example 3.6 has the opportunity to sell the land and timber at any time during the 27-year rotation? In Example 3.7, we recalulate PNW assuming the owner uses a land value of $150 per acre.

Example 3.7	*PNW With Land Cost*

What is the present net worth of growing trees on 40 acres of land under the following assumptions? (Values below are on a per acre basis.)

Year 0, Site Prep and Regeneration Cost: $160.00
Year 16, Thinning Income: 5 cords at $19.50 =$97.50
Year 22, Thinning Income: 8 cords at $19.50=$156.00
Year 27, Final Harvest: 66 cords at $19.50 =$1,287.00
Years 1–27, Annual Costs: $2.50
Alternative Rate of Return = 4%
***The Land By Itself Can Be Sold For $150.**

Since none of the original values from Example 3.6 were changed, the present value of the two original costs is still $200.82, and the present value of the three original revenues is still $564.25. *Therefore the original value we calculated for PNW can be used, we just need to modify it to reflect the fact that the analysis now includes the land values on the time-line below*:



PNW *without* land value (from Ex.3.6) was **$363.43**, and if we incorporate the two values above, the PNW *with* land cost is:

$$\$363.43 - \$150 + \$150/(1.04)^{27}$$

$$= \$265.45$$

Does the lower PNW in Example 3.7 mean that the investment does not pay when land opportunity cost is considered? Of course not, PNW is still positive in Example 3.7. In Example 3.6, the investment earned a 4 percent rate of return *plus $363.43*. When land opportunity cost was considered, the investment earned a 4 percent ROR *plus $265.34*. The investment is still attractive – it is still earning a return greater than 4 percent.

Incorporating land opportunity cost does, however, make the investment less attractive. If you calculated the ROR for each case, you would obtain 8.7% without land costs and 6.4 percent with the cost included.

Although this is merely one Example, the basic result can be generalized:

*When calculated **with land** cost, PNW, B/C, ROR, EAI, and other financial criteria* < ***will always be less than*** < *when they are calculated **without** land cost.*

An interesting case where land cost is often omitted is in valuing land with a precommercial stand of timber. In such valuation problems, if land costs are omitted from the analysis, land with precommercial timber will be undervalued (not all of the underlying costs are considered). For further discussion of this important type of valuation problem, see subsection 5.3 "Valuing Precommercial Timber."

[illegible]

Section 4.

Inflation and Taxes

Section 4.

Inflation and Taxes

Inflation and taxes must be considered for the financial evaluation of a project to be entirely accurate. The topics are included in a separate Section to emphasize their importance, and to allow the basic concepts and issues to be discussed in an appropriate level of detail.

4.1 Inflation

The most important aspect of accounting for inflation is ***consistency*** *– either include inflation in the discount rate and in all costs and revenues, or leave it out entirely. If you're consistent, whether you include or exclude inflation won't impact the outcome of your analysis – unless the investment involves costs that are "capitalized" for tax purposes (such costs are described in subsection 4.2 Taxes). If capitalized costs are involved, inflation should be included in the discount rate and in all costs and revenues.*

Since forestry investments typically involve dollar values that occur years in the future, it's extremely important to treat inflation consistently. We stress the need for consistency because examples of *in*consistencies in forestry project analysis are relatively common, and because they can have a very negative impact on the attractiveness of forest-related investments.

Two Examples of Inconsistency in Accounting for Inflation:

- *It's inconsistent to use an inflated interest rate to discount uninflated dollar values.* This error occurs, for example, when an interest rate that includes inflation is used to discount future timber sale revenues that are obtained by multiplying future timber volumes by the prices that prevail *today* (uninflated values).
- *It's inconsistent to calculate a forestry project's ROR* ***without*** *considering inflation, and then compare the ROR with an alternative rate of interest that* ***does*** *include inflation.* Comparing an uninflated ROR for a forestry investment with the interest rate earned at a bank, for example, is inappropriate since the bank rate includes inflation – you expect to receive the rate of interest they quote regardless of the rate of inflation that occurs.

[In general, what impact would the inconsistencies above have on the attractiveness of a timber-related investment?]

Again, consistency means that inflation should either be included or excluded from all values in an analysis. If inflation is *included* in an analysis, the costs, revenues, and disconnt rate are referred to as **nominal** or in **current** dollars; if inflation is *excluded* they are said to be in **real** or **constant** dollar terms.

As an example of inflation's influence on future values, consider how a general rise in prices affects the value of a specific product like timber. If a general rise in prices canses timber that's valued at \$1,000 today to be valued at \$1,090 after one year (an increase of 9%), how much will the timber be worth after *two* years – assuming the same rate of general price increase, and assuming the same timber volume and quality? The inflation compounds each year, so the timber would be valued at $(\$1,000)(1.09)^2 =$ \$1,188.10 after the second year.

If the timber also increased in value by 5% in *real* terms, that is, over and above inflation, its value after 2 years wonld be $(\$1,000)(1.09)^2(1.05)^2 = \$1,309.88$. *The real increase and the inflationary increase are treated exactly like any other compound rate of interest in calculating the future value of a sum.*

To generalize from the specific example, the future timber value was obtained by multiplying the present value by $(1+f)^n$ and by $(1+r)^n$, where "*f*" represents the annual rate of inflation and "*r*" is the annual rate of increase in real terms. Since the future value of a single sum in general is $V_n = V_0(1+i)^n$, the relationships between the real rate of price increase, the rate of inflation, and the overall rate of compound interest can be developed.

If a real price increase of **r%** per year and an inflationary price increase of **f%** per year are involved in a future valne, the combined or overall annual rate of increase, **i%**, has two compound interest components:

$$V_n = V_0\,(1+i)^n = V_0\,(1+r)^n(1+f)^n$$

4.1 Inflation (continued)

Since $(1+i)^n = (1+r)^n(1+f)^n$, the relationships between **i**, **r**, and **f** can be defined. If n=1, then $(1+i) = (1+r)(1+f)$, and if two of the three factors are known, the third may be calculated as shown in Figure 9.

Figure 9. The rate of real price increase, the rate of inflation, and the overall rate of compound interest.

[illegible]

Using the relationships in Figure 9, and the basic formula for compound interest, inflation can be [illegible]

[illegible]

If a *pre-tax* analysis is done correctly, whether or not the analysis includes or excludes inflation makes absolutely no difference in the results (again, the important aspect is consistency – inflation should either be included entirely or excluded entirely). A future revenue (R), for example, can be specified in year "n" in real terms and discounted with a real rate of interest:

$$[PV \text{ of } R] = R/(1+r)^n$$

Or it can be inflated by "f" and discounted with the inflated rate of interest:

$$[PV \text{ of } R] = [R(1+f)^n]/[(1+r)^n(1+f)^n]$$

Since the $(1+f)^n$ term can be crossed out of the numerator and denominator of the above line, the two present value calculations are identical. In general, iuflation will cancel out of all the terms in an analysis, unless the analysis is after-tax and "capitalized" costs are involved (as discussed in subsection 4.2).

Inflation-related references are listed in Section 8 under the "Inflation" heading.

Example 4.1 — ***Inflation and PNW***

Calculate PNW for the following timber investment. Incorporate an inflation rate of 3 percent in all values in the analysis (all values below are in real terms).

- Initial Cost = \$300/acre
- Thinning Revenue = \$350/acre in year 20
- Final Harvest and Land Sale Revenue = \$3,100 in year 30
- Discount Rate = 4%

With inflation, the values are:

- Initial Cost = **\$300/acre**
- Thinning Revenue, year 20 = $\$350(1.03)^{20}$ = **\$632.14/acre**
- Final Harvest and Land Sale Revenue, year 30 = $\$3{,}100(1.03)^{30}$ = **\$7,524.51/acre**
- Discount Rate = .04 + .03 + (.04)(.03) = **.0712**

PNW = Present Value of Revenues – Present Value of Costs

$$= \frac{\$632.14}{1.0712^{20}} + \frac{\$7{,}524.51}{1.0712^{30}} - \$300 = \mathbf{\$815.52/ac.}$$

Problem 4.1

*Calculate PNW for the numbers shown in Example 4.1 in **real** terms. (Answer: PNW = \$815.52; the same result obtained with inflation included.)*

Problem 4.2

*Over the past 10 years, your timber stand has increased in value from \$20,000 to \$48,000. If inflation has averaged 4.1% per year, what has been your **real** ROR? (Answer: 4.85%) Is the investment attractive compared to a bank account that pays 5%? (Answer: The bank account yields a real rate of return of only 0.86%)*

4.2 Taxes

Taxes must also be considered to accurately represent the revenues and costs of a project, and thus to accurately assess a project's ROR, PNW, EAI, or B/C ratio.

This subsection describes correct *methods* for after-tax analysis. Because many projects involve capital investment, a very brief discussion is included on specific depreciation rules that have been in effect since passage of the 1986 Tax Reform Act. Our basic emphasis is on methods, however, since correct methods of analysis do not change with changes in tax laws – this material should therefore remain relevant as a basic reference regardless of changes in specific tax provisions from year to year. Several articles and other publications that discuss specific income tax laws relating to forestry investments are listed in Section 8, References, under the heading "Income Taxes."

To consider an investment after taxes, all revenues should be converted to an after-tax basis, all deductions, credits, and other cost-related tax savings should be considered, and an after-tax discount rate should be used. The sub-headings in this Section therefore include ***After-tax Revenues***, ***After-tax Costs***, and ***After-tax Discount Rates.***

Subsection 4.2 includes:

- *After-tax Revenues*
- *After-tax Costs*
  - Expensed Costs
  - Capitalized Costs
    1. Resource-based assets like timber
    2. "Non-wasting" assets like land
    3. "Wasting" assets like equipment
- *After-tax Discount Rates*
- *Summary of After-tax Analysis*

❖ *After-tax Revenues*

After-tax revenues are calculated by subtracting taxes due from revenues received:

$$\text{After-tax Revenue} = \left(\text{Before-tax Revenue}\right) - (\text{Tax Rate})\left(\text{Before-tax Revenue}\right)$$

$$\text{After-tax Revenue} = \left(\text{Before-tax Revenue}\right)(1 - \text{Tax Rate})$$

Example 4.2 ***After-tax Timber Sale Revenues***

A landowner receives $10,000 from a timber sale. If her marginal tax rate is 28%, what are her after-tax revenues?

