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Economics for Forest Landowners

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Individuals own forest land for a variety of reasons. These reasons include aesthetics, wildlife, recreation, timber production, and others. In nearly all cases, there is an economic element associated with the landowner's goals and objectives. For example, regardless of the benefit derived, there is almost always some monetary investment made to assure that the required management activities are implemented. That investment includes not only an initial cost, but also any additional costs over the course of time. If the management objective includes some form of revenue (e.g. timber sale or other product income) an economic analysis should be completed to determine if the revenue merits a long-term forest investment.

Forest management involves a number of activities often implemented over a number of years. Thus, the evaluation of investments requires more than just determining the difference between total cost and revenues. Determining the economic value of these long-term investments requires the application of several principles of economic theory to develop meaningful financial indicators.

The Time Value of Money

One of the basic principles of economics is that money has a different value depending upon when it is spent or when it is received. For example, if an individual wishes to buy some land for $25,000, the seller may require that the total amount is paid at time of purchase. As most people cannot afford to pay that much money outright, they receive a loan for the price of the land and then pay it off over a number of years. To make that arrangement, the buyer will borrow the money at a designated **interest** rate. The land owner receives the money for the property, and the buyer then pays the lender (e.g., a bank) the $25,000 plus interest, with the total cost to the buyer dependent on the time involved and the negotiated interest rate. Thus, money paid or received today has a different value than that received or paid in the future. Another way to look at this scenario is that $25,000 today is worth about $31,907 if it is received in five years at 5 percent interest. Conversely, $25,000 due in five years is worth only $19,588 today at that 5 percent interest.

Interest vs. Discount Rate

We have all heard of interest rate – that being the percentage of the loan that we must pay to borrow money for a specified length of time. Interest rates vary depending upon the item purchased, time involved, and current market conditions. For example the interest rate for a home purchase is usually less than that for a new car purchase, and money borrowed for a used car generally has a higher interest rate than a new car.

Opposite to the interest rate is the **discount rate** or sometimes referred to as the **capitalization rate**. This rate receives its name from the fact that it is used to adjust future payments or revenue to today's value - future values are 'discounted' to present. For practical purposes, the discount rate can be assumed to be equal to the interest rate that might be applied to current investments.

Simple vs. Compound Interest

Interest is generally charged, or paid, in one of two ways. First, **simple interest** is paid at the designated rate on a regular interval, and then is kept separate from the initial deposit, investment, or amount borrowed. The initial amount is usually called **principle,** or in the case of an investment is called **capital**. In the previous example, the principle is $25,000 and the interest rate is 5 percent. The amount of interest is thus $25,000 x .05 or $1,250. If this loan, or payment, is continued over several years, in this case 10 years, the ending principle (or balance) is the $25,000 + ($25,000 x (.05 x 10)) = $25,000 + $12,500 = $37,500.

Compound interest assumes that interest that is earned on the principle is added to that principle and in the following years, the interest is earned, or paid, on the total of principle plus accumulated interest. In the example, $25,000 earns a rate of 5 percent and at the end of the first year, the interest is $1,250 and the new principle is $26,250. Thus during the second year, the interest earned, or paid, is $26,250 x .05 = $1,312.50, and so on, for the loan (payment) period. Assuming a 10-year deposit at 5 percent compound interest, the value at 10 years is $25,000 x $(1.05)^{10}$ = $40,722.37. Compare that value with $37,500 and you can see the difference compound interest makes. Figure 1 illustrates the effect of compound interest rates on an initial investment of $1,000.

Annuities

An **annuity** is defined as a regularly recurring rental, payment or receipt. Annuities are considered as one of two types; 1) a **perpetual annuity** is one that is capable of running indefinitely. In this case, the regular period payment yield does not reduce or deplete the capital sum from which it is drawn. A good example of a perpetual annuity is a forest managed on a sustained-yield basis, where income is derived periodically, 2) a **terminating annuity** is one for which a definite ending time is foreseen. An example of a terminating annuity is a forest being managed with a specified end date for complete removal.

