Land Expectation Value Calculation in Pinus pinaster forestry

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Structured Abstract:

Appraisers often use discounted cash flow (DCF) techniques to value timber and timberland. Land expectation value (LEV) is a standard DCF technique applied to many timberland situations. LEV calculates the value of bare land in perpetual timber production and is often used to value even- aged pine plantations. However, it is also useful in the valuation of immature timber stands and uneven-aged timber stands cut periodically. These models have wide applicability in timberland appraisal situations. LEV is used to estimate the opportunity costs or various management regimes for *Pinus pinaster* forestry in several locations in Portugal. We have made modelation to estimate present value of costs and revenues from an infinite series of identical even-aged forest rotations starting from bare land and take a Forest Value (a generalization of LEV): the present value of a property with an existing stand of trees plus the present value of a LEV for all future rotations of timber that will be grown on the property after harvesting the current stand. So we determine when a given stand should be cut; separate the management of the current stand from that of future stands and account for price changes that might occur during the life of the current stand. We will still assume that the rotations and prices associated with the future stands (i.e., the stands that are established after the current stand is cut) will be the same. We show some examples of land value and timber value for the *Pinus pinaster* forestry.

Keywords: LEV, land appraisal

Article Classification:

Introdution

The valuation of forest assets basically coincides with the agricultural valuation criteria. However the differences between the agrarian and forestry production require some peculiarities Whtich require the knowledge of other sciences fundamental elements and techniques specific to the forest sector. For example it is Necessary to know the forestry, *dasometria*, spatial planning, are necessaries for forest recovery (Foster, 1986).

It is well known the economic importance of the Portuguese forestry sector represents about 10 % of national exports, with the Portuguese forest industries in 2010 accounted for EUR approximately 3.5 billion exports, accounting for 10.3 % of total of the same, with a trade surplus of EUR 1.5 billion being the 3rd most important sector of Portuguese exports. The main sub-sectors of the national forestry sector (cellulose pulp and paper, cork , wood, furniture and graphic industries) are fed mainly by three species (maritime pine, cork oak and eucalyptus), the distribution of the main species of "Portuguese forest" within the current 557 million 3,458 wooded hectare, according to IFN : Maritime pine: 27 %, cork: 23 % Eucalyptus: 23 % Holm: 13 % Other: 14 % . Over the last 10 years the forest occupation had an increase of 3 % on the mainland, and the stone pine itself responsible for 68 % of that increase and pine decreased by 9 %. Recent studies admit as possible, a process of expansion, the national forest area may extend beyond the current 39 % and 50 % of the territory.

Large patches of pine forest in the country are decrepit and maimed by the resin, showing growth of instabilities, mainly medium and low dimensions and therefore only notice for grinding, hundreds of thousands of property owners, multiplied by parcels of inadequate size to good forest management.

The price of pulp has been experiencing an appreciation in recent years, however, the falling prices in China has led to the inflection of the positive trend. Also the value of timber has decreased fruit of the current economic and financial downturn, with particular emphasis affecting the construction sector and consequently all sectors who are you the amount as the forest. In this perspective, the present time is the depreciation of assets associated with productive upstream construction sectors. This depreciation can however be minimized in the case of the forest , through the management of assets in order to wait for better market conditions and / or introducing alternative income farms. Thus the market prices of properties have suffered minor oscillations of the raw material it produces. It is however a market with high speculative and rather heterogeneous due to the diversity of variables that characterize each rustic property uncertainty. Moreover, the order amounts not reflect nor assimilated, current rates of treasury bonds, which raised the discount rate and thus depress property values. The current liquidity is also low. So, it is necessary know the potential of revenue from a stand and the soil.

Appraisers often use discounted cash flow (DCF) techniques to value timber and timberland (Alonso, R; Iruretagoyena, T. (1995); Ballestero, E. (1991). Land expectation value (LEV) is a standard DCF technique applied to many timberland situations. LEV calculates the value of bare land in perpetual timber production and is often used to value even aged pine plantations. However, it is also useful in the valuation of immature timber stands and uneven-aged timber stands cut periodically. These models have wide applicability in timberland appraisal situations.