After-tax revenues = $10,000(1-.28) = *$7,200*

Example 4.3 ***After-tax Hunting Lease Revenues***

Income from hunting leases is taxed as ordinary income each year. If a landowner receives $5.00 per acre per year for hunting rights, what is the income on an after-tax basis (marginal tax rate = 31%)?

After-tax revenues = $5.00(1-.31) = *$3.45/acre*

Problem 4.3

Timber and wildlife management practices that would cost $1,700 today are expected to result in increased revenues of $400 eight years from now and $3,300 fifteen years from now. *What are these revenues on an after-tax basis if the landowner is in the 28% marginal tax bracket? (Answer: $288 in eight years; $2,376 in fifteen years)*

4.2 Taxes (continued)

❖ *After-tax Costs*

Legitimate business expenses can be deducted from taxable income in calculating tax liability, and deductible costs therefore have a tax advantage. For expenses that are deductible, the actual cost, "effective" cost, or after-tax cost is the cost after the tax savings have been considered.

There are two broad types of deductible expenditures, those that may be "expensed" and those that must be "capitalized."

- **Expensed Costs:**
  To "expense" a cost is to deduct the expenditure in its entirety in the tax year in which the expenditure occurs. Some examples of costs that may be expensed are salaries and wages, utilities, supplies, and property taxes.

The after-tax cost of "expensed" items is found by determining their tax savings and subtracting the tax savings from the before-tax cost:

[illegible]

Example 4.4	*Expensed Costs After Taxes*

If the landowner's $1,700 cost in Problem 4.3 could be expensed for tax purposes, what is the "effective" cost *per dollar* of initial expense? The marginal tax rate is 28%.

Effective cost per dollar of expense is ($1)(1-.28)=72 cents. The after-tax cost of the entire expense is $1,700(1-.28)=$1,224.00. If the $1,700 cost had not been incurred, the landowner would have paid $476 more in taxes.

Problem 4.4

What is the landowner's after-tax PNW and rate of return in Problem 4.3 (assuming the $1,700 cost can be expensed)? (Answer: $172.10)

Problem 4.5

List forestry-related items whose cost can be expensed, then list the before- and after-tax cost of each item (assume an appropriate tax rate).

Item	Before-tax Cost	After-tax Cost
1. Dibble	$23.00	$15.87
[31% tax rate: After-tax Cost = ($23)x(1-.31)]		
2. ______		
3. ______		
4. ______		

4.2 Taxes (continued)

❖ *After-tax Costs* (continued)

- **Capitalized Costs:**
  *Costs that are **not** deducted entirely in the year they occur are "capitalized."* For record-keeping purposes, they are assigned to a capital account or "basis," and they are deducted in one of three ways:

  1. *Certain resource-based assets* like oil, gas, and timber – costs are deducted as the asset is used or "depleted."

  2. *"Non-wasting" assets* like land – costs are deducted when the asset is sold.

  3. *"Wasting" assets* like buildings and equipment – costs are deducted as the asset depreciates; the schedule for depreciation deductions is defined based on the type of asset and the expected length of service.

Timberland includes both timber *and* land (numbers 1 and 2 above), and for a specific property, initial costs as well as subsequent costs must be allocated between a *land account* and a *depletion account*:

Land Account	Depletion Account
Deduct this cost from the income obtained when the land is sold.	*Deduct as the timber is sold – depleted. For partial sales, calculate a depletion allowance; adjust the "basis."*

- The *depletion rate* is the amount you can deduct *per unit* of volume cut –
  = (Basis for Depletion ÷ Total Volume) x (Vol. Cut)

- The "*depletion allowance*" is the amount you can deduct after a specific timber sale –
  = (Depletion Rate)x(Volume Cut)

NOTE: A simple interpretation of the depletion allowance for a given timber sale is to deduct a percentage of the basis equal to the percentage of the timber that is harvested: if 100% of the timber is cut, deduct 100% of the basis; if a thinning removes 30% of the volume, deduct 30%; etc.

Example 4.5 — ***Timber Depletion***

A landowner has \$20,000 in the basis for depletion on a specific tract (and \$15,500 in the land account). This year the landowner sells half of the timber volume for \$32,000, and would like to know how much money he can deduct from the timber sale income. Also, what is the *adjusted* basis for depletion?

Since 50% of the volume is harvested, 50% of the basis for depletion can be deducted (the deduction is therefore \$10,000).

Calculating the depletion rate and allowance directly yields the same result–

Assume the tract had 160 MBF of timber prior to the sale

Depletion Allowance =
(\$20,000÷160MBF) x (80MBF Cut)
= \$10,000

The "adjusted" basis for depletion is simply the original basis minus the amonnt deducted –

Adjusted Basis = \$20,000 - \$10,000
= \$10,000

After the timber sale, the landowner still has \$15,500 in the land account – which can be deducted when the land is sold, and \$10,000 in the depletion account.

- The basis for depletion is also adjusted when costs are incurred that must be capitalized. Regeneration and other stand establishment costs, as well as any other timber-related costs that must be capitalized are *added* to the property's basis for depletion. **[NOTE:** Specific tax incentives may apply to certain regeneration costs incurred by private landowners. In financial analysis, costs eligible for these incentives are treated in a manner similar to depreciation rather than depletion – Problem 4.8 provides an application of the after-tax cost of reforestation when the tax incentives apply.]

- In actual practice, the depletion account includes sub-accounts for merchantable and pre-merchantable timber.

- For timberland or other property that is inherited, the basis is the property's fair market value when inherited.

4.2 Taxes (continued)

❖ ***After-tax Costs*** (continued)

The third type of capitalized cost was "wasting" assets like buildings and equipment – assets whose costs are deducted as they depreciate.

In the following examples, after-tax costs are calculated for items whose cost must be capitalized for income tax purposes. *The effective cost is the after-tax present value of costs* – since income tax deductions from depreciation occur in the *future*, their tax savings mnst be discounted to the present and subtracted from the original cost.

As shown earlier, a deduction reduces tax liability by (Tax Rate)x(Deduction), and the *effective cost of an item whose cost is capitalized is therefore:*

$$\begin{pmatrix}\text{After-tax}\\ \text{Cost}\end{pmatrix} = \begin{pmatrix}\text{Before-tax}\\ \text{Cost}\end{pmatrix} - \sum_{n=0}^{d}\left[\frac{(\text{Tax Rate})(\text{Deduction}_n)}{(1+i)^n}\right]$$

In the notation above, "d" is the number of depreciation deductions involved. Example 4.6 demonstrates the after-tax procedure for capitalized costs of computer equipment; Problem 4.7 applies the procedure to office furniture and Problem 4.8 to reforestation expenses.

It should be noted that if the analysis includes capitalized costs, the discount rate and all other values (costs and revenues) should include inflation. The analysis otherwise would not reflect the "equity erosion" that inflation causes in the basis for deduction. Also, the discount rate should be "tax-adjnsted;" that is, an after-tax discount rate should be used [as discussed in the next subsection, the after-tax rate is (Before-tax Rate)(1-Tax Rate)].

4.2 Taxes (continued)

❖ ***After-tax Costs*** (continued)

Example 4.6 *Computer Equipment After Taxes*

On an after-tax basis, what is the present value of the cost of computer equipment per dollar of actual expense for a producer in the 34% tax bracket? The producer uses a before-tax discount rate of 10%, and the rate used below is the tax adjusted rate of (10%)x(1-.34) = 6.6%.

Computer equipment is in the 5-year class of property, and the present value of depreciation deductions is:

Year	Tax Savings	PV (6.6%)
1	($1)(.2000)(.34)	.06379
2	($1)(.3200)(.34)	.09574
3	($1)(.1920)(.34)	.05389
4	($1)(.1152)(.34)	.03033
5	($1)(.1152)(.34)	.02845
6	($1)(.0576)(.34)	.01335
Total PV of Depreciation Savings =		*.28555*

The After-tax Present Value of Costs =
(Before-tax Cost)- (PV of Tax Savings)
= $1 - .28555 = .71445

The present value of computer equipment purchases is about 71 cents per dollar of expenditure. A $16,000 computer system that is fully capitalized would therefore have an "effective" cost of: ($16,000)x(.71445)=$11,431.20.

Problem 4.6

*Would the value of 71 cents per dollar that was derived in the example above apply to **any** equipment purchased by the producer? Would the value apply to any 5-year property purchased by other producers or individuals? Why?*

Problem 4.7

On an after-tax basis, what is the present value of the cost of new office furniture per dollar of actual expense for a manufacturer in the 34% tax bracket? The firm uses a before-tax discount rate of 11%, and the rate used below should therefore be (11%)x(1-.34) = 7.27%.

Note that office furniture is in the 7-year class of property and the present value of depreciation deductions must list 8 values –

Year	Tax Savings	PV(7.26%)
___	________	.04530
___	________	________
___	________	________
___	________	________
___	________	________
___	________	________
___	________	________
___	________	________
Total PV of Depreciation Savings =		________

The present value of office furniture purchases is 73.349 cents per dollar of expenditure. New office furniture with an out-of-pocket cost of $25,000 would therefore have an effective cost of ($25,000)x(.73349) = $18,337.25.

