Valuation of Bare Forestland and Premerchantable Timber Stands in Forestry Appraisal

By Thomas J. Straka

Abstract

Rural appraisers often use Discounted Cash Flow (DCF) analysis to value timber and timberland. Land expectation value (LEV) is a standard DCF analysis technique that is applied to many timberland situations. LEV is used to calculate the value of bare land in perpetual timber production and is often used in the valuation of even-aged pine plantations. However, it can also be useful in the valuation of premerchantable timber stands and uneven-aged timber stands cut periodically. The analytical techniques appropriate to these applications are illustrated. These models have wide applicability in timberland appraisal situations.

Rural appraisers often have the problem of valuing bare forestland or premerchantable timber stands. Mature timber has a market value that is fairly easy to determine if estimated timber volume and market stumpage prices are known. What if one is asked to calculate the value of bare land about to be planted in trees or the value of a twelve-year-old timber stand that contains no merchantable timber volume? The appraiser's tool for this calculation is discounted cash flow analysis (DCF).

DCF analysis is a calculation to derive the net present value (NPV) of the income stream produced by a property (Appraisal Institute 2001). DCF is a common technique in forestry and timberland investment analysis and it is used in many appraisal situations. Forestry appraisers use a specialized DCF technique to calculate the value of bare land in timber production. It is called land expectation value (LEV) and is simply the value of a tract of bare land used for growing timber. LEV is the NPV of all revenues and costs associated with growing timber on the land in perpetuity. All future rotations of timber are considered, not just a single rotation as in many calculations. LEV can be interpreted as the maximum price that can be paid for a tract of timberland if a rate of return equal to the discount rate used to calculate LEV is required (Bullard and Straka 1998).

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When the NPV of all the future cash flows from growing timber on a piece of land is calculated, this is value of bare land in perpetual timber production and hence the term "land expectation value." This technique was first discussed in 1849 by Martin Faustmann, a German appraiser who developed the formula to value bare forestland for tax purposes (Faustmann 1849). It has also been translated as "soil expectation value" and is commonly referred to as bare land value, as the cash flow stream is assumed to begin with bare forestland.

The technique is fundamental to forestry valuation, but is not commonly used by appraisers. It does require professional forestry judgments with respect to stumpage prices, reforestation costs, and forest yield (Klemperer 1996). A forester's advice may be necessary to establish some of the parameters. Stumpage price and cost of forest practices information is published in many regions. Forest yield is a little trickier and depends on factors like site index and stocking. The calculation is no more precise than the quality of the data used as input.

The assumptions of the model may seem unrealistic. However, this is a fundamental forestry valuation calculation and the assumptions are inflexible if bare land value is to be calculated. Stumpage price and costs are projected far into the future. However, they are in constant dollars, so inflation is "netted" out of the equation. While bare land value is calculated on a perpetual basis, more than 90 percent of the value is attributable to the first two timber rotations at a 4 percent interest rate. If a higher interest rate is used, 10 percent for example, about 99 percent of value is attributable to the first two rotations.

LEV Defined

LEV has been defined as the value of bare land in perpetual timber production. This model was designed for even-aged timber stands. These are stands where all trees are harvested simultaneously (also called clearcutting) and then replanted after harvesting so that all trees are the same age. One time period from planting to harvesting is called a timber rotation. Faustmann's method was simple; he compounded all costs and revenues to the end of a rotation, in effect calculating a net future value for each rotation.

In the South a forest rotation might be 25 to 35 years. Let's assume a rotation length of 27 years. Then Faustmann's formula would have assumed this "net future value" occurred at years 27, 54, 81, and so on. Then we are dealing with perpetual periodic annuity and a net present value for all future rotations can be calculated. This would be LEV.

The formula to obtain the present value (PV) of perpetual period series or annuity is given by Equation (1):

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

Where a = dollar amount of periodic payment
i = interest rate, expressed as a decimal
t = time period between payments (rotations)

The use of this formula and several critical assumptions produces the LEV criterion.

