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The Alternative Test in forestry

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ABSTRACT

The Faustmann theory of discounted cash flow analysis remains relevant in our modern dynamic environment in which periodic reassessment of various alternatives to ongoing forest investments is necessary. The periodic reassessment can be done using the Alternative Test (ALT) approach, which simply compares the net present value of forest investments with new price and cost data and abandonment values. This monitoring approach ignores sunk costs but accounts for the new stream of benefits, the most likely future expenditures, and especially abandonment values, and is useful to readjust forest investment and management decisions any time after the initial investments are made. This approach is used here to explain recent changes in forest policy and investment decisions in America, Asia, and Europe.

1. Introduction

The Faustmann (1849) approach to forest valuation, as all classic master pieces, stays as relevant today as it was in the mid of the nineteen century. This is true in forestry as in other sectors of the economy where cash flow analysis has become the standard by which the efficiency of public and private projects, programs, and policies is monitored and judged. To the extent that social and ecological aspects are included, this analysis duly incorporates the economic with the environmental and social concerns of sustainable forestry.

Decision-making in forest investments nowadays differs from that in the 1850s as our biophysical, socio-economic, and political contexts might change more rapidly. A simple periodic revision of the cash flow estimates to monitor forest investments using the Alternative Test (ALT) was proposed by Harou. This approach can be used in either deterministic or probabilistic fashion (Harou, 1985). For the latter, Monte–Carlo simulations show that ALT could be used to lower the risk inherent to forest investments when compared with a purely static analysis that does not envisaged possible changes of forest regime, the alternative use of the land, or the abandonment of the land itself.

Following Faustmann (1849) and Samuelson (1976), many authors have discussed the assumptions of the Soil Expectation Value (SEV) to value forest lands and to optimize forest management decisions. The literature on forest economics has pursued this topic with evolving panoply of mathematical optimization tools for different types of forest management, socio-economic contexts, and forest policies such as regulations, subsidies, and taxes. In the last forty years, the environmental (initially water and biodiversity) and social (recreation and community forestry) values of forests were introduced into the modelling (e.g. Hartman, 1976). More recently, authors have extended its application to the more resilient continuous forest cover management in the wake of climate change and carbon sequestration. Newman (2002) provides a review of Faustmann–Hartman literature up to 2000. The ALT approach presented here adds to this literature by incorporating non-systematic changes in all possible parameters as well as possible structural changes affecting forest management.

The purposes of this article are to demonstrate that the ALT approach is consistent with the Faustmann–Hartman approach with an explicit recognition and addition of possible abandonment of an investment and to use the ALT approach to explain and forecast changes in forest policy and investment decisions. This article contributes to the forest investment literature (e.g. Gregersen, 1975, 1979; Bare and Waggener, 1980; Michie, 1985; Straka, 2007) and the monitoring of forest investments, programs and policies (Harou, 1987). Our main conclusion is that the ALT approach is analogous to the Faustmann–Hartman approach and relates well to the forest land use literature as it incorporates the concept of changing non-forestry land values (Haley, 1966; Ledyard and Moses, 1976; Hardie, 1984; Harou and Essmann, 1990; Parks and Burgess, 1998; Klemperer and Farkas, 2001). Further, the ATL approach is readily useful to explain various forest policy changes and forest investment decisions, such as the rise of institutional timberland ownership and the demise of industrial ownership in the U.S. and elsewhere.

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The next section briefly reviews the modern cash flows of sustainable forest investments, followed by a summary of the ALT as it relates to the Faustmann–Hartman formula. The final sections apply the ALT to forest management and investment decisions as well as forest policy changes using recent examples from Asia, North America, and Europe.

2. Modern forest cash flows

The investment analysis pioneered by Faustmann has been developed using a perpetually recurring cash flow assumption to determine the maximum willingness to pay for bare forest land, the value a forest stand, and, classically, the optimal rotation age. Faustmann (1849) provides three different ways to obtain this maximum willingness to pay: compounding costs, compounding or discounting annuities, and discounting future cash flows. In our ever changing world, discounting future cash-flows is more appropriate.

