THE ESTATE OWNER'S APPROACH TO FOREST ECONOMICS

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Abstract—Faustmann's formula is often used by forest economists but some landowners ignore the time value of money and rely primarily on some type of cashflow analysis. A cashflow method was used by "estate owners" like kings, land barons, and governments. We coin the term "estate owner's method" to describe one version of cashflow analysis. This approach can be used for either a "fully regulated forest" or for a forest that is harvested using the single-tree method. When calculating a return on investment, all past investments are "sunk" and all future returns and investments are ignored. Only costs and revenue realized during the current year are considered. This method is occasionally used by some large landowners to justify long rotations. Long rotations are easier to justify when time value of money is ignored or when the interest rate is close to zero.

INTRODUCTION

Prior to 1849, the nobility (who owned large tracts of forests) kept a close eye on their forest management accounts. Some estate owners hired foresters with graduate degrees from universities in France and Germany. Trained foresters were more likely to produce a continuous source of income from the forested estate than untrained managers who simply harvested stands with no concern for regeneration success. However, regardless of who was in charge of wildlife management and timber harvesting, the estate owner's approach to cashflow analysis was employed. This method does not involve calculating a "land expectation value" (LEV) and does not involve discounting.

In current times, some large estates are managed by foresters who use the single-tree selection method of harvesting (McIntyre and others 2008). Others' estates might involve establishing a "fully regulated" forest, a.k.a. normal forest, where the forest contained an even distribution of age classes, so that it would be capable of yielding the same volume of timber every year in perpetuity (Helms 1998, Tahvonen and Viitala 2006, Viitala 2006). Regardless of the harvesting method, the estate bookkeeper examines the income and expenses on an annual basis. If income from harvests and processing exceeded expenses, the estate owner is usually satisfied. However, if expenses exceeded income for the year, the landowner would ask the forester why the expenses were so high or the harvests so low. The next year, the process would begin anew with an annual accounting of costs and income. We define this method as the "estate owner's method" (EOM) of forest economics. This approach to analyzing forest costs and returns has been used by the South African Timber Growers' Association (1993) in South Africa.

In 1849, Faustmann wrote his now famous (among academics) article on calculating forest land value (Faustmann 1849). This formula has been adapted and is taught in most forestry schools in North America. This formula allows the user to determine an LEV which could be used to determine an inherent value of the land (assuming certain management practices were used in perpetuity). However, today some forest economists select the goal of "maximizing LEV" in order to determine the optimum site preparation methods (Busby and others 1998) or the optimum rotation age for even-age management (Caufield and others 1992, Huang and others 2005).

Although developed in Germany, Faustmann's formula is seldom used in the public sector in Germany (Ince 1999). It also is given low priority when managing plantations managed by the U.S. Forest Service. Government foresters in France manage publicly owned forests using a zero interest rate. In some circles, discount rates of 4 percent are viewed as socially unethical (Sukhdev 2008). Typically, the rotation age used for public forests is much longer than that based on maximizing LEV at discount rates of 3 percent or more. For example, in the Ukraine, the official rotation age for spruce is 81 to 100 years while LEV rotation (at 4 percent) would only be 32 years (Nijnik 2004). We wonder, how often is the LEV formula used by private landowners who own large estates? Do they tend to manage on long rotations and accept low discount rates, or do they tend to manage their estates under the objective of maximizing LEV?

Is Faustmann's Formula Used in the Real World?

Faustmann's LEV formula is likely used by forest industry economists and by those of us in academia. However, it seems that landowners—either owners of single-aged plantations or owners of estates—often have objectives that do not involve calculating an LEV (e.g., McIntyre and others 2008). Some landowners may desire a plantation that offers a "sustained cashflow." Others may want a forest that "maximizes return on assets." Some may want a forest with a high benefit/cost ratio. Some may want to own forests in order to diversify their investments. Some view the timber as an "insurance policy" while others may be reluctant to pay capital gains taxes on old stands (Haney and Siegel 1993). Some may prefer a management regime that results in asset appreciation rather than maximizing new present value (NPV) or internal rate of return (IRR) (Anonymous 2002). Some may simply want the forest to provide sufficient revenues to support operations well into the future (McIntyre and others 2008). In addition to simply ignoring the power of discounting (Bilek 1994, Henry 1994), these objectives can lead to adopting rotation lengths that extend well beyond a stand's economic maturity as determined by LEV.