Chang (1990) show discounted cash flow (DCF) analysis derives the net present value (NPV) of the net income stream produced by a property. It is a relatively simple calculation, applicable to many timberland appraisal situations. Forestry and timberland investment analysts commonly use a specialized DCF technique to calculate the value of bare land in timber production. Land expectation value (LEV) is simply the value of a tract of land used for growing timber. It is the NPV of all revenues and costs associated with growing timber on the land in perpetuity (not just those associated with one “rotation of timber” or other time period). LEV is thus a special case of DCF where a perpetual stream of revenues and costs are considered. LEV can be interpreted as the maximum price possible for a tract of timberland if a rate of return equal to the discount rate used to calculate LEV is expected.

If the NPV of all cash flows expected from growing timber on a specific tract of land is estimated, 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," because many applications assume the cash flow stream begins with bare land. LEV also is sometimes called the Faustmann formula." The technique was first published in 1849 by Martin Faustmann, a German appraiser who developed the formula to place values on bare forestland for tax purposes. (Davis. L. S.. and K. N. Johnson.,1987; Straka. I. J. Waluing 1991)

Material and Methods

The plots to review are occupied with maritime pine (*Pinus pinaster*), this plant is a medium tree, reaching 20 to 35 meters high. The canopy of young trees is pyramidal, and the adult is rounded. The trunk is covered by a thick, rough skin, the reddish-brown and deeply fissured. The sub-species Mediterranean tends to have thicker shell, which may occupy more than half of the trunk section. The leaves are evergreen leaves shaped needles grouped in pairs, with 10 to 25 inches long. Has a verticilated, dense branching, the branches when they are young are very spaced and large.
Exploration model adopted for the purpose of review, considering a crop cycle of 35 years with planting and replanting the first year cleaning stand at 5 and 10 years. Thinnings to 20,25 and 30, and the cut at 35.We use the LEV technique to asset the value of *Pinus pinaster* forestry and determine the best management practice for cut the stand.
Most of times the present value (PV) is used to estimate the land value, i.e. LEV the bare land value in perpetual timber production. However there are some issues with this technique. In fact we assume the values of all costs and revenues are identical for all rotations (constant values). All costs and revenues are compounded to the end of the rotation to get the future value of one rotation. This value will be the amount received every t years. As Vicary. B. P. (1988) we also assume that the land will be forested with the same species in perpetuity, and the land requires regeneration costs at the beginning of each cycle. Finally, the cost of the land does not enter into calculation.

The LEV formula gives the value of bare land in permanent forest production (standard DCF calculation), however, when one timberland fund buys bare land, for example, it doesn't buy timberland with the intention of holding it to perpetuity.

LEV formula uses a real interest rate and 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 percent from one time period to the next).
Note that, 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 timber production, for evaluating the value of various forest management alternatives, or even for determining the age of final timber harvest (rotation age). Much timber is grown in plantations or stands with trees with the sameage witch is called even-aged management (Klemperer. W. D,1987).

Bearing in mind the business plan and the age of the forest at present, we determined the cash flow at constant prices of exploration. For this purpose it was considered an average annual increase (AAI) of 10 m^3/year of wood, resulting in the final average production of 350 m^3/ha at the end of the lifecycle of a stand. We assumed an average cost of 10 euros/ha/year for management costs of the forest and 17 euros/m^3 for transport and felling.

The thinning operations were considered to be zero balanced considering current market conditions. The forecast cut to 35 years may also be altered as a result of a price management which can perform with trees in production. On the revenue side it was considered a value of 45 euros/m^3 for timber sales for cellulose pulp.

The forester can specify the timber yields expected and should know current prices of the expected timber yields. The appraiser will be required to project future timber prices, or will probably do a constant-euro analysis and use a real interest rate as the discount rate. Timber prices have easily kept up with inflation thus the calculation for the net future value (NFV) of one rotation is:

$$NFV = \sum_{n=0}^{t} Rn(1+i)^{t} - n - \sum_{n=0}^{t} Cn(1+i)^{t} - n \quad (1)$$

$$LEV = \frac{NFV}{(1+i)^{t} - 1} \quad (2)$$

NFV = Net future value of one rotation at year t
R_n= Revenue received in year n
C_n = Cost incurred in year n
t = Rotation length in years
n = Year of a particular revenue or cost
i = Real discount rate, expressed as a decimal

Results

a) LEV values for a Pinus pinaster

If a buyer intends to follow this management sequence and wants to earn at least 4% on the investment, how much can the buyer afford to pay for the bare land?

