PROSIECT CARTREFI O BREN LLEOL
THE HOME-GROWN HOMES PROJECT

04 Economic aspects of woodland creation for timber production

Accounting for time

Written by Ashley Hardaker
for Woodknowledge Wales
March 2021

PRIFYSGOL BANGOR UNIVERSITY
woodknowledge WALES

Guidance

This document is part of a series of *guidance notes* aiming to provide practical information for farmers and other landowners interested in investing in forestry. It is designed to help develop a first understanding of economic evaluation of afforestation projects. As such it introduces the basic steps involved in the assessment of such projects to allow some preliminary due diligence when considering an investment in forestry. This does not replace a full assessment and advice by a chartered forest manager.

There are six documents in this series

01 Financial evaluation of afforestation projects - basic steps

02 Evaluating the financial costs of forestry

03 Revenue from forestry enterprises

04 **Accounting for time**

05 Alternative tools for financial evaluation of forestry

06 Incorporating uncertainty and risk into forestry financial evaluations

Production of timber occurs on a timescale quite different to agriculture or other investments. Money is spent today, hedging on major returns in 40 years' time or more. This makes time a relevant factor when undertaking financial evaluations of afforestation projects. Investment timescales in such projects are lengthy, costs are typically front loaded and there is a long time delay before incomes are received from harvesting timber. Different afforestation projects can have very different cash flows where revenues and costs accrue at varying points in time in the future. Two planting schemes may have the same establishment costs but the planting scheme with a long rotation may yield more timber (and hence higher timber revenues) than the scheme with a shorter rotation. For the investor, this begs the question: is it worth the wait for the higher revenues? In this guidance note we will explain why accounting for time is important when undertaking financial evaluations of afforestation projects and how it is accounted for using a process called discounting.

Theoretical background: Investment and Consumption

In order to understand why accounting for time in financial evaluations is important, it is useful to understand key elements of capital theory, investment and consumption. According to this, resources such as land, labour and capital can either be used to create capital goods or sold to generate incomes immediately.

Capital goods are assets needed for production or to generate income from production. This is termed an *investment*, as costs are incurred with the purpose of increasing future revenues. In forestry, resources are used to create a capital good, i.e., a woodland, from which incomes can be derived by selling timber in the future. When resources are sold to generate incomes immediately, this is termed *consumption*. The land that trees might be planted on could be sold to generate income immediately rather than waiting for trees to grow, harvesting them and then selling timber.

This choice between investment and consumption involves two time related considerations that have an important bearing on financial evaluations, the so-called *opportunity cost of time* and *time preference*.

The opportunity cost of time

In economic terms, if you sold your land today and could receive £5,000 per hectare, this would be *consumption*. If instead you retained possession of your land and grew trees for timber, and could receive £16,000 per hectare in 40 years' time, this would be *investment*.

By choosing the investment option you are forgoing immediate income from an alternative use of resources (e.g., putting the sales revenue into a savings account) in order to generate future income. Forgoing the revenues from the best alternative use of resources is an opportunity cost. The opportunity cost of choosing between consumption and investment is known as the *opportunity cost of time*.

Time preference

In addition to the opportunity cost of time, the value of income varies depending on its timing. According to economic theory, the income is more valuable the earlier it is received. Hence, a given quantity of income today has a higher value than the same quantity in the future. This is the concept of *time preference*. It is based on the assumption that most people would prefer the immediate reward, even if the future income is potentially greater.

Discounting

The two factors, *opportunity cost of time* and *time preference*, are accounted for by a process called *discounting*. Discounting is used to compare cash flows that accrue at different times. Future revenues and costs are discounted to a common point in time at or before the first cash flow using a defined discount rate. This point is usually the present day. Discounting weights the value of cash flows that occur closer to the present day higher than cash flows further into the future (see time preference). The present day equivalent value of a future cost or revenue is its present value (Box 1).

Box 1: Calculating present values

The present value of future costs or revenues can be calculated using the following formula:

$$\text{PRESENT VALUE} = \frac{\text{value of future cost/revenue}}{(1+\text{discount rate})^{\text{year into the future}}}$$

When using this formula, the chosen discount rate needs to be expressed as a decimal number, e.g., a discount rate of 3% would be expressed as 0.03.