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Paper Objectives

The primary objective of this paper is to outline an approach to forest accounting that is sometimes used by some estate owners. This approach does not involve discounting and is referred to as the EOM. This method does not account for any costs incurred in previous years.

The secondary objective of this paper is to illustrate how seductive the EOM may be when comparing the outcome of "fully regulated" plantations. With the EOM, the inherent value and risk of the standing (uncut) timber is not taken into account when calculating the benefit/cost ratio or IRR. As a result, the benefit/cost ratio is inflated when using the EOM method. Since the EOM does not take into account the foregone benefits and further risks associated with developing the "wood factory" the EOM method favors longer rotations while the LEV method favors shorter rotations (when the interest rate is sufficiently low).

MATERIALS AND METHODS

Objective 1

We follow the example of Haney and Siegel (1993) who provide examples of forest owners who own large estates. They provide and compare specific examples of forest management plans that are designed for large estates. To illustrate the EOM, we provide two examples of estates that contain fully regulated plantations.

The first example involves the landowner, Larry, who recently inherited an estate that contained 5000 ha of loblolly pine (*Pinus taeda* L.) plantations. The estate is fully regulated, i.e., 100 ha are harvested each year and 100 ha are planted each year. The estate is valued at $36 million ($15 million for the land and about $21 million for the trees). Larry has an experienced forester who manages the forest using a 50-year rotation (note: his annual salary is $50,000).

The second case involves Terry, who also inherited a 5000-ha estate consisting of "fully regulated" loblolly pine plantations. The estate is managed by a forester (salary = $50,000) on a 25-year rotation, i.e., 200 ha are harvested each year and 200 ha are planted each year. The estate is valued at $21 million ($15 million for the land and about $6 million for the trees).

Each year, both estate managers submit financial reports to show the costs, revenue, and net profits for the year (table 1). The EOM report only considers the current year's income and expenditures. All previous investments and past revenues (spent by the original estate owner) are ignored, a.k.a. sunk. The information in this financial report is used when filling out tax forms.

Objective 2

Each year, Terry prepares a financial report that compares the estimated LEVs for both estates (table 2). When calculating the LEV, a 6-percent discount rate is used and future stumpage values are assumed to be fixed at $7, $17, $35, and $60 per green ton for pulpwood, chip-n-saw, sawtimber, and poles (all poles are older than 28 years). An adjacent neighbor recently paid $3,000/ha for a large tract of cutover land (the forest had been harvested prior to selling the property).

RESULTS

According to the EOM, the annual cashflow was approximately $0.4 million higher for the 50-year rotation than for the 25-year rotation (table 1). The annual income per ha was about 39 percent greater for the longer rotation ($293 vs. $211/ha/year). The $36 million estate generates about $1.4 million in profits each year, i.e., 9.1 percent IRR, while the $21 million estate generates about $1 million in profits, i.e., 10.3 percent IRR.

Note, however, that the LEV for the 25-year rotation was slightly higher than the LEV for the 50-year rotation. In neither case did the LEV equal $3,000/ha. The EOM and LEV methods produced different benefit/cost ratios. Due to no discounting, the benefit/cost ratio was higher for the EOM (table 2).

DISCUSSION

A major difference between the LEV and EOM is the time value of money. With LEV, establishment costs are compounded over time and with long rotations, this reduces both the LEV and the benefit/cost ratio. In contrast, costs incurred in the past are "sunk" with the EOM and therefore these costs do not lower the benefit/cost ratio. Only costs during the current calendar year are included in the calculations. Therefore, if a reforestation check is written in December 2009, the value is "sunk" and does not enter into the EOM benefit/cost ratio for 2010.