Assuming the constancy in forest cash flows today is unrealistic given changes in technology, prices and costs, macro-economic policies affecting inflation, exchange rates, and the discount rate, and emerging global markets for forest goods and services. Further, one needs to consider more inputs and outputs in forest investments today than in the 1850s as many environmental and social impacts are now entering forest investment cash flows. This occurs more often in public investments but increasingly in private investments as well. Thus, the analysis of forestry investments under today's environmental awareness becomes more elaborate (Markandya et al., 2002).

Environmental values, which may be obtained using various valuation techniques can complicate the decision-making process (Hartman, 1976; Zhang and Pearse, 2011). When these valuations are repeated over time in different settings and for different environmental goods and services, a meta-analysis of these values can provide a more plausible range of values that can be transferred into the cash flows of similar forest investments (Stenger et al., 2009). As will be illustrated in one of our examples, however, for the most important forest goods and services, a market will eventually appear, making these valuation methods less necessary.

On social grounds adding or changing some inputs or outputs of forest investments maybe required. For instance, it has become standard procedure to incorporate the shadow price of unemployed workers in an economic analysis. A forest investment involving resettlement, as could happen in many countries, should ensure that the displaced people are at least as well off as before. This may force the considerations in the cash flows of a series of new physical inputs and outputs to be integrated into the forest investment analysis. A supplementary analysis may separate the costs and benefits by stakeholders and calculate the cost/benefit for each. More rarely the values may be modified according to those who benefits and who bear the costs for equity considerations (Harou, 1982).

The considerations of the environmental and social aspects of projects proposed in an annual budget allocation allow implementing incrementally sustainable development policies (Harou et al., 1994). Increasing the sophistication of the analysis will most likely increase the number of variables to monitor when implementing forest investments. In times of rapid changes, the economic, environmental, and social values could change rapidly and are more likely to force the reconsideration of some forest investments.

3. The Alternative Test

The ALT is the final step in the Forestry Project Monitoring Cycle in monitoring forest investments (Harou, 1979). From the pre-implementation appraisal, periodic comparisons with the actual cash flows need to be made, discrepancies identified and explained, and changes incorporated in new estimated costs and benefits if trends have been identified. Once a new forecast of the cash flows is made and past costs and benefits are treated as sunk, one may use the ALT to decide whether to continue the project in its present form or to find new alternatives.

The ALT calculates the best estimated Net Present Worth (NPW) for the remaining years of a forest project including a possible future Abandonment Value (AV), considering all possible future alternatives for managing the forest or for using the forest land that can be foreseen at the moment of the review. AV is the net benefit estimated today of a possible modified forest management plan or of the sale of the land in the future. If the land stays in forestry, only in rare instances AV could be identical in the remaining rotations as in the first rotation. The ALT compares this NPW (with a possible future abandonment) with the abandonment value (AV_0) at the time of the investment review (time = 0) to decide whether to continue the project as initially conceived, or to modify it, or to sell the forest land. The test is run every control period based upon expectation at that time.

As there may be various possible alternatives, different abandonment values should be considered over the long life of a forest investment. Estimating them is not a simple task in a dynamic world. However, if this information is available, the decision regarding whether to continue a forest investment can be readily made, as the ALT calls for possible abandonment of an investment in the first year when one of the abandonment values (AV) exceed the NPW of the remaining expected cash flows. In other words, one must choose the NPWa with abandonment in year “a” which includes the highest sum of future cash flows and future abandonment value AV_a (AV_a is the abandonment value in year a; see Eq. (1) in the next section). Otherwise, continuing the investment or abandoning the project later on can result in a suboptimal decision.

Since this analysis is full of uncertainty for forestry investments, for a forest project to continue as initially envisioned, one has to find at least one stream of cash flow that yields an expected NPW_a that is greater than the abandonment value today (AV_0, which is, again, the abandonment value at the time of evaluation, year 0). If $NPW_a > AV_0$, repeat the comparison with $a = n - 1, n - 2, \ldots$, where n is the foreseen duration of the investment. At the end of this iterative process, either $NPW_a > AV_0$ and one continues the project, or $NPW_a < AV_0$ and the project is abandoned before it ends.

The NPW_a obtained in this way is the best estimate of combined cash flows and abandonment values over the life of the forest project and can be compared with other mutually exclusive alternatives for the land or abandonment, i.e., selling of the forest land for other uses. Hence the name, the Alternative Test. An example of the calculation mechanics is provided in Harou (1987).