Problem 4.8

Federal tax incentives for reforestation include a tax credit, and a series of deductions. If a 10% credit is claimed, and if 95% of the reforestation costs are deducted as shown below, what is the effective cost per dollar of initial expense? (Tax rate = 28%, after tax discount rate = 7.2%)

Year	Item	Tax Savings	Present Value
0	Credit–10%	.10	.10
0	Deduction–1/14th of .95	.0679(.28)	.0190
1	Deduction–1/7th of .95	.1358(.28)	.0355
2	Deduction–1/7th of .95	.1358(.28)	____
3	Deductiou–1/7th of .95	.1358(.28)	____
4	Deduction–1/7th of .95	.1358(.28)	____
5	Deduction–1/7th of .95	.1358(.28)	____
6	Deduction–1/7th of .95	.1358(.28)	____
7	Deduction–1/14th of .95	.0679(.28)	____
	Total Present Value of Tax Savings =		______
	Effective Cost per Dollar of Expense =		______

4.2 Taxes (continued)

❖ *After-tax Costs* (continued)

The after-tax cost of depreciable assets is calculated *per dollar* of initial cost in the preceding examples and problems, and the values calculated are therefore *multipliers*.

One multiplies .73357, for example, by the initial cost of the office furniture in Problem 4.7, and the same multiplier would apply for the after-tax cost of *any* item of 7-year property where the marginal tax rate was 34% and the before-tax discount rate was 11%.

Table 2 includes multipliers for 5- and 7-year property for other discount rates and tax rates. The numbers were calculated exactly as demonstrated in the preceding Examples and Problems.

Table 2

[illegible]

[illegible]	[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

❖ *After-tax Discount Rate*

Interest paid on business-related loans is deductible from income for tax purposes. The interest is deducted in the year it is paid, i.e., it is expensed, and the after-tax "cost" of interest is therefore determined exactly like the after-tax cost of any other expensed item:

(After-tax Discount Rate) = (Before-tax Rate)(1 − Tax Rate)

If interest is *received*, taxes must be paid on the income, and the after-tax rate of interest is also reflected by the above. If 10% interest is received by an individual in the 28% tax bracket, for example, the individual retains 1-.28 = 72% of the 10% – the after-tax rate of return is 7.2%.

❖ *Summary of After-tax Analysis*

To account for taxes in forestry or other investment analyses, convert all costs and revenues to an after-tax basis, and calculate all present values using an after-tax alternative rate of return. If the investment has any costs that must be capitalized for tax purposes, the discount rate and all costs and revenues should include inflation.

[illegible]

The Examples and Problems in this Section demonstrated each of the above "steps." For detailed applications of after-tax investment analysis, however, see appropriate references in subsection 5.5 "Some references to published applications." For more information on income taxes and forestry investments, see the references listed in subsection 8.2 under the "income tax" heading.

Section 5.

Applications

Section 5.

Applications

This Section has four applications of valuation and investment analysis techniques. These particular applications were chosen because they clarify important basic concepts, and because they are types of applications we've often been asked about in continuing education workshops.

The final subsection, **"Some references to published applications,"** provides citations to published analyses of specific forestry investments.

5.1 Sensitivity analysis of reforestation costs

Our simple financial analyses thus far have assumed we know the value of key variables such as reforestation cost, stumpage prices, yields, length of rotation, and interest rate. Of course, in many analyses several of the values may not be known with certainty, and reasonable assumptions must be made.

When you perform a financial analysis, prudence requires you evaluate how sensitive your results are to the many assumptions in the model. In most applications there is no need for calculus or sophisticated mathematical analysis. Simply modifying the key variables, one at a time, will easily illustrate how important each assumed value is to the PNW, ROR, or other criterion you've calculated.

There are at least two analysis situations where you definitely should assess the sensitivity of your results to potential changes in the values that were used:

- *If you are highly uncertain of the exact value(s) of one or more key variables in the analysis (the following discussion helps identify which variables may be critical).*
- *If your PNW, B/C or other financial result is marginal in acceptability (for example, if PNW is near 0, B/C near 1, etc.) In such cases, the accept/reject decision for the investment may be "sensitive" to changes in key values in the analysis .*

❖ *Basic Concepts*

The influence of major variables can be seen in a simple present net worth calculation. Consider only the front-end costs of reforestation and the harvest value of the timber yield. The present net worth of one rotation for this simple example is:

$$PNW = \frac{HV}{(1 + i)^n} - RC$$

where HV = Harvest Value,
RC = Reforestation Cost, and
n = rotation length, in years.

This relation merely says that the present net worth of a reforestation investment is the discounted harvest value minus the cost of site preparation and regeneration. Our simple example includes the four major variables that affect the economics of reforestation (i, n, HV, and RC).

The **interest rate**, "i," is one of the most important variables affecting reforestation decisions. When compounding or discounting over a rotation of many years, a small change in the interest rate can make a great difference in an investment's PNW, B/C, etc. The choice of an appropriate interest rate is therefore a key decision affecting forestry investment analysis. *If the interest variable changes, through a change in time preference (how soon you need cash), market rates, or land ownership, forestry investment decisions may change dramatically.*

Likewise, the **rotation length**, "n," or the length of the investment, will have a major impact on the compounding and discounting of investment dollars. The present value of revenues is inversely related to the interest rate, and will also decrease as "n" increases, unless increased stand age brings quality or product changes whose value differences more than offset the discounting effects of interest.

Site preparation and regeneration costs, "RC," occur at the beginning of the rotation. In calculating PNW for forestry investments, site preparation and regeneration costs undergo little discounting – if they ocur in year 0, of course, they are not discounted at all. Front-end costs can therefore be *very* critical in influencing financial criteria like PNW in forestry investments. *This important type of cost is critical to the financial criteria we calculate, but since they occur at the beginning of the investment, they are near the present and can usually be estimated accurately.*

5.2 Determining rotation length

Optimal rotation age is commonly determined using one of the decision criteria we've discussed – usually PNW, ROR, or LEV. To determine the best rotation age, timber growth and yield values are necessary; future revenues depend on expected yields. In our example, we use the following simple yield relationship:

Age	Yield (cords/ac.)
10	13.4
15	38.4
20	54.0
25	67.9
30	76.8

You may be familiar with the term *mean annual increment*. Mean annual increment is simply the average volume of wood grown each year (average annual growth). Or, in formula form:

$$\mathbf{MAI} = \frac{Y}{r}$$

where MAI = Mean Annual Increment,
Y = yield at rotation age, and
r = rotation age.

The rotation age that maximizes MAI will maximize wood yield from a stand over time. It is often used by public agencies in rotation determination.

Optimal rotation using MAI: 25 years

Using 5-year age increments, MAI is maximized at age 25. Therefore, if you managed the stand for an infinite series of rotations, you'd produce the greatest total volume of wood over time by harvesting and regenerating at age 25.

In this application, we calculate optimal rotation length using:

- ***Mean Annual Increment***
- ***Present Net Worth***
- ***Rate of Return***, and
- ***Land Expectation Value***

Is MAI the best criterion for determining optimal rotation length? *MAI is the best criterion if the time value of your money is 0*, i.e., if you have no alternative uses for your resources. As you can see, MAI simply considers physical timber growth and does not reflect the time value of money.

When financial considerations as well as growth and yield relationships are considered, an optimal rotation length *shorter* than maximum MAI is usually calculated. This results because financial criteria reflect initial costs and the financial advantage of receiving early harvest revenues.

In the remainder of this subsection, we present the optimal rotation length based on PNW, ROR, and LEV (criteria that *do* consider the time value of money). In each of the following cases, we used the simple yield relationship above, and we used these additional values:

- pulpwood price = $16/cord
- site preparation/regeneration cost = $80/acre
- annual management cost = $1/acre, and
- discount rate = 6%.

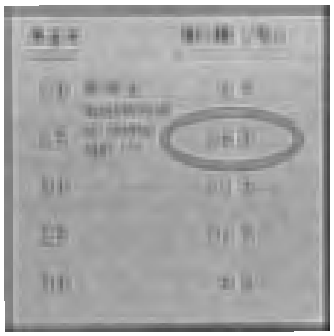
[*In the following, note that PNW, ROR, and LEV do not provide identical answers to the question of optimal rotation age.*]

5.2 Determining rotation length (continued)

Optimal rotation using PNW: 20 years

Age	Yield (cds./ac.)	Money Yield	Discounted Money Yield	Site Prep/ Regeneration Costs	Discounted Annual Costs		Present Net Worth
			(a)	(b)	(c)		(a) – (b) – (c)
10	13.4	$214.40	$119.72	$80.00	$7.36		$32.40
15	38.4	614.40	256.37	80.00	9.71	*PNW is maximized*	166.66
20	54.0	864.00	269.40	80.00	11.47	*at stand age 20...*	177.93
25	67.9	1,086.40	253.13	80.00	12.78		160.35
30	76.8	1,228.80	213.95	80.00	13.76		120.19

Optimal rotation using ROR: 15 years



NOTE: Using compound interest formulas, you should be able to replicate the numbers shown here. The letters in parentheses above columns are to clarify calculations of PNW and LEV.

Optimal rotation using LEV: 15 years

Age	Yield (cds./ac.)	Money Yield	Compounded Establishment Costs	Compounded Annual Costs	Net Value at Rotation End		LEV
		(a)	(b)	(c)	(d) = (a) – (b) – (c)		$(d)/[(1.06)^n - 1]$
10	13.4	$214.40	$143.27	$13.18	$57.95	*LEV is maximized*	$73.27
15	38.4	614.40	191.72	23.28	399.40	*at stand age 15...*	285.99
20	54.0	864.00	256.57	36.79	570.64		258.55
25	67.9	1,086.40	343.35	54.86	688.19		209.06
30	76.8	1,228.80	459.48	79.06	690.26		145.52

5.2 Determining rotation length (continued)

Summary of optimal rotation results:

Age	Yield (cds./ac.)	MAI (cds./ac.)	Present Net Worth	ROR (%)	LEV
10	13.4	1.34	$32.40	9.5	$73.27
15	38.4	2.56	166.66	14.0	285.99
20	54.0	2.70	177.93	11.9	258.55
25	67.9	2.72	160.35	10.5	209.06
30	76.8	2.56	120.19	9.1	145.52

MAI is maximized at stand age 25... *PNW is maximized at stand age 20...* *ROR is maximized at stand age 15...* *LEV is maximized at stand age 15...*

Note that the optimal rotation ages using the economic criteria, PNW, ROR, and LEV, are all shorter than the one obtained by maximizing MAI. As stated earlier, shorter rotations are to be expected using these criteria because they consider the time value of money.