Using the LEV method, the benefit/cost ratio is about same for both Terry's and Larry's estates, i.e., 2.5. In contrast, the EOM produced a benefit/cost ratio of 8 to 15.6 (table 2). The much higher ratio for Larry's estate might persuade some landowners to say the economics of long-rotation loblolly pine stands is attractive. However, we cannot compare "apples with oranges" and therefore any benefit/cost ratio calculated with no discounting should have a footnote to indicate that no discounting was used. We suspect that most forest economists would agree that discounting should be used when comparing forestry investments.

Larry's estate is worth about $14 million more than Terry's estate because of the stock of old-growth timber. All other things equal, when a 50-year-old stand is harvested, the wood is worth about $9,200/ha while a 25-year-old stand is worth about $4,250/ha. When discounted at 6 percent, these values are roughly $500 for the 50-year-old stand and $1,210 for the 25-year-old stand. Therefore, the high value of the standing trees looks more attractive to an estate owner when discounting is ignored. Discounting is not used with the EOM (table 3).

Should LEV Be Used to Compare Fully Regulated Forests?

Terry and Larry sat down to discuss the management regimes of their "normal forests." Terry said the 25-year

Table 1—The estate owner's method of cashflow analysis. Each estate contains 5000 ha (adjacent cutover land valued at $3,000/ha) and the following expenses are only for the year 2000. Each estate is fully regulated; Terry's estate is managed on a 25-year rotation while Larry's estate is managed on a 50-year rotation.

			EOM
Estate	Treated each year	Per ha (cost) or revenue	Annual cashflow
	ha	---------- *dollars* ----------	
Terry's estate			
Site preparation and planting	200	($500)	($100,000)
Forester costs	5000	($10)	($50,000)
Total costs			($150,000)
Thinning revenue (age15 years)	200	$715	$143,000
Harvest revenue (age 25 years)	200	$5310	$1,062,000
Total revenue		$6025	$1,205,000
Net profit for 2000			$1,055,000
Larry's estate			
Site preparation and planting	100	($500)	($50,000)
Forester costs	5000	($10)	($50,000)
Total costs			($100,000)
Thinning revenue (age15 years)	100	$715	$71,500
Thinning revenue (age 30 years)	100	$3,585	$358,500
Thinning revenue (age 40 years)	100	$2,017	$201,700
Harvest revenue (age 50 years)	100	$9,584	$958,400
Total revenue		$15,901	$1,565,000
Net profit for 2000			$1,466,000

EOM = estate owner's method.

rotation was the best option since it produced the highest LEV while Larry said the 50-year rotation was best since it produced a higher cashflow with less harvesting, i.e., 100 ha/year, and less capital expenditures. Larry said that he did not care if the LEV was 16 percent higher because his objective was to optimize cashflow. He did not care about a value that is based on the assumption that future stumpage prices and future management regimes would not change. Besides, the LEV is used to determine how much one could afford to pay for land, but Larry already owned the land. He had no intention of stopping forest management because the LEV was <$3,000/ha.

Which Option Would You Choose?

Larry said the question is not which regime has a higher LEV, but which regime is more profitable? Therefore, should Larry manage his estate? Should he continue to harvest on a 50-year cycle on a fully regulated basis, or should he convert the estate to a 25-year cycle? Terry thought for a while, ran several scenarios on her computer, and came up with several hypothetical "tipping point" alternatives (each with an annual cashflow of about $1.4 million).

A. The first case involved selling the entire estate for $36 million and investing the capital in a 3.9-percent Certificate of Deposit (CD). This would bring in an annual cashflow of $1.4 million.