The four assumptions are:

1. The values of all costs and revenues are identical for all rotations. These identical costs and revenues are compounded to the end of the rotation to obtain the net future value (NFV) of one rotation. This NFV would be the periodic payment, "a", in the formula and would be received every "t" years. Since these cash flows do not change over time, we will use a real discount rate, one that is net of inflation.
2. The land will be forested in perpetuity.
3. The land is bare and requires reforestation at the beginning of each rotation.
4. Land value does not enter into the calculation; it is what you are calculating.

This *Journal* has presented a forestry valuation model that can perform the land expectation value calculation (Straka and Bullard 2006). It lacked the detail of this article, but the example in that article will provide a good computational framework to illustrate the calculation. Table 1 illustrates a simple timber rotation of 27 years. The bare land requires $160 of reforestation cost today and every 27 years. Annual management and property tax cost is $2.50 per year. Three revenue flows occur due to timber harvests.

Table 2 illustrates the calculation of NFV at a 4 percent real interest rate. Each cost and revenue is simply compounded to year 27 and the NFV is the sum of these compounded costs and revenues, or $1,047.85. This NFV is received every 27 years into perpetuity and Equation (1) can be used with this value to obtain land expectation value:

(2) $$LEV = \frac{\$1{,}047.85}{(1.04)^{27} - 1} = \$556.37 \text{ per acre}$$

LEV represents the maximum amount that could be paid for bare forestland and the investor earn the required interest rate. If a buyer paid $556.37 per acre for the tract, he/she would earn exactly 4 percent on the investment, assuming that the land was used to grow timber according to the management schedule outlined.

This simple example does not include some common costs and revenues. For example, there is no provision for revenue from hunting leases. In the Southeast, income from hunting leases could be significant. These types of costs and revenues could simply be added to the calculations in Table 1 (e.g., hunting lease revenue could be netted with annual costs). Note that the LEV formula uses constant dollars and a real interest rate. The calculation can include prices or costs adjusted for real price increases by using the formula for a geometric series of cash flows (cash flows that increase or decrease by a fixed percentage from one time period to the next). Of course, the annual percentage increase must be less than the discount rate or the LEV will tend towards infinity.

LEV is the theoretically correct criterion for valuing bare land in perpetual timber production. Since it accounts for all future rotations it is the standard criterion for determining rotation length and other standard forestry financial applications. It is so widely recognized in forestry as a standard criterion that appraisers certainly ought to include it in their "menu" of valuation techniques. If you look at the assumptions, LEV was developed for a single application of even-aged management for bare land. However, LEV has other useful applications. In these situations it is technically not the LEV that Faustmann developed, but it still makes perfect theoretical sense.

Premerchantable Timber Stands

Premerchantable timber holdings pose a difficult valuation problem. The trees have value, but by definition have no potential for conversion to timber products. The value is intrinsic and is equal to the DCF expected from future timber harvests. The value of premerchantable timber increases as it grows towards mature commercial timber. The value is affected by the sunk cost of stand establishment and the opportunity cost of holding land to grow timber. Immature timber often is undervalued by conservative appraisers as it does lack immediate value, but LEV can be used to establish the value of this premerchantable timber. The formula to obtain this value is given in Equation (3)

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

Where: Vm = value of m-aged timber stand,
NFV = net future value of all costs and revenues remaining in the rotation
t = rotation length, in years.

Let's consider the same 27-year management regime discussed earlier and assume that the stand is 12-years old. Twelve-year old timber has no commercial value for any timber product. Table 3 shows the calculation of NFV of the remaining costs and revenues. Using Equation (3) and the previously calculated LEV, the value of the 12-year old timber is:

(4) $$V_{12} = \frac{\$1{,}572.34 + \$556.37}{(1.04)^{15}} - \$556.37 = \$1{,}182.00 - \$556.37 = \$625.63$$

The value of this premerchantable timber is $625.63. Note that the value of the premerchantable timber and the bare land is $1,182.00 (see Equation (4) calculations). Why does this equation work? If the interest rate and future management decisions are as originally assumed in the LEV calculation, the value of the premerchantable timber has two components: (1) the discounted value of the net timber revenue that will be produced by the trees, or the next 15 years of cash flows; and (2) the discounted value of the bare land that can't be planted for 15 years. Both of these are added together and then discounted to account for the 15 yeart delay until the current rotation is over. If the value of the land is subtracted from this number, then the result will be the value of the premerchantable timber only.