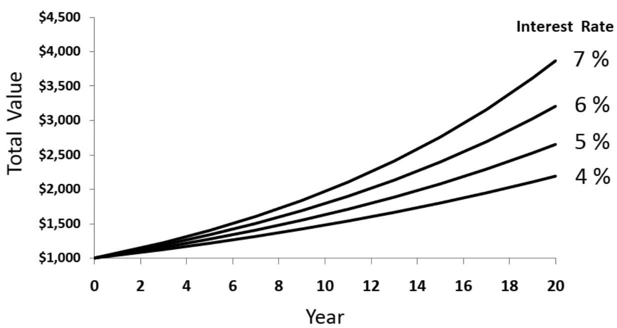

Figure 1. Value of Investment with Compound Interest (Initial Investment - $1,000).

Amortization

Amortization refers to a payment on a regular basis whereby a portion of that payment is used to offset the interest on the principle and the remainder of the payment is applied to the principle. In this manner, each successive payment applies less to the interest (as it is lower) and more to the principle. In today's economy, the method of amortization is generally utilized by purchasers of cars, homes, etc. Likewise, large purchases, such as tracts of land may involve amortized payments.

The Importance of Notation

Economic analyses utilize a series of formulas, which are simply shorthand tools for solving problems. These formulas can be found in any economics text. However, such formulas found in texts may have the same meaning, but often vary in the symbols used to represent the different components. For example, the terms principle, investment or capital may be represented by P, C, V or some other letter. To be consistent, the following symbols are used in this publication:

Vo = Value at the initial time, which may be designated as in the past, now, or in the future.
Vn = Value at some point in time; for example V_{10} is the value at age 10 of the payment or investment.
p = Interest rate on an annual basis expressed as a decimal. Thus 5 percent interest is written as .05 in the formulas.
n = The number of years during which the interest applies.
r = A regular payment, rental or return - often considered as the return from an annuity.

Formulas

$(1+p)^n$ Is used to calculate compound interest. The interest rate is given as **p,** and **n** is given of years in the term.
$(1+p/t)^{nt}$ Should interest or payments be made on a different schedule than once each year, p should be divided by the number of interest periods in a year (represented by **t**), and the value for n should be multiplied by the number of periods covered. As an example, payments made twice a year for 10 years would have as the interest formula $(1+p/t)^{nt} = (1+.05/2)^{20}$.
Vn = Vo x $(1+p)^n$ is the compound interest formula - an example of which is provided in the above discussion on compound interest.
Vo = Vn/$(1+p)^n$ is the discount formula used to bring a future value at time 'n' back to the current time.
r = (Vo x $(1+p)^n$ x p)/($(1+p)^n$ – 1) is the amortization payment required to fully satisfy a debt of Vo amount over **n** number of years at **p** interest rate. As in the compound interest/discount formula, payments on a schedule different than one- year intervals require the use of p/t and nt in the equation.
a = The net value of each recurring payment over an infinite time period.
BLV = **Bare Land Value**, which represents the current value of the land given a perpetual management regime. It is calculated as a/($(1+p)^n$ – 1).

In mathematical formulas, parentheses are used to assist in assuring that calculations are performed in the proper order. As a rule of thumb, always perform the calculations from 'inside out.' That is, the first calculations are completed on variables inside each set of parentheses before continuing.

Economic Analyses of Forest Enterprises

Example 1. Assume an individual is considering paying $100,000 to purchase the timber on a tract of land. The land is not included in the purchase. The estimated value of timber in 10 years is $120,000. Assuming a discount rate of 5 percent, is this purchase a wise investment?

$$Vo = \frac{Vn}{(1+p)^n} = \frac{\$120{,}000}{(1+.05)^{10}}$$

$$= \frac{\$120{,}000}{1.6289} = \$73{,}669$$

Thus, the current value of the timber is calculated to be $73,669 or $26,331 less ($100,000 - $73,699) than the proposed purchase price. Not a good investment. Note that the costs and revenues are expressed as being today's values. This is the commonly used approach to assessing long-term investments. This value, when all costs and revenues are considered on a current basis is known as the **Net Present Value (NPV)**.