Assuming the revenues and harvests as described in the Table 1 a 35-year rotation is described for a standart Pinus pinaster in Portugal. The real cost of capital is 4%. Site preparation and regeneration will occur in year 0 at a cost of 200 euro/ha. Annual management costs and property taxes will be 10 euros/ha/year. Thinnings will occur at ages 15, 25 and 30 and will yield 4 and 6 m^3/ha/year, respectively. Final harvest will yield 350 m^3 per hectare. Pulpwood is worth 45 euros per m^3 and the total costs of feling and transport is 17 euro/m^3. All revenues and costs must be compounded to the end of rotation (year 35 in our example) and so, the calculation for the net future value (NFV) of one rotation is:

Year	Revenue	Cost	Amount	Presente Value	Future Value
0		200,00 €	-200,00 €	-200,00 €	-1.103,20 €
5		150,00 €	-150,00 €		-648,29 €
15	5.250,00 €	1.837,50 €	3.412,50 €		9.054,38 €
25	8.750,00 €	3.062,50 €	5.687,50 €		9.264,34 €
30	10.500,00 €	3.675,00 €	6.825,00 €		8.710,62 €
35	14.000,00 €	4.900,00 €	9.100,00 €		9.100,00 €
					34.377,84 €

TABLE 1 Revenues and Costs of a Typical Forestry Investment in *Pinus pinaster* and Calculation of Net Future Value (i= 4%)

Using equation 2, LEV value is € 6.232.

Assuming that LEV represents the maximum amount that could be paid for a tract of land and still earn the required interest rate, a buyer could pay 6.232 euros per hectare for the tract and earn 4% on the investment, assuming that the land is used to grow timber according to the management schedule outlined.

This simple example does not include some common costs and revenues like hunting leases that could be significant in the Southeast of Portugal These types of costs and revenues could easily be added to the calculations in Table 1 (e.g., for example, hunting lease revenue could be netted with the annual property tax). Also the LEV calculation applies to a forest with a predictable periodic timber yield. As a practical matter, unproductive land may have to be averaged into the expected yields, or its value calculated on a separated basis.

b) Valuing Immature Even-Aged Stands Using the LEV Criterion

Pre-commercial timber holdings pose a difficult valuation question. The stands of trees have value but, by definition, they have no current potential for conversion to timber products. The value is intrinsic and is equal to the DCF expected from future timber harvests. Pre-commercial timber value changes with its temporal progression toward mature commercial timber. This value is affected by the sunk cost of stand establishment and the opportunity cost of holding land to grow trees.
Comparable sale information often does not reflect the value of immature timber. To value a parcel of land and immature timber at near bare land value, however, clearly does not make economic sense. Fortunately, a second method using LEV can clearly establish the value of immature timber,considering the same forestry investment described in Table 1.

c) Calculation of the Value of an Immature Timber Stand

Assuming a timber stand of 25 years old, a simple calculation can be used to estimate the value of this immature stand:

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

where:

V_m = Value of *m*-aged timber stand
m = Age of the immature stand
NV_t = Net value of the income and costs associated with the immature stand between year *m* and rotation age *t*.

The value of this immature stand is calculated in Table 2. The value of the immature timber is 14.634 euros.

$$V_m = \frac{24655 + 6232}{(1+0{,}04)^{35-25}} - 6232 = 14634 euros$$

Note that the value of the immature timber and the bare land is 20.866 euros. In fact, shows how the 20.866 euros was derived (14634+6232). Then ff the interest rate and future management decisions are as originally assumed in the LEV calculation, the value of an immature stand has these two components.

Year	Operation	Revenue	Cost	Amount	Future Value
25	2st Thnining	8.750,00 €	3.062,50 €	5.687,50 €	7.643,52 €
30	3st Thinning	10.500,00 €	3.675,00 €	6.825,00 €	7.912,05 €
35	Final Harvest	14.000,00 €	4.900,00 €	9.100,00 €	9.100,00 €
	Net Value at age 35				24.655,57 €

TABLE 2 - Calculation of Value of an Immature Even-Aged Timber Stand (Age = 25 years)

Note that, 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 witch is the discounted net value of the income and costs associated directly with the existing, immature stand (NV). LEV is also discounted for 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.

d) The best time to be harvested the timber

One of the highlights of the LEV is to determine which of the several alternatives for managing on even-aged stand is the best, assuming as the perspective of the forestry fund is maximize the financial return. One of the fundamental decisions that one must be make in managing an even-aged stand is decide when the stand is to be harvested and establish a new stand.