4. An analogy with the Faustmann–Hartman formula

A simple analogy of the ALT approach with the classical Faustmann–Hartman formula can be made. The abandonment value in a classical Faustmann approach would just be the Soil Expectation Value of the following rotations.

As stated earlier, the ALT approach seeks to find the highest Net Present Worth (NPW_a) which includes the highest possible Abandonment Value in a certain year a, AV_a, before or at the furthest foreseeable year n of the forest investment. It is defined as follows:

$$NPW_a = \sum_{t=0}^{a} \frac{C_t}{(1+r)^t} + \frac{AV_a}{(1+r)^a} \tag{1}$$

where C_t is the expected cash flow in year t ($t = 0, 1, \ldots a$; 0 is the evaluation year), AV_a is the expected abandonment value in any period “a” before or at the end of the project year n, and r is the discount rate. When $a = 0$, the first term in Eq. (1) disappears ($NPW_a = NPW_0 = AV_0$), which implies a land sale or change forest management regime at the time of evaluation.

The Faustmann formula giving the Soil Expectation Value (SEV) is:

$$\mathrm{SEV}(t) = \frac{P \cdot S(t) - C_0(1+i)^t}{(1+i)^t - 1} \tag{2}$$

where P is the stumpage price, S(t) is the merchantable volume at age t, C_0 is the regeneration cost. It is assumed that all compounded cash flows are added to the end of the rotation. The denominator is the general formula for a perpetual periodic series assuming the same cash flows every rotation.

Under the Faustmann approach, the optimal harvest age is determined by the following marginal condition:

$$\frac{P \cdot S(t) - C_0(1+i)^t}{(1+i)^t - 1} = \frac{P \cdot S(t+1) - C_0(1+i)^{t+1}}{(1+i)^{t+1} - 1} \tag{3}$$

Or simply,

$$P \cdot S'(t) = r \cdot P \cdot S(t) + r \cdot \mathrm{SEV}(t) \tag{4}$$

where $S'(t)$ is the marginal change, usually one year, in timber volume. Note that $r \cdot \mathrm{SEV}(t)$ is the annual opportunity cost of land, or land rent.

Eq. (4) is the well-known marginal condition for Faustmann rotation age in continuous format. It can be derived algebraically by subtracting $P \cdot S(t) - C_0(1 + i)^t$ from both sides of Eq. (3) and then simplifying, using $P \cdot S'(t) = P \cdot S(t + 1) - P \cdot S(t)$ and the definition of SEV(t).

To pursue the analogy with the Faustmann model, the ALT marginal conditions could be rewritten simply as:

$$P \cdot S(t) + AV(t) = \frac{P \cdot S(t+1) + AV(t+1)}{1+r} \tag{5}$$

Assuming that the subsequent rotations will be identical, the abandonment value (AV) will simply become SEV. In that case, a simple marginal analysis suffices to decide on the termination of the rotation as in Eqs. (3) or (4). It could also be that the abandonments are different in two successive rotations, and AV is equal to SEV of the second rotation (Chang, 1998). Today, the decision could include changing the present type of forest, the type of forest management, and/or the land use or mix of use at the middle of the forest rotation. A periodic reassessment with the ALT helps with adjustment in a dynamic environment.

The ALT approach is also consistent with the Hartman formula (Hartman, 1976), which incorporates non-timber benefits into the Faustmann formula. Here non-timber values are broadly defined and include benefits derived from a forest's scenic amenities, watershed functions, biodiversity, carbon sequestration services, and non-timber products such as wild flowers and mushrooms. Each of these non-timber values is related to timber volume or the age of the forest, but the exact relationship varies and may be estimated only by empirical investigations. However, unlike timber benefits that can only be obtained once timber is harvested, all of these non-timber benefits accrue incrementally (or annually). Thus, marginal (incremental/annual) non-timber benefits, n(t), can be directly added to the marginal condition of Faustmann formula in Eq. (4) (Zhang and Pearse, 2011, p. 217). Thus, we have

$$P \cdot S'(t) + n(t) = r \cdot P \cdot S(t) + r \cdot \mathrm{SEV}(t) \tag{6}$$

As we have maintained all along that AV(t) in Eq. (5) include environmental benefits (as well as social benefits), the ALT approach is analogous to the Hartman approach whose optimal condition is expressed in Eq. (6). However, the ALT approach extends the Faustmann–Hartman formula by explicitly considering possible abandonment values (including changes in forest management regimes, forest land uses, or other alternatives) in the middle of a forest investment (or rotation). On the other hand, this is the limitation of the ALT approach: it is mostly used in review process.