Example 2. Assume the purchaser of a tract of land for $200,000 borrows that amount, and then wishes to pay off the amount during a 20-year period. The purchaser will be charged 4 percent interest and will make yearly payments. How much is each payment if the first is one year from the day the loan is signed?

$$r = \frac{(Vo \times (1+p)^n \times p)}{(1+p)^n - 1} = \frac{(\$200{,}000 \times (1+.04)^{20} \times .04)}{((1+.04)^{20} - 1)}$$

= Payment of $14,716.35 per year. For a total cost of $294,327.

Example 3. A forest landowner wishes to purchase a small sawmill for his woodlot. The cost is $45,000 at 4 percent interest. The landowner wishes to make monthly payments over 10 years. What is the payment each month?

$$r = \frac{(Vo \times (1+(p/t))^{nt} \times (p/t))}{((1+(p/t))^{nt} - 1)}$$

$$= \frac{(\$45{,}000 \times (1+(.04/12))^{120} \times (.04/12))}{((1+(.04/12))^{120} - 1)}$$

= Payment of $455.60 per month. The total cost becomes $54,672.

Example 4. Let us assume that a landowner wishes to determine the **Net Present Value** of his 400 acre woodlot, being managed on a 30-year rotation. The land is owned, but the calculations need to include several of the expenses that may be incurred over time. The discount rate is assumed as 4 percent. To complete the calculations, a table of revenues and expenses, **on a per acre basis**, should be developed, with the present value of each (see Table 1). Calculations are the same for each entry as demonstrated in Example 1. The numbers provided below are examples only and do not reflect current conditions. It should also be noted inflation is not considered for either costs or revenues. The net present value is $356.02 per acre.

Example 5. From Example 4, let us now include an annual land rental fee of $15 per acre for the 30-year rotation. A shortcut formula to calculate the current (discounted) value of this recurring rental fee is:

$$\mathbf{Vo} = \frac{\text{Payment x } ((1+p)^n\text{-}1)}{((p) \text{ x } (1+p)^n}$$

$$= \frac{\$15 \text{ x } ((1+.04)^{30} - 1)}{((.04) \text{ x } (1+.04)^{30})} = \$259.38$$

Subtracting this amount (as it is a cost) from the **Net Present Value (NPV)** per acre derived in Example 4, gives a **NPV** of $356.02 - $259.38 = $96.94 per acre, or a total **NPV** for the 400 acres of $38,655.80.

Example 6. This final example revolves around the question, "What can I pay for timberland, and make a certain percentage return on my investment over an infinite number of rotations?" In essence the question is really asking about the current value of a perpetual annuity, as we are calculating the present value of a perpetual series of cash flows. In this case that present value is known as the **Bare Land Value** (**BLV**), **Land Expectation Value** (**LEV**) or **Soil Expectation Value** (**SEV**). In order to make this calculation, three important points must be considered.

1. Revenues and costs are not considered at current values but rather, are carried forward to the end of the rotation.
2. All rotations are considered to be continued under a single management regime (i.e., the management stays the same for all rotations in perpetuity).
3. The cost or value of the land is not considered – that is what we are attempting to determine. However, anticipated land taxes during the course of the rotation should be included. To calculate future value of these taxes, use the formula: Payment x $((1+p)^n$-1)/p.

Using the numbers from Example 4, we carry the costs and revenues forward from the age of incurrence to age 30 (final harvest). Again we use a 4 percent interest rate and calculate on a per acre basis (Table 2).

The future value of taxes (assuming $10 per acre per year) for this example is calculated as:

$$= \frac{\text{Payment x } ((1+p)^n\text{-}1)}{p} = \frac{\$10 \text{ x } ((1+.04)^{30} - 1)}{.04}$$

$$= \$560.85 \text{ per acre.}$$

As before, this amount of taxes is included as a cost.

Table 1. Costs and Revenues for Example 4.

Time of Event	*Activity*	*Expected Revenue*	*Expected Expense*	*Current Value**
Age 0	Road Construction		$550	- $550.00
Age 0	Regeneration (planting)		$150	- $150.00
Age 3	Herbicide Application		$85	- $75.56
Age 15	Marking for Thinning		$25	- $13.88
Age 15	Thinning Revenue	$100		$55.53
Age 20	Thinning Revenue	$125		$57.05
Age 25	Bridge Repair		$3,000	- $1,125.35
Age 30	Final Harvest	$7,000		$2,158.23
			Net Present Value =	$ 356.02 per ac.