Why is there a difference between the optimal rotations using the economic criteria? The difference arises because of the underlying assumptions of each criterion:

PNW in the above example is the discounted net worth or value of *one* rotation. Since only one stand of trees is considered, there is no incentive to harvest the stand so that the next stand can begin. Hence the optimal rotation is longer using this criterion than if subsequent stands are also considered.

LEV is the present value of net income from *all* future stands of timber. Recall from Section 3 that the criterion assumes an infinite series of rotations; the criterion therefore will result in a shorter optimal rotation than if only one stand is considered. *Because LEV considers all net income, it is the most valid economic criterion for setting rotation age.*

ROR maximization simply produces the rotation that yields the greatest *rate* of return on the initial reforestation investment. The criterion is not recommended for optimal rotation determination.

Each economic criterion reflects different management objectives. PNW's objective is to maximize the present net worth of the future cash flows from one rotation, LEV's objective is to maximize bare land value, the present worth of all future net income, and ROR's objective is to maximize the rate of return on investment.

Problem 5.1

Below is a yield table for planted loblolly pine on an average site in eastern Virginia. Calculate the best rotation length using the MAI, PNW, ROR, and LEV criteria. Assume establishment costs for a loblolly pine plantation in eastern Virginia are $100 per acre and annual management costs and property taxes are $2 per acre per year. Stumpage price is 20¢ per cubic foot. Cost of capital is 3%. (Results are in Section 9.)

Rotation Age	Yield per acre (cubic feet)
15	1,217
20	2,135
25	2,968
30	3,715
35	4,379
40	4,958

5.3 Valuing a precommercial forest stand

Precommercial timber poses a difficult valuation question. It has value, but by definition has no current potential for conversion to timber products. The value is intrinsic and can be represented by the discounted cash flow expected from future timber harvests.

Precommercial timber's value can also be represented by its temporal progression towards mature commercial timber. Primarily, tbis value results from the sunk cost of stand establishment and the opportunity cost of holding land to grow trees.

❖ *Seller's Value Versus Buyer's Value*

Two methods are commonly used to value precommercial timber (see Foster's *Forest Farmer* article cited in Section 8.2):

- **"Seller's value"** is based on compounding all production costs at a specified interest rate – usually the historical market rate over the time period involved. This represents a *minimum* value for the seller, i.e., the seller would accept no less than this compounded value.

- **"Buyer's value"** is based on discounting all of the projected timber sale revenues to the present – often using the current market interest rate or an estimate of expected interest rates over the projection period. This value represents the *maximum* a buyer would be willing to pay for a precommercial stand.

Obviously, when compounding or discounting over the long time periods common for forestry investments, the choice of an interest rate is crucial to the valuation process. In many cases, buyer's and seller's values are determined using different interest rates, but even if the same interest rate is used, inconsistent results may occur.

As will be discussed, the appropriate interest rate for precommercial stand valuation is the internal rate of return, ROR, of the timber investment. If the interest rate used for compounding and discounting equals the ROR, the buyer's value will equal the seller's value at every stand age.

In the following discussion, inflation is not specifically factored into the analysis. Standard computational techniques can be used to account for inflation in the model described, but discussing inflation would unnecessarily complicate this discussion of opportunity cost.

❖ *Illustration of Buyer's and Seller's Values*

Listed below is a typical cash flow generated by a southern pine plantation.

Year	Item	Cash Flow Per Acre
0	Site Prep/Planting	–$150.00
1-25	Annual Property Tax and Management Fee	–3.50
1-25	Annual Hunting Lease	+3.50
25	Net Harvest Revenue	+2,550.00

Annual expenses equal annual revenues (a reasonable assnmption that doesn't affect the analysis). Also, intermediate costs and intermediate harvest revenues are not projected; this allows for simpler graphics, but doesn't impact the analytical results.

The concepts illustrated here work equally well with plantations or naturally regenerated stands – establishment costs for natural stands may be simulated by using establishment costs estimated for planted stands of similar forest type and stocking (note, however, that the Internal Revenue Service would probably not accept such a simulation).

The concepts of buyer and seller's values are illustrated for our example in Figure 10 on the next page.

5.3 Valuing a precommercial forest stand
(continued)

If establishment costs in our example are compounded to year 12 at 8% interest, the plantation has a seller's value of $377.73. However, discounting the net harvest revenue at 8% produces a buyer's value of $937.63. The $559.90 difference represents the inconsistency mentioned on the previous page – *unless the interest rate used to compute buyer's and seller's value is the ROR of the underlying timberland investment, this inconsistency will occur.*

Since this plantation investment has only one cost and one revenue, the ROR can be calculated easily – using Formula 3.1 on page 20: ROR = $(2{,}550/150)^{1/25} - 1$ = 12%. When buyer's and seller's values are computed using the 12% ROR, Figure 10 shows complete consistency. The 12-year old precommercial pine plantation would be valued at $584.40 in the example.

The lowest value the seller will accept, to recoup planting cost at his 8% alternative rate of return is $377.73. If the buyer also has an 8% alternative rate of return, she will pay no more than $937.63. The negotiating range is the $559.90 difference between the buyer's and seller's values. If the buyer's value had exceeded the seller's value, no negotiating range would exist.

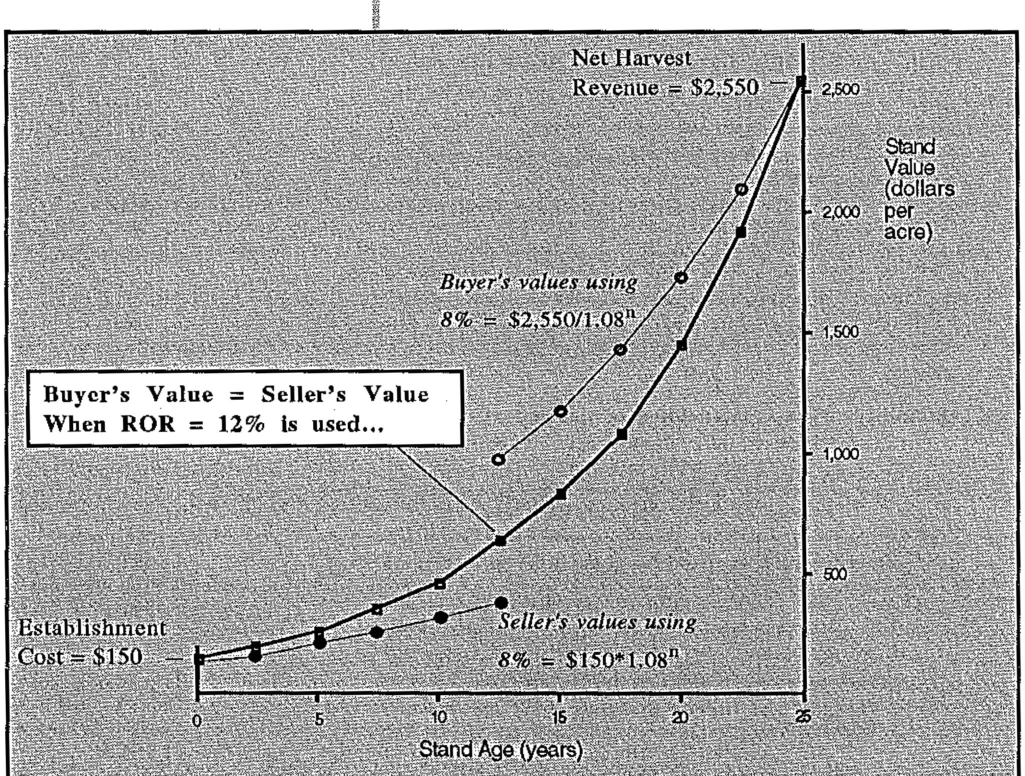


Figure 10. Seller's and buyer's values for the southern pine plantation example.

Forest management plans are required for sound forest management and investment decisions. Profesionally prepared plans will list by year all scheduled activities and related costs and revenues. This equates into the cash flows from which an ROR can be calculated.

The value determined using the interest rate equal to ROR will produce an equitable valuation of precommercial timber. In the example this occurs at a selling price of $584.40 per acre at stand age 12.

5.3 Valuing a precommercial forest stand
(continued)

❖ ***Land Opportunity Cost***

The general importance of land opportunity cost was discussed in subsection 3.2. The omission of land opportunity cost as a production cost has caused many stands of precommercial timber to be undervalued.

Returning to the pine plantaion example, let's assume a land value of $400 per acre for the stand. If land value remains constant over the 25-year investment period, the initial investment becomes $150 + $400 = $550, and the net harvest and land value becomes $2,550 + $400 = $2,950. The ROR of the pine plantation investment is:

$$\text{ROR} = (2{,}950/550)^{1/25} - 1 = 6.95\%.$$

If 6.95% is used to evaluate this investment, the seller incurs an annual land rent opportunity cost of $27.80 (calculated as 6.95% of $400). This annual opportunity cost should be added to the seller's value to determine tbe land value that will produce his minimum required return. At age 12, the $400 per acre land opportunity cost causes the value of the precommercial timber to increase from $584.40 to $831.78, a 42% increase.

References on this important topic are under the ❖ ***Valuing Precommercial Timber*** *heading in subsection 8.2.*

Figure 11 illustrates the effects of land opportunity cost on the value of our example precommercial stand at age 12. It should be noted that the value of the precommercial stand is higher when land cost is considered at all stand ages except final harvest age (no land rent is incurred and stand value is the net harvest value).