B. This option keeps the land in the estate, but all the old timber is sold and the receipts are put into a 5-percent CD. All the 26- to 50-year-old timber, i.e., 2500 ha, is sold for about $18 million, i.e., $7,200/ha. The clearcut half would be allowed to regenerate naturally and the remaining stands (containing 2500 ha) would be managed on a 25-year rotation. The profit from annual timber harvests ($427,500 per year) could be combined

Table 2—A comparison of the LEV approach with the "estate owner's" approach to forest economics. Each estate is fully regulated, i.e., each year an equal amount of land is harvested. Terry's estate is on a 25-year rotation (clearcut of 200 ha/year) while Larry's estate is managed on a 50-year rotation (clearcut 100 ha/year). Cashflow is higher on Larry's estate while Terry's estate has a higher LEV.

	Terry's estate		Larry's estate	
Comparison items	Discounted value/ha at 6 percent	Annual cashflow	Discounted value/ha at 6 percent	Annual cashflow
Harvest revenue	$1,534		$1,638	
Total costs	($618)		($647)	
Net present value	$917		$991	
Equal annual equivalent	$72		$62	
Land expectation value	$1,196		$1,030	
Internal rate of return	10.3		9.1	
Annual revenue		$1,205,000		$1,566,000
Annual costs		($150,000)		($100,000)
Net profit for 2025		$1,055,000		$1,466,000
Profit per ha/year		$211		$293
Benefit/cost ratio	2.5	8.0	2.5	15.6
Land value		$15,000,000		$15,000,000
Value of standing timber		$6,600,000		$21,000,000
Asset value		$21,600,000		$36,000,000
Return on assets		4.9 percent		4.1 percent

LEV = land expectation value.

from the interest from the CD ($972,500 per year) to equal an annual cashflow of $1.4 million.

C. The third option is similar to the second, except that instead of relying on natural regeneration, 2500 ha are converted to a single plantation to be harvested in 25 years. All 2500 ha are replanted in year 2011 at a cost of $500,000. Each year, a loan (to be paid back in 2035) is obtained from the bank at 6 percent real to produce an income of $276,500 per year. All the 26- to 50-year-old timber, i.e., 2500 ha, is sold for $18 million. After paying the $0.5 million bill, the remaining $17.5 million is invested in a 4-percent CD (to yield $696,000 per year). This, plus the $276,500-per-year loan plus the $427,500 per year results in an annual cashflow of $1.4 million.

Therefore, if a cashflow of $1.4 million per year is desired, it could be achieved either by: (1) investing $36 million at 3.9 percent (real); (2) investing $18 million at 5 percent (real) and managing half of the estate on a fully regulated 25-year rotation; (3) investing $17.5 million at 4 percent (real), borrowing $204,000 per year, converting half the entire estate to a single stand (25-year rotation) and leaving the remaining half on a fully regulated basis; or (4) managing a 5000-ha, fully regulated estate on a 50-year rotation, i.e., no change in management.

Terry said that when banks are only offering 3-percent real interest rates for CDs, then Larry's current management (option 4) would be favored over option 1. In contrast, if banks are offering a 5-percent real interest rate CDs, then option 1 would be favored over option 4.

Larry said he has no intention of selling his property. Although the risk might be less if he had $36 million in the bank, he chooses to accept the 0.5-percent-per-year risk of losing his timber in a wildfire. Larry also said the tax implications would likely favor option 4 over 1, especially in cases when the capital gains taxes were lower than the personal income tax rate. Since option 1 is not on the table, why would Larry choose option 2 or 3 just because the LEV/ha is higher? With option 3, he is taking the risk that a hurricane might destroy much of his stand prior to paying off the bank loan.

Is the Estate Owner's Method Similar to Using a Discount Rate Near Zero?

When the discount rate selected is 0.00001 percent, then, in some cases, the classical method of forest economics and

Table 3—A comparison of the land expectation value method of forest economics with the estate owner's method of cashflow analysis.