At the end of a forest investment or in any given year during the rotation, an investor could receive an income which is composed of a stumpage value, $P \cdot S(t)$, and an abandonment value AV(t). Under certain conditions, the investor could abandon the ongoing forest investment without receiving any revenue from timber harvest but rather a substantial abandonment value. This could be the result of a change in the socio-economic context, a new policy, or the reconnaissance of important environmental benefits from his forest. Therein resides the major difference of the ALT method with the Faustmann–Hartman assumption: the consideration of the termination of the ongoing investment at any time during the rotation by reconsidering the cash flows and alternatives. Even if the investor could consider a post-harvest change in the use of the forested land which would bring more than SEV, the land could remain under forest cover but with different uses or different owners. Thus, ALT is perhaps better suited to explain changes in forest management, forest land uses, and land ownerships.

The forest investor's decision depends on multiple factors including the timing of the investment ending, stumpage, and a mix of forest land uses. Therefore different abandonment values can be considered including the sale of the land or the sale of some sticks from the bundle of property rights pertaining to the forest and forest land. As these values can be difficult to anticipate, the ALT approach should be repeated over time. Let us now turn to some examples faced by forest managers in today's dynamic and global context.

5. Application of the ALT in different contexts

The abandonment value of a forest investment may increase or decrease depending on changes in policies, new socio-economic situations, and environmental values.

5.1. Changes in policies

The effects of policy change on abandonment values are illustrated here with examples from Taiwan and mainland China. The establishment of a new tree planting program in Taiwan illustrates how a change in forest policy can impact abandonment values, rotation age, and forest compositions. On the other hand, lack of secure property rights in mainland China between the 1980s and 1990s made the abandonment value of existing forests high so that some farmers had converted their forest lands to agricultural uses.

Since the mid-1980s, the forest sector of Taiwan has faced with increased international competition exacerbated by the appreciation of its currency and the rise in local wages. Stumpage prices dropped precipitously as imports of forest products soared—since 2000, the island has only produced 3% of its forest products need from its own forest resources. This drop in local stumpage prices made private forest landowners neglect forest management, abandon their forest assets, or convert them to agricultural or other uses. This shift in land use and land cover resulted in serious environmental externalities, such as land slide, soil erosion, and poor water quality, especially in the typhoon season.

After serious damages resulting from a 1996 typhoon, the Taiwanese government designed a generous tree planting subsidy program. The objective of this program was to provide forest landowners with incentives to plant trees and to do intensive forest management. The program participants could receive a subsidy of up to US$ 3030 per hectare in the first year to plant seedlings, US$ 909 annually between 2nd and 6th years for weeding and replanting, and US$ 606 annually between the 7th and 20th years for certain silvicultural practices. The total amount of subsidy for afforestation reached US $16,000/ha over a 20-year period. The program had a successful start with 20,234 ha planted between 1997 and 1999. However, environmentalists rallied against it. They argued that the overgenerous incentives pushed forest landowners to shorten the rotation of existing forests or to abandon their natural forests for planted forests; thus creating new harm to the environment. As the program was under attack, fear of termination of the subsidy might have further accelerated the abandonment of the ongoing forest investments. The program was eventually terminated in 2005 when the government realized its pervasive incentives to landowners and impacts on environment and budget.

The unintended consequences of this well intentioned program might have been anticipated had the ALT approach be followed. The abandonment value created by this incentive program in a depressed timber market could only have resulted in ending prematurely many existing forest investments. Indeed, the subsidy provided a relatively large inflow of cash and presented an unexpected opportunity for some landowners to terminate their ongoing forest investments as soon as possible to maximize their net present worth, NPW_a by receiving a high, subsidy-inflated, abandonment value.