Uneven-aged Timber Stands

Uneven aged timber stands contain trees of various ages.

Usually mature trees are selectively harvested on a cutting cycle of some sort. The tract may be harvested annually, removing a small timber volume each year, or, perhaps, timber volume is removed every "so many" years (this is called a cutting cycle of "c" years). LEV type calculations can still be used to obtain value. However, in this case the value of the land and the timber must be estimated concurrently and one cannot separate land and timber values. Unless the timber is completely cut, bare land never exists under uneven-aged management. In effect, DCF is used to value a perpetual timber production "factory."

The simplest case is when an annual income stream is produced. This is a perpetual annual annuity situation. Equation (5) is the formula for this situation:

$$LEV = \frac{a}{i} \quad (5)$$

Where: a = net annual income generated, and
i = interest rate expressed as a decimal.

Consider a 1,000 acre tract of timber that produces $52,500 of timber revenue every year. Management fees and property taxes are $4,500 per year. Then net annual revenue is $48,000 per year. Using a 4 percent real discount rate, the LEV of this tract is given in Equation (6):

$$LEV = \frac{\$48{,}000}{0.04} = \$1{,}2000{,}000 \text{ or } \$1{,}200 \text{ per acre} \quad (6)$$

The other situation occurs when net timber revenue is periodic; say it occurs every other year or every five years. The standard LEV calculation is appropriate in this case. Such a forest is said to have "cutting cycles," where "reserve growing stock" is permanently maintained. This is analogous to maintaining the principal in a savings account and periodically withdrawing interest. Note that annual management costs and property taxes are subtracted from net timber revenue after being adjusted using the future value of a terminating annuity formula. Consider a 1,000 acre forest that produces $200 of net timber revenue per acre every five years, beginning in five years. Annual management costs and property taxes are $2.50 per acre per year. LEV using a 4 percent real discount rate is calculated in Equation (7) as:

$$LEV = \frac{\$200 - \left[\$2.50\,\frac{(1.04)^5 - 1}{0.04}\right]}{(1.04)^5 - 1} = \$860.64 \text{ per acre.} \quad (7)$$

Note that land and timber cannot be separated in this case. Again, we are dealing with a timber production entity.

Conclusion

The land expectation model is a standard forestry valuation model. It does have a rigid set of assumptions. When these assumptions are violated the calculated result is not technically an LEV. However, the concept of putting net timber revenue cash flows on a cyclical or periodic basis and calculating the present value of perpetual series of these cash flows can be applied to many forestry situations. Rural appraisers need to be aware of these techniques when performing forestry applications.

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Table 1. Cash flow from a typical forestry rotation (per acre)

Item	Year Incurred	Type of Cost or Revenue	Amount (Dollars)
Establishment cost	0	Single sum	-160.00
Annual management & tax costs	1-27	Terminating annual	-2.50
Thinning revenue	16	Single sum	97.50
Thinning revenue	22	Single sum	156.00
Harvest Revenue	27	Single sum	1,287.00

Table 2. Calculation of net future value per acre (interest rate = 4%)

Item	Year Incurred	Dollar Amount	Future Value ($)
Establishment Cost	0	-160.00	-461.34
Annual Management & Taxes	1-27	-2.50	-117.71
Thinning Revenue	16	97.50	150.10
Thinning Revenue	22	156.00	189.80
Harvest Revenue	27	1,287.00	1,287.00
			Net Future Value = 1,047.85

Table 3. Calculation of net future value for remaining costs and revenues for a 12-year old timber stand

Item	Year Incurred	Dollar Amount	Future Value (year 27)
Thinning Revenue	16	97.50	$150.10
Thinning Revenue	22	156.00	189.80
Harvest Revenue	27	1,287.00	1,287.00
Annual Management & Taxes	12-27	-2.50	-54.56
			Net Future Value = $1,572.34