Mathematically, discounting is the reverse of compounding, e.g., interest accrued on money in a savings account. Instead of multiplying an amount by the rate of interest once for every year into the future, it is divided by the rate of interest once for every year back in time from the point in the future that benefit is obtained.

When using discounting to compare cash flows between two investments, the present value of each cost or revenue needs to be calculated at the point in time it accrues. This is because cash flows at different points in the future do not have equivalent value. Taking this approach, the discounted costs and revenues can provide an estimate of the profitability of an investment. Table 1 provides an example: Option 1 seems to have higher revenue than option 2. When this revenue is discounted to factor in *opportunity cost of time* and *time preference*, the opposite is true. In this example, the option giving lower revenue on a shorter timescale is financially favourable.

Table 1: Comparing revenues that accrue at different times

Option	Revenue source	Year	Revenue (£)	Discounted revenue to present day (£)
1	1st thinning	15	1,000	$1{,}000 \div 1.03^{15} = 642$
	2nd thinning	25	3,000	$3{,}000 \div 1.03^{25} = 1{,}433$
	Final harvest	50	12,000	$12{,}000 \div 1.03^{50} = 2{,}737$
		Total	**16,000**	**4,812**
2	1st thinning	10	1,000	$1{,}000 \div 1.03^{10} = 744$
	2nd thinning	20	3,000	$3{,}000 \div 1.03^{20} = 1{,}661$
	Final harvest	40	10,000	$10{,}000 \div 1.03^{40} = 3{,}066$
		Total	**14,000**	**5,471**

Discounting sets a condition that, for an investment to be profitable, the revenues that accrue at some point in the future must be sufficient to cover:

1. The explicit costs incurred as part of the investment (e.g., establishing the plantation woodland).

2. The implicit costs incurred to account for the 'opportunity cost of time' and 'time preference' enumerated as a proportion of the future value of a revenue lost (i.e., the difference between the discounted and undiscounted value of the revenue).

For useful discounting formulas see *Basic Concepts in Forest Valuation and Investment Analysis*, for more information on the theory of discounting see *Time, Discounting and Value* and for the use of discounting in forestry economics see *The Theory and Application of Forest Economics* or *Forestry Economics*.

Choosing a discount rate

The choice of discount rate can have a dramatic effect on the overall profitability of an investment option. Choosing the right discount rate for your financial evaluation is very important. In the private sector where commercial returns on investments are being assessed, discount rates are generally based on alternative uses of capital or expected returns on alternative investments. Two types of discount rates, nominal and real, may be used in financial evaluations:

1. *Nominal discount rates* are based on interest rates on borrowing money or the rate of returns on alternative investments. They are sometimes called the *cost of capital*. This refers to the rate you could have earned on funds by other uses, or the rate you're paying to borrow someone else's funds, and includes a measure of inflation. The nominal discount rate is used when future revenues or costs are projected to include *inflation* (see Box 2).

2. *Real discount rates* represent the *opportunity cost of time* and *time preference* only. The real discount rate is used when future revenues or costs are projected uninflated in present day (real) terms. They are used in economic evaluations in the public sector. Real discount rates can be derived from nominal discount rates by removing the measure of inflation using the following formula:

$$\text{REAL DISCOUNT RATE} = \frac{(1+\text{nominal discount rate})}{(1+\text{rate of inflation})} - 1$$

The nominal discount rate and rate of inflation need to be expressed as decimal numbers. For example, the cost of borrowing (interest) on a loan is 5% (0.05) and inflation is currently at 2% (0.02), using this formula the real discount rate would be 3% (0.03).

When choosing between nominal and real discount rates consistency is key. If your projection of costs and revenues reflects inflation, use a nominal discount rate. If your projection of costs and revenues is in constant money terms (i.e., today's costs and prices) use a real discount rate.

Box 2: Inflation

Inflation is the decline in the purchasing power of money compared with the price of goods over time. Discounting is not used to account for inflation within financial evaluations. Inflation can be explicitly included or excluded from the financial evaluation depending on how costs and revenues are projected into the future. For example, if you are expecting to yield 600 m^3 from timber in 40 years times and standing timber is selling at £25 per m^3 today, when estimating the future revenues from timber you can either:

Project them based on prices prevailing in the present day, so you are expecting to receive £25 x 600 = £15,000.