In mainland China, the lack of secure property rights on forests and the need for more agricultural lands to feed a growing population in the 1980s and 1990s also made the abandonment values of existing forests rise. In the collective forest region of China, forest had been owned by the Communes before the economic reforms started in 1978. Between 1985 and 2003, some farmers were granted forest use rights for 15 years. However, the possibility of renewing the use rights was not clear. Further, they sometimes had to wait for more than a year to get a timber harvesting quota, which further infringed and limited their property rights. As forests have a long production period, this lack of secure and clear property rights made farmers less willing to invest in forests (Zhang, 2001), and increased their likelihood of abandonment prematurely of existing forest investments (Qin, 2009).

The opportunity cost of some forest land, i.e., their present abandonment value, AV_0, is agriculture use. It just happened that China needed more agricultural lands to produce foods for its increasing population then. This made the abandonment value of existing forests even more substantial. Not surprisingly, some Chinese households converted their forests to agricultural uses. A study from satellite imagery (Li et al., 2005) shows that, in the 1980s, some forests were converted into crops and grasses in some parts of China. In fact, there were more designed forest lands in China that were without trees than with trees in the 1980s (Zhang, 2001).

5.2. Changes in socio-economic context

Change in socio-economic context can elevate the value of forests and forest lands to some potential investors and increase the opportunity costs (or abandonment value) of those holding these assets. Thus, the former would potentially buy these assets from the latter. A cursory look at the web in different parts of the world seems to illustrate certain investment in forests could be explained by the ALT.

In Australia, like in many parts of the world, dynamic global markets forced some forest products companies to “abandon” their forest assets. For example, Forest Enterprises Australia Limited (FEA), which started as a purely forest investor before investing in forest products industry, stated in a recent letter to their stockholders that the company did not necessarily need to own forest lands anymore. This was because the market price of their forests and forest lands was often over their book value since new buyers value non-timber services provided by their forests. This value for the buyers had become the abandonment value for FEA.

This is also why there were significant changes in industrial timberland ownership in the last two decades in the U.S. In fact, most industrial timberland owners have either sold their timberlands to institutional investors who hire Timber Investment Management Organisations (TIMOs) to manage their forests, or converted themselves to Timberland Real Estate Investment Trusts (Timberland REITs) (Zhang et al., 2012). Often these industrial firms have signed a timber supply agreement with the new buyers. These sales allow different management alternatives while ensuring the supply of logs to their mills.

Whether a forest products industry firm decides to sell or manage its forests differently depend on its perceived cash flows and the combinations of possible abandonment values. Yet, the abandonment values of forests owned by industrial firms were changed for several soico-economic and institutional reasons (Zhang and Pearse, 2011). First, unlike these firms who primarily look after timber from their timberlands, institutional timberland owners maximize profits through timber production and non-timber uses and through converting some forest lands to other uses (higher and better uses).

Second, changing economic conditions such as low earnings of forest products firms and heavy debts put pressure on them to sell assets. Related are the US accounting rules (GAAP, or generally accepted accounting principles, which apply to all publicly traded companies), which undervalue timberland because tree growth is not considered an increase in asset value. GAAP undervalues industrial owners' timberland assets, leaving them subject to potential buyouts and added on the pressure to sell timberland.

Third and perhaps more important, the tax treatment of the revenue generated from timberland played a role. The US Internal Revenue Code provides capital gains tax preference for individuals as well as organizations (such as pension funds owned by institutional investors) that generate passive income from timberland. This means that individuals or organizations selling trees they have owned for at least a year are subject to a tax on their income of only 15%, compared to 30% to 40% income tax paid by industrial forest companies on such income. Finally, most forest product firms are classified as *C corporations* so they also pay dividend tax on earnings distributed to their shareholders. As a result, the difference in timber harvest profits between a double-taxed C corporation and a tax-advantaged financial ownership such as TIMOs and REITs can be as high as 39%. Thus, although owning timberland may be advantageous (Li and Zhang, forthcoming), forest product companies can by no means compete with REITs and TIMOs on such a high margin.