Thus, at 4 percent, the total **Net Present Value** of the 400-acre property is $356.02 x 400 = $142,408.

* Using a discount rate of 4 percent. Using a different discount rate will change both the current value of a given activity and the Net Present Value of the investment. As you can see, higher interest/discount rates penalize long-term forest investments, due to the time required to obtain significant revenues.

Table 2. Example for Calculating Bare Land Value (BLV).

Time of Event	*Activity*	*Expected Revenue*	*Expected Expense*	*Projected Value at Rotation**
Age 0	Road Construction		$550	- $1,783.86
Age 0	Regeneration (planting)		$150	- $486.51
Age 3	Herbicide Application		$85	- $245.09
Age 15	Marking for Thinning		$25	- $45.02
Age 15	Thinning Revenue	$100		$180.09
Age 20	Thinning Revenue	$125		$185.03
Age 25	Road Repair		$3,000	- $3,649.96
Age 30	Taxes ($10 per year)			- $560.85
Age 30	Final Harvest	$7,000		$ 7,000.00
			Value at Rotation =	$ 593.83 per ac.

* Rotation age assumed to be 30 years.

To complete the evaluation, the following formula is used.

$$\textbf{Bare Land Value (BLV)} = \frac{a}{((1+p)^n - 1)}$$

Where:

a = Net value at the end of each of a series of rotations (i.e., a perpetual annuity)

p = Interest rate (assumed as 4 percent in this example)

n = Years between annuity payments (assumed as final harvest or rotation age)

$$\textbf{BLV} = \frac{\$593.83}{((1.04)^{30} - 1)}$$

= $ 264.70 per acre, which is the current value of the land over an infinite series of rotations.

Figure 2 demonstrates the impact of timber value at rotation on the calculated **Bare Land Value**.

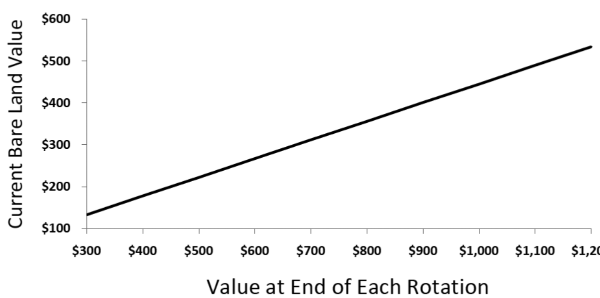

Figure 2. Bare Land Value (BLV) with Varying Rotation Values (30-year rotation - Perpetual Anuity) 4% Interest Rate.

Summary

Forest management often requires that decisions are made far in advance of any estimated costs or returns. To better evaluate the financial impact of those decisions, a number of mathematical tools are available. Proper application of these tools not only can provide guidance as to when costs should be incurred and revenues received, but can also point out when overall forest investments should or should not be made. The use of these by forest managers and owners, regardless of their management objectives, is encouraged.

Glossary

Amortization: Method of loan retirement where regular periodic payments are used to pay interest and reduce principal simultaneously.

Annuity: A regularly recurring rental, payment, or receipt of income.

Bare Land Value (**BLV**), **Land Expectation Value** (**LEV**) or **Soil Expectation Value** (**SEV**): Calculated as the present value of all cash flows from an infinite series of rotations. These rotations are all assumed to be identical to the management scenario under consideration.

Discount Rate or Capitalization Rate: The interest rate used to calculate the present value of future income and/or expenses.

Interest: The cost of using money belonging to someone else. In essence, a rental fee paid by the borrower.

Simple Interest: Where any interest earned by loaning money is kept separate and not added to the principle for future periods.

Compound Interest: Where interest earned by loaning money is added to the principle on which future interest is earned.

Net Present Value (NPV): Calculated as the current value of all projected income less the current value of all projected expenses.

Principal: Amount of money initially borrowed, loaned or invested.

Rate of Return (ROR): A ratio of the amount of money gained or lost divided by the amount of money invested. The rate of return is generally calculated based present values, using the appropriate discount rate.

Terminating Annuity: An annuity which is to cease at a specified time.

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