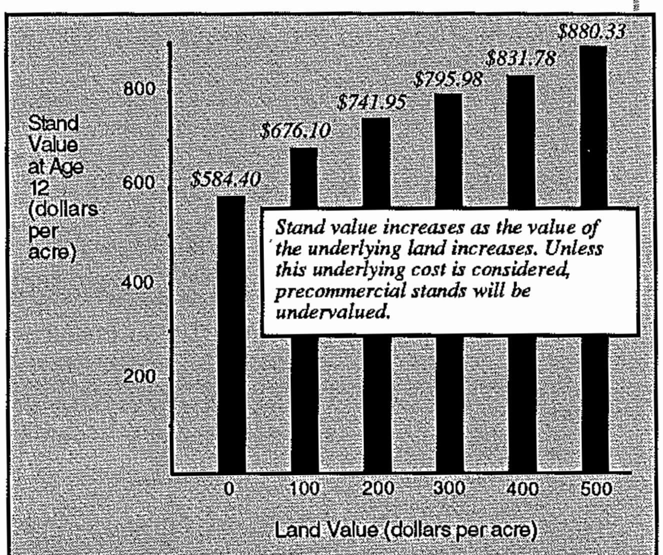


Figure 11. Stand value at stand age 12 using land values from 0 to $500.

The stand values in Figure 11 were calculated by:

(1) Considering land cost in calculating ROR...

$$\text{ROR} = \left(\frac{\text{Land Cost} + \text{Harvest Value}}{\text{Land Cost} + \text{Establishment Cost}}\right)^{1/25} - 1$$

(2) Calculating annual land rent as (Land Cost) x (ROR), and

(3) Including the annual land rent (opportunity cost for land) in the stand values calculated at age 12...

$$\text{Stand Value at Age 12} = \underbrace{\$150(1+\text{ROR})^{12}}_{\text{Future Value of a Single Sum}} + (\text{Annual Rent})\underbrace{\left[\frac{(1+\text{ROR})^{12}-1}{\text{ROR}}\right]}_{\text{Future Value of a Terminating Annual Series}}$$

5.4 Valuing immature even-aged stands using the LEV criterion

Land Expectation Value (LEV) was described in Section 3. For a stand that meets the LEV assumptions, a simple calculation can be used to estimate the value of an immature stand:

$$V_m = \frac{NV_t + LEV}{(1+i)^{t-m}} - LEV$$

where V_m = Value of the m-aged stand,

m = age of the immature stand, and

NV = Net Value of the income and costs associated with the immature stand between year m and rotation age t.

Consider Example 3.5 on page 21. The LEV for a 30-year old stand was calculated as $193.96 per acre. What is the value of a 13-year old stand under the usual LEV assumptions?

$$V_m = \frac{\$1{,}757.78 + \$193.96}{(1.08)^{30-13}} - \$193.96$$

$$= \$527.49 - \$193.96 = \$333.53$$

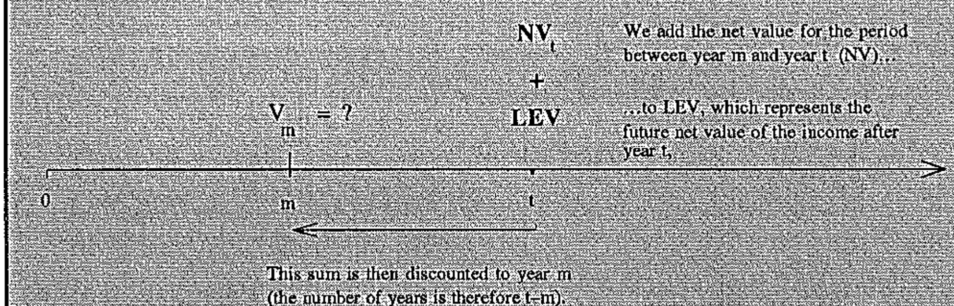
The value of the immature stand is $333.53. [Note that the value of the immature stand and the land is $527.49.]

Why does the calculation above "work?"

If the interest rate and future management decisions are as originally assumed in the LEV calculation, the value of an immature stand has two components:

① the discounted net value of the income and costs associated directly with the existing, immature stand (NV), and

② the discounted LEV. LEV is also discounted for t–m years because of the delay in harvesting subsequent stands... the LEV of all subsequent stands isn't realized until the existing stand is harvested in year t.



$$V_m = \frac{NV_t + LEV}{(1+i)^{t-m}} - LEV$$

Why do we then subtract LEV to obtain V_m?

With LEV included, we have the value of the land *and* timber. When we subtract LEV we have the value of the immature stand of timber only.

5.5 Some references to published applications

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Section 6.

Sources of Price and Cost Data

Section 6.

Sources of Price and Cost Data

6.1 Stumpage and delivered prices

❖ *Stumpage Price Sources for Individual States*

Useful information on the availability of timber price reports for individual states was recently presented in:
Price Reporting for Nonindustrial Private Owners, A Ten-Year Progress Report. B.N. Rosen and N. Carryl. 1993. *Journal of Forestry* 91(1): 34-41. The article lists the types of price data reported by each state, based on a 1990 survey.

Our list of states (at right) is a subset of the states in Rosen and Carryl's Table 2 – we excluded states whose reports were listed as "internal use only," and states whose reports didn't have stumpage prices or "delivered" prices for roundwood. Agency titles and telephone numbers were obtained by calling the appropriate offices within each state. The telephone numbers may be used to obtain copies of the reports or to find out more about the specific data included.

As noted above the state list at right, the small numbers under state names correspond to articles and other publications in the ❖***Price References*** subsection on the next page. The articles indicated for each state specifically mention stumpage or delivered product prices within the state.

1. *Timber Mart South* is produced for commercial distribution by Timber Marts, Inc., P.O. Box 1278, Highlands, NC 28741 (704)526–3653.

2. The *Quarterly Report of the Timber Market* (Louisiana) and the *Hillfarmer* (Kentucky) are summaries developed from *Timber Mart South*.

Stumpage and Delivered Price Reports for Individual States

NOTE: The numbers beneath state names refer to article numbers in ❖ ***Price References*** (on the next page).

Alabama 16	*Timber Mart South* (See Footnote 1)
Arkansas 16	*Timber Mart South* (See Footnote 1)
Connecticut	*S. New Eng. Stumpage Price Survey*, Coop. Ext. Serv., U. Conn. (203)774–9600
Florida 16	*Timber Mart South* (See Footnote 1)
Georgia 5,16	*Timber Mart South* (See Footnote 1)
Kentucky #1	*Timber Mart South* (See Footnote 1)
Kentucky #2	*Hillfarmer*2 (elect. bulletin board also), Coop. Ext. Serv., U.Ky. (606)257–2703
Louisiana #1 10,16,24	*Timber Mart South* (See Footnote 1)
Louisiana #2	*Quarterly Report of the Timber Market*2, Coop. Ext. Serv., LSU (504)388–4087
Illinois 3,11,25	*Ill. Timber Price Survey*, Illinois Department of Conservation (217)782–2361
Indiana	*Forest Products Price Report*, Dept. For. and Nat. Res.,Purdue (317)494–3580
Maine	*Stumpage Price Report*, Maine Forest Service (207)289–2791
Massachusetts	*S. New Eng. Stumpage Price Survey*, Coop. Ext. Serv., U. Mass. (413)545–2943
Minnesota	*Public Stumpage Price Review*, Minn. Dept. of Natural Resources(612)296–6491
Mississippi #1 16	*Timber Mart South* (See Footnote 1)
Mississippi #2	*Timber Price Report*, Cooperative Extension Service, Miss. State (601)325–3150
Missouri	*Timber Price Trends Report*, Missouri Dept. of Conservation (314)751–4115
New Hampshire #1 8	*Forest Market Report*, Coop. Ext. Serv., U. of New Hampshire (603)862–1029
New Hampshire #2	*Qtrly. For. Prod. Mkt. Rep.*, N.H. Timberland Owners Assoc. (603)224–9699
New York	*Stumpage Price Report*, N.Y. Dept. of Envir. Conservation (518)457–7431
North Carolina	*Timber Mart South* (See Footnote 1)
Ohio #1	*Timber Prices Report*, Ohio Agricultural Statistics Service (614)469–5590
Ohio #2	*Bulletin of Hardwood Market Statistics* (see #17 in ***Price References***, next page)
Oklahoma	*Timber Mart South* (See Footnote 1)
Pennsylvania	*Timber Market Report*, Cooperative Ext. Serv., Penn. State (814)863–0401
Rhode Island	*S. New Eng. Stumpage Price Survey*, Dept. of Environ. Manage. (401)539–2356
South Carolina 16	*Timber Mart South* (See Footnote 1)
Tennessee 16	*Timber Mart South* (See Footnote 1)
Texas #1 16	*Timber Mart South* (See Footnote 1)
Texas #2	*Timber Price Trends*, Texas Forest Service (409)845–2641
Vermont 23	*Vermont Forest Quarterly**, Extension Service, Univ. of Vermont (802)656–2913 *Discontinued, but stumpage price information is available.
Virginia 16	*Timber Mart South* (See Footnote 1)
West Virginia	*W.V. Timber Price Report*, West Virginia Division of Forestry (304)558–2788

6.1 Stumpage and delivered prices (cont.)

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6.2 Costs

❖ *A Source of Cost Data for Southern States*

For analyzing forestry investments in southern states, an excellent source of cost data is the continuing series of articles on "Costs and Cost Trends" in the biannual Manual Edition* of *Forest Farmer* magazine. At right, we present examples of the types of cost information in the 1993 "Costs and Cost Trends" article – information based on a cost survey done in 1992.

We present the cost values at right simply as examples of the types of cost data in the *Forest Farmer* articles. The original articles in this series have many more cost values, as well as cost values for various years since 1952. Rates of cost increase are also evaluated for important practices. We strongly recommend that readers with interest in costs of forestry practices in the South refer to the original articles in the "Costs and Cost Trends" series. The 1993 article is:

Belli, M.L., T.J. Straka, M. Dubois and W.F. Watson. 1993. Costs and cost trends for forestry practices in the South. For. Farm., 29th Manual Ed., 52(3): 25–31. [The 1993 article includes complete references to earlier ones in the series.]

* The Manual Edition of *Forest Farmer* magazine is compiled and distributed biannually to members of the Forest Farmers Association. However, the Edition is also available to non-members – cost and ordering information is available from the Association's Atlanta office (404) 325–2954.