Comparison items	LEV	EOM
Harvest age required?	Yes	No
Useful for optimum afforestation evaluation?	Yes	No
Useful for thinning regime comparison?	Yes	No
Useful for a single stand?	Yes	No
Used to determine optimum LEV?	Yes	No
Assumes no change in future management?	Yes	No
Assumes fixed stumpage prices?	Yes	No
Discounting used?	Yes	No
Fully regulated forest required?	No	Desired
Considers only current year's costs?	No	Yes

LEV = land expectation value; EOM = estate owner's method.

the EOM will produce similar results. However, since the EOM "sinks" costs for previous years, the two methods are not identical when the discount rate is zero. The output from the EOM will fluctuate from year to year (depending on the costs and returns for that year), while results from using the Faustmann LEV formula are more stable (since users of the formula assume constant stumpage prices, constant labor prices, and a constant interest rate).

Do All Estate Owners Use the Estate Owner's Method?

Some estate owners do not use the EOM spreadsheet. In some cases, cashflow methods include inflating stumpage values 50 years into the future (McIntyre and others 2008). Occasionally, foresters compare management records over a 17-year period (Handley and Dickinson 2008). When cashflow methods involve more than one calendar year or predict future stumpage values, they do not qualify as an EOM.

The Estate Owner's Method Is Not a Method Used to Determine the Optimal Rotation

The EOM is an inappropriate method of comparing various management options since previous stand management costs are "sunk." Since the EOM uses actual stumpage values (that vary with year and season of harvest), the benefit/cost ratio will vary from year to year. In contrast, with the LEV method, the value of products at harvest is assumed to be constant and therefore the theoretical LEV for 1 year will be the same as for the next. In some cases, the "sinking of past establishment costs" might mislead landowners into thinking that planting trees for a 46-year rotation would be more profitable than for a 23-year rotation. This is because the EOM produces a benefit/cost ratio that is higher for the longer rotation (due to comparing costs and benefits for 1 year). The net cashflow for the 46-year-old pine plantation is higher than for the 23-year plantation (due in part to planting twice as many ha/year). When considering tree planting on an old field, the LEV is the appropriate method to apply when answering the question: What rotation length is optimum when the objective is to maximize the internal rate of return?

Risk

Risk can be included in both EOM and LEV comparisons. However, there are two schools of thought when it comes to assessing risks associated with long rotations. Some believe 50-year rotations of loblolly pine carry more risk while others say that 25-year rotations carry more risk. One school believes that old loblolly pines are more susceptible to beetles than young stands, especially when the basal area is high (in most years after age 25 years). Some say the risk of damage and windthrow from hurricanes is greater soon after thinning and long rotations may average more thinnings per century. Loblolly pine decline is more likely when thinning and burning cause stress to develop in loblolly pine plantations (Menard 2007).

In contrast, the other school believes risks are lower with long rotations. When consideration is given to fluctuations in stumpage prices, price appreciation, and discount rates, management for high-value products like poles may indicate a reduced risk (Anonymous 2002). In addition, historical performance has proven that favorable rates of return can be achieved from holding properties with higher near-term cashflows (MacKay 2001).

Quantifying risk is difficult which explains why risk is often ignored when comparing various scenarios. When a landowner inherits a long-rotation estate, e.g., Larry's estate, the decision to shorten the rotation might have more to do with the perceived risks than with the perceived LEV.

CONCLUSIONS

Many landowners pay taxes on their forestry investments and, therefore, each year they examine the costs and revenues from their forest land. The EOM can easily be applied each year at tax time. In contrast, the LEV method is more complicated and is typically not required for most landowners' objectives. For example, some landowners are more concerned with maximizing cashflow than they are with maximizing LEV. In general, maximizing cashflow will favor longer rotations, i.e., 35 to 50 years for southern pines, while maximizing LEV will favor shorter rotations, i.e., 20 to 25 years if a reasonable interest rate is selected.

Many landowners have multiple objectives when managing their forest land. Some do not use an LEV calculation to determine if they should own or sell their forest land. Some estate owners use a cashflow method of analysis to support their decision to manage pine stands on a long rotation. In some cases, the method of cashflow analysis involves the EOM where previous investments are "sunk" and when the time value of money is ignored.

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