Or

Project them based on prices adjusted for inflation (e.g., inflation at 3%), so you are expecting to receive (£25 x 1.0340) x 600 = £48,931.

Effects of discounting on revenues and rotation lengths

Discount rates used by forest managers when assessing the returns on investments in afforestation and timber production typically range from 1% to 7%. Table 2 shows the huge effect of discount rates on the calculation of present value. Discounting at a rate of 7% diminishes undiscounted timber revenues of £27,250 per hectare at 80 years to only £122 per hectare. The choice of discount rate can also affect how long you might leave a timber crop to grow to maximise revenues.

When timber revenues are undiscounted, revenue is maximised on the longest rotation. However, when revenues are discounted, the rotation length at which revenue is maximised gets shorter and shorter (see Table 2). Given the significant impact of time and discounting, it is advisable to include different discount rates and rotation lengths in the sensitivity analysis of your financial evaluation (see *Financial Evaluation of Afforestation Projects - Basic Steps*).

Table 2: Present value of timber revenues from a one hectare stand of yield class 16 mixed conifers planted at a 2-m spacing discounted at varying real discount rates (from 1% to 7%) across varying rotation lengths

Rotation length (years)	Harvested volume (m³ per hectare)	Undiscounted revenue (£ per hectare)	1%	2%	3%	4%	5%	6%	7%
20	7,585	2,000	1,639	1,346	1,107	913	754	624	517
25		4,250	3,314	2,591	2,030	1,594	1,255	990	783
30	490	7,000	5,193	3,864	2,884	2,158	1,620	1,219	920
35	476	9,750	6,883	4,875	3,465	2,471	1,768	1,269	913
40	124	12,250	8,228	5,548	3,755	2,552	1,740	1,191	818
45		14,750	9,426	6,050	3,900	2,525	1,642	1,072	702
50		17,250	10,489	6,409	3,935	2,427	1,504	936	586
55		19,250	11,137	6,478	3,788	2,226	1,315	781	466
60		21,250	11,697	6,477	3,607	2,020	1,138	644	367
65		23,000	12,046	6,349	3,368	1,797	965	521	283
70		24,500	12,209	6,126	3,094	1,573	805	415	215
75		26,000	12,327	5,888	2,833	1,372	670	329	163
80		27,250	12,293	5,589	2,561	1,182	550	258	122

Practical Guidance & Advice

In this guidance note, we have explained why time is an important input into financial evaluations and introduced you to the use of discounting. The examples given have been based on future revenues but the principles are the same for future costs.

We hope that this will help you undertake some preliminary due diligence when considering whether to adopt a forestry enterprise or invest in an afforestation project. Before making the final decision we recommend seeking further advice and guidance from a *forest manager or agent*.

You can find more detailed information on financial evaluations of forestry investments *here*:

01 Financial Evaluation of Afforestation Projects - Basic Steps
02 Evaluating the Financial Costs of Forestry
03 Revenue from Forestry Enterprises
04 Accounting for Time
05 Alternative Tools for Financial Evaluation of Forestry
06 Incorporating Uncertainty and Risk

Technical Information

Basic concepts in forest valuation and investment analysis: Edition 3.0 2011. Bullard, S.H. and Straka, T.J. Available at: *http://scholarworks.sfasu.edu/forestry/460%5Cnhttp://scholarworks.sfasu.edu/forestry/460/*

The Theory and Application of Forest Economics. Price, C. Blackwell 1989

Time, discounting and value. Price, C. Oxford: Blackwell 1993

Forestry Economics. Wagner, J.E. Abingdon: Routledge 2012

About the author
Ashley Hardaker is an interdisciplinary researcher at Bangor University interested in decision analysis in relation to land use, forestry, agroforestry and agricultural systems. He is particularly interested in research to inform decision making surrounding woodland creation in agricultural systems and how they can be designed to deliver public and private economic benefits. He engages with a range of research disciplines including ecosystem services, GIS, economics and operations research. The author is grateful for contributions to these briefing notes from Prof. John Healey of Bangor University

Llywodraeth Cymru
Welsh Government

Published with financial support from Welsh Government