Examples of Costs from the 1993 *Forest Farmer* "Costs and Cost Trends" Article

	Average Cost $ Per Acre, 1992
Mechanical Site Preparation	
Single-Chop	*$75.02*
Shear Only	*60.60*
Shear-Rake-Pile	*127.15*
Chop-Bed	*103.56*
Shear-Rake-Pile-Bed	*160.01*
Shear-Rake-Disk	*174.39*
Rip Only	*66.05*
Bush Hog	*25.00*
Planting (seedling costs not included)	
Hand Planting, Old Field	*$38.00*
Machine Planting, Old Field	*38.85*
Hand Planting, Cutover (intensive site prep)	*38.96*
Hand Planting, Cutover (non-intensive site prep)	*44.48*
Machine Planting, Cutover (non-intensive site prep)	*40.74*
Average All Types	*40.20*
Burning	
Prescribed Burning	
Ground Drip Torch	*$9.61*
Aerial Drip Torch	*6.40*
After Chemical Site Preparation	
Ground Drip Torch	*13.00*
Aerial Drip Torch	*12.81*
Average All Types	*10.95*
Chemical Treatments	
Site Preparation	
Aerial Spray	*$87.32*
Injection	*48.39*
Release	
Aerial Spray	*56.64*
Injection	*41.10*
Fertilization (including fertilizer costs)	
Aerial Application	*$42.10*
Ground Application	*43.63*
Timber Cruising	
Plot Sampling	*$3.19*
Point Sampling	*4.87*
Overall Average	*4.11*
Timber Marking	
Regeneration Cuts	*$24.20*
Thinning Plantations	*11.80*
Thinning Natural Stands	*13.97*
Precommercial Thinning	
Overall Average	*$69.47*

The original article for 1993 has many more cost values, as well as breakdowns of cost values by subregion of the South. Also, Tables showing the important components of the costs are included. Rates of increase and reasons for increase in the costs of important practices in recent years are also discussed.

6.2 Costs (continued)

❖ ***Cost References***

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2. Belli, M.L., T.J. Straka, M. Dubois and W.F. Watson. 1993. Costs and cost trends for forestry practices in the South. For. Farm., 29th Manual Ed., 52(3): 25–31.

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Section 7.

Computer Programs

Section 7.

Computer programs

Specialized computer programs can be extremely useful tools for forestry investment analysis. Compared to using a handheld calculator, the speed, accuracy, and overall efficiency of computer programs is particularly advantageous:

- *Where there are many single-sum entries* – each single-sum value on a timeline must be compounded or discounted separately, and computations can become burdensome if there are many entries.
- *Where ROR is calculated and the analysis has more than two values* – if an analysis has more than two values, the iterative process of identifying the interest rate where PNW = 0 can be time-intensive.
- *When a sensitivity analysis is conducted* – that is, where PNW, B/C or other financial criteria are re-calculated using different values for the interest rate, costs, revenues, etc. As with the iterative method of estimating an ROR, the same formulas and methods are applied; numbers within the formulas are the only factors changed.

In these and certain other types of applications, compound interest computations can be highly repetitive and time-intensive unless specialized computer programs are used.

7.1 Computer programs for forestry investment analysis

❖ *A Listing of Computer Programs*

In this subsection, we list some of the programs that have been listed and fully described in Directories published by Forest Resources Systems Institute (FORS). Our list is intended to create an awareness of the great number of programs that have been developed specifically for analyzing forestry and natural resource investments. It would be beyond the scope of this book, however, to include current, exhaustive information on all of the programs presently available.

Complete, current information on the cost, availability, and distribution of specific software for forestry investment analysis (and other purposes) may be obtained by contacting FORS:

Forest Resources Systems Institute
122 Helton Court
Florence, AL 35360
(202) 767–0250

[illegible]

[illegible]

DISCO–*uses cash flow and interest rates to generate present vet value, annual equivalent rent, and percent return on investment.*

WORTH–*will analyze a stream of costs and revenues associated with forestry investments.*

TIMBER–*reports standing timber values based on timber cruise data. Economic analysis reports are available.*

BUYLEAST–*a decision tool to decide whether to buy or lease timberlands.*

QUICK-SILVER–*a powerful and easy-to-use program to compute financial returns from many forestry investments.*

PEAP–*Preliminary Economic Analysis Program–provides a method for making feasibility analyses of proposed equipment investments.*

DF PRUNE–*designed to estimate the expected financial return from pruning coast Douglas-fir.*

7.1 Computer programs for forestry investment analysis (continued)

❖ ***A Listing of Computer Programs*** (continued)

PP PRUNE–*a spreadsheet that simulates the financial return from pruning ponderosa pine.*

ECONHDWD–*used to predict the growth and yield of unthinned loblolly pine plantations established on cutover, site-prepared lands and perform financial analyses based on those predictions.*

FIDME PC–*Forest Investment Decisions Made Easy on the PC.* Allows the forest manager to *choose, with a known degree of confidence, between investment alternatives.*

RETURN–*an economic model for assessing the value growth rates of plantation grown loblolly pine by diameter class over time.*

TREEVAL+ –*used to calculate tree or stand values and volumes based on predicted product recovery.*

RPGrow$–*a stand-level, interactive spreadsheet for projecting growth and yield and estimating financial returns for managed red pine stands in the Lake States.*

SUPER INVEST–*computes net present value, net future value, equivalent annual income, and internal rate of return for user inputs of costs and incomes by years for timber or alternative investments.*

NECORE–*differences in net reforestation costs under federal law PL 96-451 and older capitalization programs.*

PIMAX–*a financial package for investments exhibiting complex cash flows.*

FOREST RETURNS–*an interactive program for making economic comparisons of land use alternatives.*

CASH–*allows the user to quickly evaluate cash flows of costs and revenues (expenditures and receipts or costs and benefits, respectively) over the investment period for any type of investment alternative (i.e., forestry, agriculture, engineering, etc.)*

FORVAL –*present, future, and soil expectation values as well as sinking fund amounts and installment payments can be obtained. Value of reforestation costs and depletion alloances can be calculated.* [Described in the next subsection –❖ ***An Example Program: FORVAL***.]

Net Cash Flow–*40-year investments can be evaluated from inventory and cut volume, appreciation and tax rates. Cash flows and internal rate of return are generated.*

INVES–*an easy-to-use spreadsheet template for determining financial returns of pine plantation alternatives.*

[illegible]

7.1 Computer programs for forestry investment analysis (continued)

❖*An Example Program: FORVAL*

FORVAL (FORest VALuation) is a computer program for cash-flow analysis of forestry investments.

The program was originally designed as a teaching aid – a tool to accurately and efficiently perform basic compound interest computations after all of the specific values corresponding to a potential forestry investment have been determined or estimated. Students and other users of FORVAL are thus encouraged to specify all dollar values and their timing on a cash-flow diagram; the user may then input the values and their timing in FORVAL by responding to qnestions displayed on the screen.

One of the first questions displayed by FORVAL lists the options available:

[illegible]

The **present value (PV)** option is used for standard financial calculations. Any cash flow or forestry investment can be analyzed once the values involved and their timing are specified. The program calculates present net value (called present net worth in Section 3), equivalent annual income, the benefit/cost ratio, and the investment's internal rate of return (called rate of return in Section 3). Single-sums and any type of payment series can be specified – terminating or perpetual series, and annual or periodic series can be defined.

The **future value (FV)** option allows the user to compute the value of a single-sum at a future date, considering a real rate of increase and an expected inflation rate.

The **land expectation value (LE)** option is the value of bare land if put into perpetual forest production. The user inputs all costs and revenues associated with a rotation of the forest including establishment costs.

The **sinking fund (SF)** option assumes you will put money into an account at the end of each year, beginning one year from the present, and that interest compounds annually (sinking funds are described in Section 2). The result obtained answers the question: "How much money must be placed in an interest-bearing account annually to have a specified sum in a certain number of years?"

The **installment payment (IP)** option calculates the payment that will pay off a loan in a specified period of time. This option can be used to determine home mortgage payments, land and timber payments, or automobile and other equipment payments.

The **reforestation cost (RC)** option calculates the after-tax present value of regenerating a forest tract (taking into account income tax incentives and cost-share assistance programs). The after-tax present value of reforestation costs is demonstrated in Problem 4.8 on page 31).

The **depletion allowance (DA)** option reports the depletion allowance corresponding to a timber sale, the adjusted basis for depletion, and the after-tax value of the revenue. The user inputs the percentage of standing timber removed, the timber revenue generated, the landowner's marginal tax rate, and the cnrrent basis for depletion. Upon request, FORVAL will output the detailed calculations used to derive the depletion allowance.

FORVAL allows users to do sensitivity analysis for their input values – one or more inputs can be changed, and the program will recalculate the output value(s) for the option selected.

[illegible]

7.2 Computer program references

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Section 8.

References

Section 8.

References

This Section has reference citations for a limited number of articles and other publications in broad categories of potential interest in forestry investment analysis. The reference lists for various topics are not exhaustive, but provide a beginning point for finding further information

In subsection **8.1** we include "general" articles and publications – ones that focus on the methods and techniques of forest valuation and investment analysis. In **8.2** we list articles and other publications that apply to specific, important topics.

> NOTE: Three other Sections of the book also include reference lists for specific topics:
>
> In Section 5 (Applications), see **5.5 Some references to published applications;**
>
> In Section 6 (Sources of Price and Cost Data), see
> ❖ *Price References* (in subsection 6.1), and
> ❖ *Cost References* (in subsection 6.2);
>
> In Section 7 (Computer Programs), see **7.2 Computer program references.**

8.1 General forest valuation and investment analysis

Bullard, S.H., T.A. Monaghan and T.J. Straka. 1986. Introduction to forest valuation and investment analysis. Public. 1546, Miss. Coop. Ext. Serv., Miss. State Univ., Mississippi State, MS, 131p.

Clutter, J.L., J.C. Fortson, L.V. Pienaar, G.H. Brister and R.L. Bailey. 1983. Timber Management: A Quantitative Approach (Chapter 5. Forest Finance). John Wiley & Sons, New York, 333p.