For instance, Stora Enso North America, a subsidiary of the global forest products company Stora Enso which has investments in Asia, Europe and North America, announced in 2002 to sell most of their forest land in Wisconsin—approximately 300,000 acres for $49 million (StoraEnso, 2002). The decisions to sell timberlands follow the ALT as the company stockholders require higher yield on their investments. Conversely, the company management could fear a buyout from purely financial institutions which have figured out that abandonment values could consist of many small pieces of the forest estates for urbanites in quest of bucolic surroundings.

5.3. Changes in the environmental context

As noted earlier, the reason behind the abandonment of forest lands by forest products companies is sometimes the realization that the environmental assets of their forests add a significant value to the land but they are not in a position to cash on these opportunities. Consequently, they may sell some of their forest lands to conservation groups. On the other hand, as the financial situation of some conservation organizations deteriorated in the recent financial crisis, they would be willing to sell some of the forest lands they acquired with the conditions that the new buyers practice sustainable forestry.

This was precisely what happened to Nature Conservancy who bought 161,000 acres of forest lands from a forest products company, Finch Paper LLC, in 2007 and then sold some 92,000 acres of it to a Danish pension fund (an institutional investor) that is managed by RMK Timberland Group (a TIMO). These two transitions symbolize the compatibility of forestry and conservations (The Nature Conservancy, 2009). They were made possible by aligning the newly considered environmental benefits from forests firstly with conservation purpose of a conservation organization (the Nature Conservancy) and then with investment opportunities for the institutional investor (the Danish pension fund).

Often changes in environmental contexts may lead governments to purchase land for environmental benefits and regulate forest land uses. For example, a 1911 U.S. law, the Weeks Act authorized the President to purchase from willing private landowners in the east part of the country for watershed protection at the headwaters of navigable streams. Similarly, the Clinton Administration designed more than 50 million acres of U.S. National Forests as working "wilderness areas" that exclude timber production. This, plus the 30 million acres of legislatively defined wilderness areas, has made nearly half of the 192 million acres of U.S. National Forests out of timber production since late 1990s.

5.4. Summary of the examples

These examples show that more factors need to be considered today than historically and that these factors can change rapidly. They illustrate that changing forest and land values are important for investment and policy-making decisions. The applications of the ALT approach in these different contexts around the world are summarized in Table 1.

In essence, at any points in the life of a forest investment, the investor needs to consider the future cash flows C_t but ignores the past costs and benefits when making forest management decisions at the margin. Past costs and benefits are sunk and thus irrelevant in investment decisions. However, changes in forest yield, management costs, and benefits need to be incorporated in C_t. The apparition of new environmental, social and cultural values, with corresponding changes in forest benefits and in land values, may suggest changes in the way the forest is managed now and at some points in the future.

Table 1 lists 5 different new options (A1, … A5) with 5 immediate and future changes in forest abandonment values. In rare situations in which past inputs, outputs and prices could be maintained, the existing or status quo option (A0) is chosen. Sometimes, the market price of lands could be different from the forest values obtained from both SEV and the ALT models. This could happen when new information on rapid changes has not yet been capitalized in the market price of forest land.

In the Taiwanese example, the price of input (essentially labor) increased, stumpage prices decreased, and the environmental benefit of soil protection increased. When these environmental benefits are entered into the economic cash flows, a well-managed forest providing soil protection has a positive return from a societal point of view. However, for a landowner, managing the forest stand is not financially profitable, $NPW_{A0} < 0$. This discourages active forest management by private owners. This dual analysis from societal and private points of view suggests that it is necessary to use a proper policy instrument to align private decisions to societal interests (Cubbage et al., 2007).

But in this case, the over-generous forest incentive program, conceived to correct for the negative impacts of soil erosion, created a new abandonment value under option A2 (establishment of new forests). This invited landowners to clear cut their forests prematurely because $NPW_{A2} > NPW_{A0}$. The end result is that land owners chose to have profitable financial returns along with new negative environmental impacts. A run of the ALT could have shown *ex-ante* that an incentive of this magnitude would make it more profitable to clear-cut many existing well managed forests. A smaller subsidy or a subsidy with restrictions (excluding the eligibility of well-managed forests) might have prevented or lessened this problem.