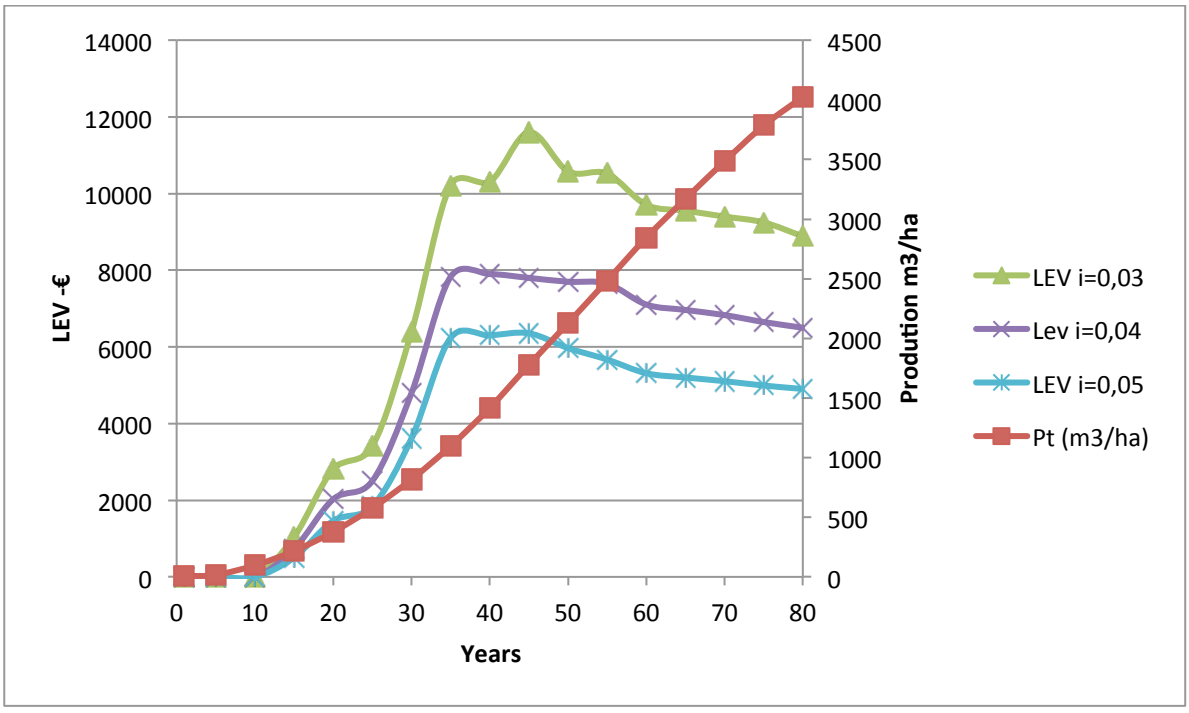

Figure 1 Calculation of the best time to be harvested the timber, for 3 capital cost.

Financially, the optimal rotation is the one that maximizes the LEV. To identify the best rotation for a stand, it is needed to calculate the LEV for a variety of rotation ages and the select the rotation age corresponding to the highest LEV. Pt is the cumulative production for the stand in m^3/ha, which is based in a model for the mean annual increment. The optimal biological rotation is when the MAI (mean annual increment) is maximized, and in our conditions 80 years. At this rotation age the LEV is only 9.000 euros/ha for 3% of cost

of capital and 4.500 euros for the 5% cost of capital. The financially optimal rotation age is between 35 and 40 years, for all the yields, it is almost a half of the optimal biological rotation. Such conclusion can be drawn based on other analysis techniques as marginal analysis of the rotation decision.

Conclusion

The LEV show's to be a powerful technique to evaluation of timberland.
A standard forestry DCF calculation is appropriate for most timberland valuation situations. In many cases the value of land and timber can be separated. The LEV model described assumes a cycle or rotation of growing trees. The standard assumption is that valuation takes place at the beginning of a cycle or rotation. The rigid assumptions of the model may make the formula inappropriate in some valuation situations, but it represents the standard forestry DCF valuation model.
The model can easily be adapted, however, to immature even-aged stands, uneven-aged stands, and uneven-aged stands between cutting cycles. Appraisers should find these techniques very useful in timberland valuation.

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