Davis, L.S. and K.N. Johnson. 1987. Forest Management (Part 2, Chapter 7. Financial Analysis and the Arithmetic of Interest). McGraw-Hill, New York, 790p.

Elwood, N.E. 1983. Forestry financial analysis I: An introduction for landowners. Extension Circular 1146, Oregon St. Univ. Ext. Serv., Corvallis, OR, 6p.

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Elwood, N.E. 1983. Forestry financial analysis III: How to compare two (or more) investments. Extension Circular 1148, Oregon St. Univ. Ext. Serv., Corvallis, OR, 27p.

Garfitt, J.E. 1986. The economic basis of forestry re-examined. (see Price, 1986) Quarterly J. For. 80(1):33–35.

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Rose, D.W., C.R. Blinn and G.J. Brand. 1988. A guide to forestry investment analysis. Res. Pap. NC–284, USDA For. Serv., North Cent. For. Exper. Stn., St. Paul, MN, 23p.

Straka, T.J., S.H. Bullard and W.F. Watson. 1985. Primer on forestry investment. For. Farm. 45(2):10,11.

Straka, T.J. and W.F. Watson. 1988. Basic forestry investment analysis for timberland owners. For. Farm. 48(2):6–8.

8.2 Specific topics in forest valuation and investment analysis

❖ *Income Taxes*

Bettinger, P., H.L. Haney, and W.C. Siegel. 1989. The impact of federal and state income taxes on timber income in the South following the 1986 Tax Reform Act. South. J. Appl. For. 13:196–203.

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Bullard, S.H. 1985. Reforestation timing influences after-tax present value of costs. J. For. 83(9):561.

Bullard, S.H. and T.J. Straka. 1985. What is your "effective" rate of reforestation cost? For. Farm. 45(1):16–17.

Bullard, S.H. and T.J. Straka. 1992. A note on after-tax analysis where capitalized costs are depreciated. North. J. Appl. For. 9(1):31,32.

Campbell, G.E. and J.P. Colletti. 1990. An investigation of the rule-of-thumb method of estimating after-tax rates of return. For. Sci. 36(4):878–893.

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❖ *Inflation*

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❖ *Financial Criteria*

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Section 9.

Solutions to Problems

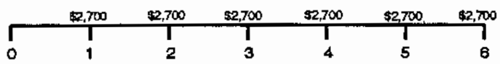
Section 9.

Solutions to Problems

9.1 Problems from Section 2

Problem 2.1

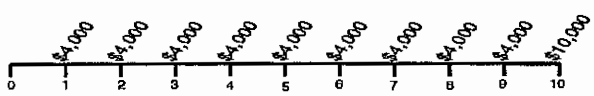
A six-year, terminating annual series. Calculate V_0 using 10%.



$$V_0 = \$2{,}700\left[\frac{(1.10)^6 - 1}{.10(1.10)^6}\right] = \$11{,}759.20$$

Problem 2.2

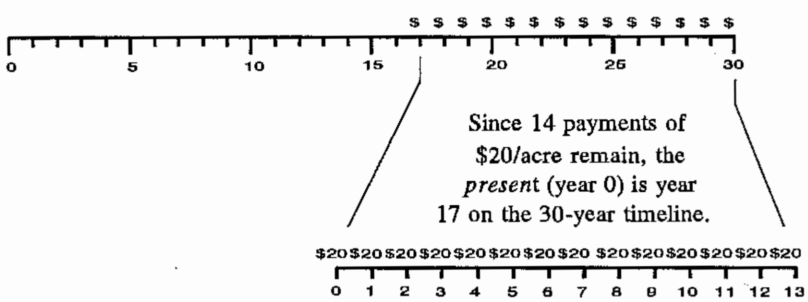
A nine-year, terminating annual series ***plus a single-sum in year 10.*** *Calculate V_0 using 7%.*



$$V_0 = \$4{,}000\left[\frac{(1+.07)^9 - 1}{.07(1+.07)^9}\right] + \frac{\$10{,}000}{(1.07)^{10}} = \$31{,}144.42$$

Problem 2.3

A 30-year, terminating annual series that has 14 payments remaining (one immediately). Calculate V_0 using 6%.



The first↑ of the 14 remaining payments occurs immediately (in year 0), so the correct calculation of V_0 is:

$$V_0 = \$20 + \$20\left[\frac{(1.06)^{13} - 1}{.06(1.06)^{13}}\right] = \$197.05/\text{acre}$$

NOTE: *In the calculation above, why is $20 added to the present value of a 13-year series?* Recall that the formula we're using for the present value of an annual series assumes the first income (or payment) occurs at the *end of the first year.* We therefore have $20 already in year 0, *and* a 13-year series to be discounted to year 0.

9.1 Problems from Section 2 (continued)

Problem 2.4

Compare the present value of net annual income with the present value of presecribed burning costs using a 7% discount rate.

For the net annual income, calculate the present value of a perpetual *annual* series:

$$V_0 = \frac{\text{Net Annual Income}}{\text{Discount Rate}} = \frac{\$4.00 - \$3.10}{.07} = \$12.86$$

For the burning costs, calculate the present value of a perpetual *periodic* series:

$$V_0 = \frac{\text{Periodic Value}}{(1+i)^n - 1} = \frac{\$10.00}{(1+.07)^9 - 1} = \$11.93$$

The net annual income *would* offset the periodic costs of prescribed burning.

Problem 2.5

Since the $15 permit fee occurs each year (in perpetuity), it's a perpetual annual series. A lifetime permit costs $200 (so V_0= $200). Solve the perpetual annual series formula for "i:"

$$V_0 = \frac{\$15}{i}, \text{ so } i = \frac{\$15}{\$200} = 7.5\%$$

If you did *not* purchase the permit, but placed the $200 in an account earning 7.5% per year, your annual return would be $200(.075) = $15 – enough to pay for the permit each year. If your alternative rate of return is any rate *less* than 7.5%, your $200 investment would not generate enough money each year to purchase the permit, and the $200 purchase price is financially attractive. If the $200 can be invested at a rate *higher* than 7.5%, it would earn more than enough to purchase a $15 permit each year and the lifetime permit would not be attractive financially.

Problem 2.6

a) Annual income of $2,000 for five years – calculate present value using 11.5%.

$$a = \$2,000 \left[\frac{.115(1.115)^5}{(1.115)^5 - 1}\right] = \$7,299.76$$

b) Quarterly income of $500 for five years – calculate present value using 11.5% compounded quarterly.

$$a = \$500 \left[\frac{\left(\frac{.115}{4}\right)\left(1+\frac{.115}{4}\right)^{5*4}}{\left(1+\frac{.115}{4}\right)^{5*4} - 1}\right] = \$7,525.44$$

9.1 Problems from Section 2 (continued)

Problem 2.7

Monthly payment for a $100,000 loan, APR = 12% –

Repay in *10* years: $$a = \$100{,}000 \left[\frac{\left(\frac{.12}{12}\right)\left(1+\frac{.12}{12}\right)^{10*12}}{\left(1+\frac{.12}{12}\right)^{10*12} - 1} \right] = \$1{,}434.71$$

Repay in *15* years: $$a = \$100{,}000 \left[\frac{\left(\frac{.12}{12}\right)\left(1+\frac{.12}{12}\right)^{15*12}}{\left(1+\frac{.12}{12}\right)^{15*12} - 1} \right] = \$1{,}200.17$$

Problem 2.8

The *seller* is responsible for the payment due on April 1. The end-of-year assumption used in developing the *annual* formula for terminating series becomes an "end-of-month" assumption for *non-annual* terminating series (the non-annual formula was a simple modification of the annual formula–none of the underlying assumptions changed). The non-annual formula for installmeut payments therefore assumes that each payment is due (or each income is received) at the *end* of the period – so the payment due on April 1 is for the March period. The seller owned the land during March and therefore owes the payment due on April 1.

Problem 2.9

Calculate the effective rate of compound interest when APR = 28%.

$$\text{Effective Rate} = \left(1 + \frac{.28}{12}\right) - 1 = 31.9\%$$

Problem 2.10

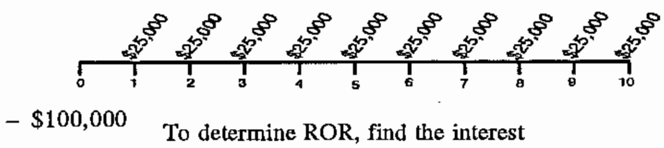
Calculate the monthly sinking fund amount necessary to accumulate $25,000 in four years using an annual interest rate of 4.5% (the annual rate is compounded monthly).

$$a = \$25{,}000 \left[\frac{.045/12}{(1+.045/12)^{4*12} - 1} \right] = \$476.34$$

9.2 Problems from Section 3

Problem 3.1

Calculate ROR for the values on the time-line below.



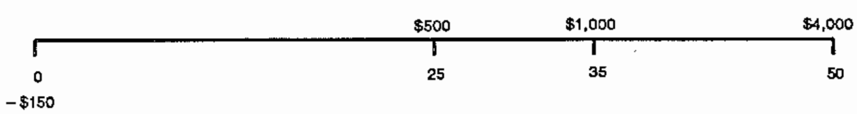
To determine ROR, find the interest rate that makes the present value of the \$25,000 annual series equal to \$100,000 ... What "i" will make→ **\$100,000** $= \$25,000 \left[\frac{(1+i)^{10}-1}{i\,(1+i)^{10}}\right]$ **?**

ROR is determined through the iterative process illustrated in Figure 8 on page 19. If you try an interest rate of 10% in the formula above, for example, the present value of the \$25,000 annual series will be greater than \$100,000 – the present value of revenues is greater than the present value of costs, indicating that the ROR is greater than 10%. If you try 25%, however, the present value of the series will be less than the \$100,000 cost – ROR is less than 25%. Through this process, ROR can be estimated as about 21.4%

PNW would be positive at 9% (because the ROR is greater than 9%). If the logger's guiding rate of return is 9%, the investment would be acceptable.