Similar reasoning can be followed for China. The pressure on some farmers was to abandon existing forests and not to invest in tree planting ($NPW_{A0} < 0$), in favor of agriculture even on marginal land ($NPW_{A4} > 0$). This problem could be partly solved by providing secure property rights and ensuring the users of the forestland to receive adequate stumpage benefits.

Turning to the socio-economic contexts, many economic and institutional factors in Australia, America, and Europe disfavored industrial timberland ownerships. Sometimes it is because the revenues from timber growing is too low to just maintain the value of the capital invested in forest land, unless environmental or other non-timber benefices are monetized. More often, it was because of markets, taxes, and accounting rules that have favored other owners. In all cases, forest products companies had to sell their land (because $NPW_{A5} > NPW_{A0}$).

Concerning the new environmental context, non-government organizations such as the Nature Conservancy are interested in managing the forest for timber and environmental goods and services. For them, it is profitable ($NPW_{A3} > 0$) to buy forest land at a market price (NPW_{A0}) which has not yet incorporated positive externalities, and to find acquirers for these environmental assets, such as the Danish pension fund, with a stipulation of sustainable forestry practices.

Many uncertainties exist in these decisions and today new contexts evolve constantly and rapidly. The ALT approach proposed here is simple but potentially powerful to incorporate these changes in the management of forest land and to guide proper forest investments. The approach is useful also to help guide forest policies by tailoring appropriate incentives to internalize forest externalities. Misguided forest policies could do more damages than without policies. The ALT can be used also to monitor and evaluate periodically the impacts of various policies and programs.

Table 1
Summary of ALT examples.

Change factors	CF_0[a]			Options[b]					NPW_{A0}[c]	ALT[d]
	PI	PS	PE	A1	A2	A3	A4	A5		
Policies										
Taiwan	+	−	+		X				< 0	$NPW_{A2} > NPW_{A0}$
Mainland China		+	+				X		< 0	$NPW_{A4} > NPW_{A0}$
Socio-economics										
Australia			+					X	< 0	$NPW_{A5} \geq NPW_{A0}$
USA/EU	+		+	X	X	X	X	X	> 0	$NPW_{A1\text{-}5} > NPW_{A0}$
Environment										
Denmark/USA			+			X		X	> 0	NPW_{A3} or $NPW_{A5} > NPW_{A0}$
USA			+			X		X	> 0	NPW_{A3} or $NPW_{A5} > NPW_{A0}$

Note: Past cash flows from the beginning of the investment up to the monitoring year, 0, are sunk and thus irrelevant for decision-making.
[a] CF_0 = new cash flow from year 0 to the end of the investment period, n; PI = price of inputs; PS = stumpage price; PE = price of environmental goods and services; "+" means increasing; "−" means decreasing.
[b] A0 = with unchanged forest management plan (or SEV); A1 = with different silviculture; A2 = with a new forest; A3 = with a new mix of forest uses; A4 = with new land use; A5 = with land sale.
[c] NPW_{A0} = Net present worth with unchanged forest management plan or identical SEV (status quo), at evaluation year 0.
[d] When more than one options are viable, the investor chooses the one with the highest NPW.

6. Conclusions

Faustman's theory of estimated discounted cash flow analysis to value and manage forests stays much relevant today. The simple ALT approach explicitly considers a possible future abandonment of the land, current forest use, other forest management schemes, and revised cash flows of the same forest investment. It is analogous to the Faustmann–Hartmann approach without assuming constant forest production functions and prices. It allows integrating appropriate abandonment values in the cash flow analysis, and thus help ensure in many cases the proper forest valuation at any time during the life of the investment.

The examples provided show how using the cash flows analysis together with the ALT approach may help make management decisions in our fast moving economic and biological world. The decisions to change a rotation depend on the abandonment of the land use or the need to follow new silvicultural prescriptions given modified forest management objectives and a change of context. For instance, the abandonment of even age management for continuous forestry could become the management alternative if it brings, on top of a more resilient forest ecosystem, interesting new recreation or carbon market benefits. The management of the new forest will be guided by the ALT as different abandonment values embodying different forest investment alternatives evolves over time. The difficulty to correctly appraising the new possible alternatives is the reason why the ALT requires forest managers to just find one path of possible abandonment in the future, NPW_a, being greater than the current abandonment value, AV_0. The manager then waits for the next period to reassess the situation.

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