Problem 3.2

Calculate LEV for the per acre values on the time-line below.



Assume an infinite series of identical rotations.

Compound all values to the end of the first 50-year period, then treat the compounded net value as a perpetual periodic series.

$$\text{LEV} = \left[\frac{\$500(1.07)^{25} + \$1.000(1.07)^{15} + \$4,000 - \$150(1.07)^{50}}{(1.07)^{50} - 1}\right]$$

= \$177.61/acre

9.2 Problems from Section 3 (continued)

Problem 3.3

On the time-line below, "A" represents the market value of the lumber and dimension facility after 12 years (the value to be determined in the analysis). Using 10% as a guiding rate of interest, calculate the value of "A," the market value of the facility that's necessary if the overall investment is to have a PNW $\geq$ 0.

												$A
	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4
0	1	2	3	4	5	6	7	8	9	10	11	12
–$15												

(Time-line units are millions of dollars.)

For the project's PNW to be $\geq$ 0, the following relationship must hold:

$$(\$1.4 \text{ million})\left[\frac{(1.10)^{12}-1}{.10(1.10)^{12}}\right] + \frac{A}{(1.10)^{12}} - \$15 \text{ million} \geq 0$$

Simplifying yields: $\frac{A}{(1.10)^{12}} \geq \$5{,}460{,}831.50$

And the value for A must be: $\geq \$5{,}460{,}831.50\ (1.10)^{12} = \$17{,}138{,}428$

If PNW $\geq$ 0, then EAI $\geq$ 0, B/C $\geq$ 1, and ROR $\geq$ 10%.

Problem 3.4

Calculate PNW for the values on the time-line below using 6.5%.

	$400	$3,300
0	8	15
–$1,700		

$$\text{PNW} = \frac{\$400}{1.065^{8}} + \frac{\$3{,}300}{1.065^{15}} - \$1{,}700 = -\ \$175.18$$

9.3 Problems from Section 4

Problem 4.1

Calculate PNW for the per acre values on the time-line below using a real discount rate of 4% (the values are from Example 4.1 on page 26). Dollar values in parentheses have 3% inflation included; values outside parentheses are in constant dollar or real terms.

($632.14) ($7,524.51)
$350 $3,100
0 20 30
– $300

$$\text{PNW} = \frac{\$350}{1.04^{20}} + \frac{\$3{,}100}{1.04^{30}} - \$300 = \mathbf{\$815.52/acre}$$

The PNW calculated in real terms is identical to that obtained with inflation included (Example 4.1). *Whether or not inflation is included in a pre-tax analysis has no impact on the PNW, B/C or other present value criteria if inflation is treated consistently* – either included or excluded in the discount rate and in all dollar values in the analysis.

Problem 4.2

*Calculate ROR for the cash-flow diagram below. Since the values include inflation, calculate the **real** ROR using the average rate of inflation for the period (4.1%).*

Since there are two single-sums in the analysis, ROR can be computed directly (using Formula 3.1 on page 20):

$48,000
0 10
– $20,000

$$\textbf{Inflated ROR} = \left(\frac{\$48{,}000}{\$20{,}000}\right)^{1/10} - 1 = 9.15\%$$

If inflation averaged 4.1% per year during the 10-year period, the **real** ROR can be calculated as shown in Figure 9 on page 26:

$$\textbf{Real ROR} = \frac{1.0915}{1.041} - 1 = 4.85\%$$

The timber stand earned an average rate of interest that was 9.15% in inflated terms – significantly greater than the bank's 5% (inflated) return. The *real* return on the bank account is only .86% if inflation is 4.1%.

Problem 4.3

Calculate the after-tax value of two revenues: $400 and $3,300. The marginal tax rate is 28%.

After-tax Value of $400 Income = ($400)(1 – .28) = $288.00

After-tax Value of $3,300 Income = ($3,300)(1 – .28) = $2,376.00

9.3 Problems from Section 4 (continued)

Problem 4.4

Calculate the after-tax PNW for the values on the time-line below – assume the income is taxable at 28% and the $1,700 can be expensed. Use an after-tax discount rate of 4.68%.

Year	0	8	15	
Before-taxes	–$1,700	$400	$3,300	
(After-taxes)	(–$1,224)	($288)	($2,376)	

After-tax values are (Before-tax Value)(1 – Tax Rate)

$$\text{PNW} = \frac{\$288}{1.0468^{8}} + \frac{\$2,376}{1.0468^{15}} - \$1,224 = \$172.19$$

The investment is acceptable on an after-tax basis – although it was not acceptable on a before-tax basis (see the solution to Problem 3.4). The after-tax discount rate of 4.68% is tbe before-tax rate multiplied by (1 – .28).

Problem 4.5

The after-tax cost of an item that can be expensed for tax purposes is (Before-tax Cost)(1 – Tax Rate). Additional examples:

- A consultant in the 34% marginal tax bracket hires an additional worker whose wages are $450 per week. The after-tax cost is: ($450)(1 – .34) = $297/week.
- Your timberland property taxes are $3.50 per acre, but you deduct this expense on your federal income tax return. If your tax rate is 28%, the after-tax cost of the property taxes is: (3.50)(1 – .28) = $2.52

Problem 4.6

The value of 71 cents per dollar would apply only to equipment that was considered 5-year property, and it would apply only to individuals or firms with a tax rate of 34% and a before-tax discount rate of 10%.

9.3 Problems from Section 4 (continued)

Problem 4.7

Calculate the after-tax present value of new office furniture per dollar of actual expense – use a before-tax discount rate of 11% and a marginal tax rate of 34% [the after-tax discount rate = (11%)(1 – .34) = 7.26%]. The schedule below shows the annual tax savings and the present value of eight tax returns (the new furniture is considered seven-year property and the annual percentages used in depreciation are shown in Table 1 on page 30).

Year	Tax Savings	PV (7.26%)
1	($1)(.1429)(.34)	.04530
2	($1)(.2449)(.34)	.07238
3	($1)(.1749)(.34)	.04819
4	($1)(.1249)(.34)	.03208
5	($1)(.0893)(.34)	.02139
6	($1)(.0892)(.34)	.01992
7	($1)(.0893)(.34)	.01859
8	($1)(.0446)(.34)	.00866
	Total PV of Depreciation Savings =	.26651

The effective cost of the office furniture per dollar of expense is: $1 – .26651 = .73349. This value may be multiplied by the purchase price of the furniture (to obtain the *effective* total cost). The effective cost is 73.349 cents per dollar of initial expenditure.

Problem 4.8

Calculate the effective cost of reforestation per dollar of initial expense if a 10% credit is claimed and if 95% of the cost is deducted as shown in the second column of the schedule below. Use a tax rate of 28% and an after-tax discount rate of 7.2%.

Year	Item	Tax Savings	Present Value
0	Credit of 10%	.10	.10
0	Deduction of 1/14th Of .95	.0679(.28)	.0190
1	Deduction of 1/7th of .95	.1358(.28)	.0355
2	Deduction of 1/7th of .95	.1358(.28)	.0331
3	Deduction of 1/7th of .95	.1358(.28)	.0309
4	Deduction of 1/7th of .95	.1358(.28)	.0288
5	Deduction of 1/7th of .95	.1358(.28)	.0269
6	Deduction of 1/7th of .95	.1358(.28)	.0251
7	Deduction of 1/14th of .95	.0679(.28)	.0119
		Total Present Value of Tax Savings =	*.3112*
		Effective Cost per Dollar of Expense = 1 – .3112 =	*.6888*

For example, if $500 is spent on reforestation practices that are approved for the tax incentives, the after-tax present value of costs using the tax and discount rate assumptions above is: ($5,000)(.6888) = $3,444.

9.4 Problem from Section 5

Problem 5.1

For the yields and other values given, calculate the optimal rotation age using MAI, PNW, ROR, and LEV.

Age	MAI (cu.ft./ac.)	Present Net Worth	ROR (%)	LEV
15	81.13	$32.35	4.8	$90.34
20	106.75	106.66	*ROR is maximized at stand age 20...* 6.55	238.98
25	118.72	148.68	6.4	*LEV is maximized at stand age 25...* 284.61
30	123.83	166.91	6.1	283.85
35	*MAI is maximized at stand age 35...* 125.11	*PNW is maximized at stand age 35...* 168.27	5.6	261.04
40	123.95	157.75	5.1	227.49

Formulas and Notation: A Quick Reference

Use the chart below as a quick reference to find the appropriate formula for the following cash-flow types: *Single-sums, Terminating Annual Series, and Perpetual Series–Annual and Periodic.*

Note: *If you have a* ***terminating*** *series that is* ***periodic*** *(non-annual), use the single-sum formulas to calculate present and/or future values for each number in the series separately.*

Single-sum? Yes ➤ *Are you calculating* ***Future Value or Present Value?*** ➤

Future Value *of a Single-sum*

$$V_n = V_0\ (1+i)^n$$

Present Value *of a Single-sum*

$$V_0 = \frac{V_n}{(1+i)^n}$$

Terminating Annual Series? Yes ➤ *Are you calculating* ***Future Value or Present Value?*** ➤

Future Value *of a Terminating Annual Series*

$$V_n = a\left[\frac{(1+i)^n - 1}{i}\right]$$

Present Value *of a Terminating Annual Series*

$$V_0 = a\left[\frac{(1+i)^n - 1}{i\ (1+i)^n}\right]$$

Perpetual Series? Yes ➤ *Is the perpetual series* ***Annual or Periodic?*** ➤

Present Value *of a Perpetual* ***Annual*** *Series*

$$V_0 = \frac{a}{i}$$

Present Value *of a Perpetual* ***Periodic*** *Series*

$$V_0 = \frac{a}{(1+i)^n - 1}$$

Notation Summary

V_n = Future Value (value in year n)

V_0 = Present Value (value in year 0)

i = interest rate (decimal percent)

n = number of years

a = annual or non-annual payment or income

Other Formulas

Present Net Worth, Rate of Return and other criteria are in Section 3 – page 17.