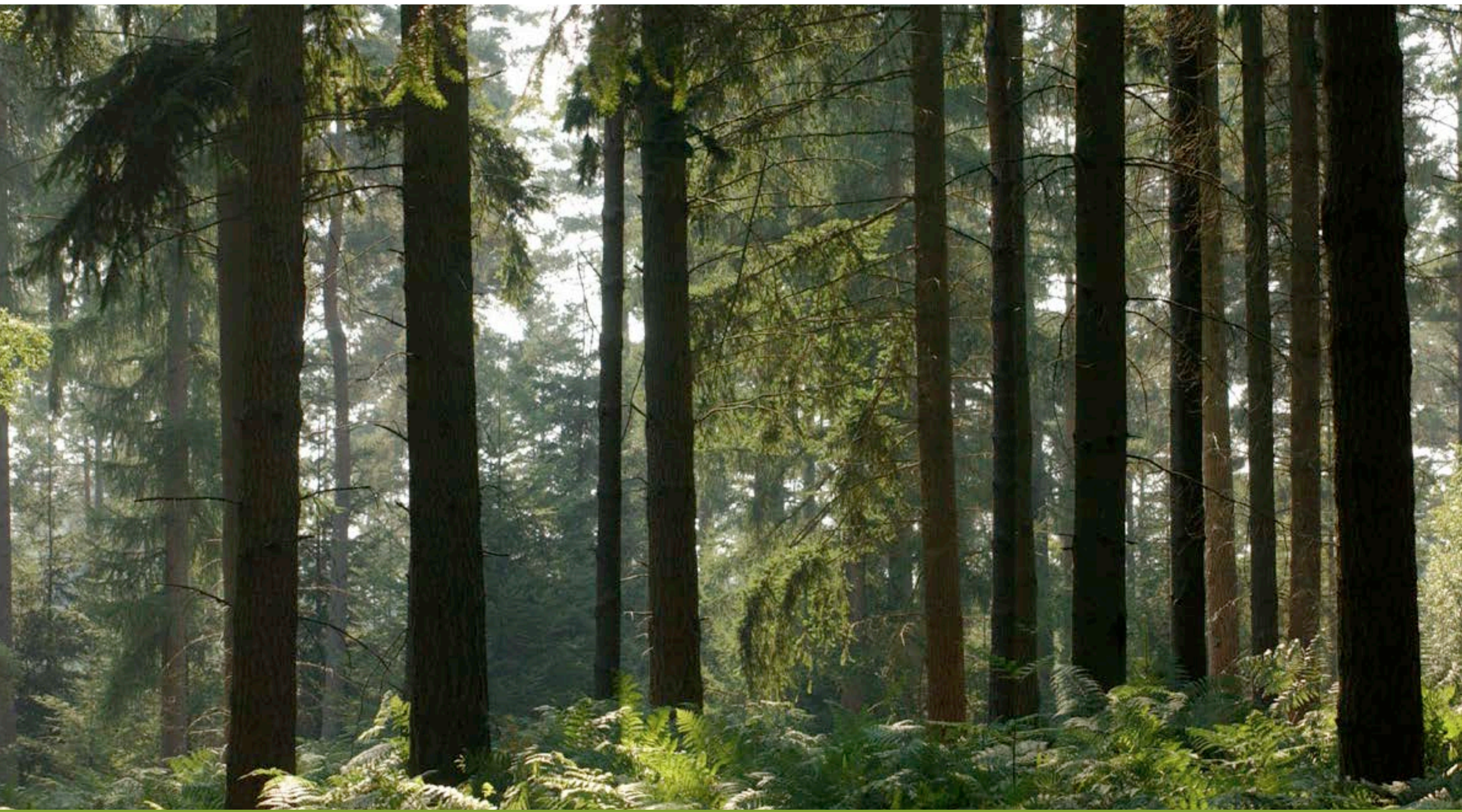

Research Note

Assessing the investment returns from timber and carbon in woodland creation projects

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Financial returns from woodland creation have traditionally been generated from sales of timber. In recent years, the voluntary carbon market has established and grown in the UK and landowners can now generate additional revenue from the sale of carbon. The sale of carbon 'credits' allows landowners to increase their financial returns by creating woodlands for both timber and non-timber objectives. Even at conservative yield classes and low carbon prices, woodlands can generate £400–£1300 of extra income per hectare when carbon credits are included, and much more for higher yield classes or carbon prices. The costs and benefits of woodland creation projects can vary significantly. However, this Research Note shows that, based on conservative assumptions for the five woodland types analysed here, the net present value for woodland creation increased by around 40–70% for some projects and enabled other projects to produce positive returns from the inclusion of carbon revenue. The analysis also shows that financial returns from commercial rotations can be increased by selecting a longer rotation length that will sequester more carbon. Even at low carbon prices, the extra carbon revenue generated from increasing the rotation length by five years outweighs the reduction in timber value from delayed harvesting. At higher carbon prices a further increase in rotation length could also be substantiated.

Introduction

This Research Note estimates financial returns to landowners from planting woodlands and selling carbon credits and explores how these returns vary based on woodland type, trends in carbon prices and other factors.

The traditional income source from woodlands is timber. In recent years a voluntary carbon market has been established. In this market, firms will pay landowners for creating woodlands to sequester carbon. This presents landowners with a potentially significant source of additional income.

This Note uses investment appraisal techniques to estimate the financial viability of woodland creation for five different woodland types, presenting the results as net present values (NPVs) per hectare. It then uses a sensitivity analysis to see how these values are affected by varying factors such as carbon prices, discount rates, yield class, whether third parties are involved in project development, and rotation length.

Although details are not given in this Note, landowners also need to be aware that rising woodfuel demand has increased timber prices at the lower end of the price–size curve. Woodlands can also provide a wide range of other services, which are typically not bought and sold in markets but are highly valued by society.

Background

Demand for wood products in the UK greatly outstrips domestic production. The UK imports around 80% of its timber needs, and is widely accepted to be a price-taker in the timber market. There is an active market for domestically grown softwood (conifer) timber. In addition, there is an increasing desire to establish a quality hardwood sector in the UK, which would increase standing values for broadleaved woodland. Further, a growing market for woodfuel is increasing the economic viability of many conifer and broadleaved woodlands.

Woodlands are often seen as a long-term investment, providing investors and landowners with steady returns and a good degree of certainty associated with timber outputs, in addition to a number of tax exemptions. Martinez-Oviedo and Medda (forthcoming) show that including woodland in an investment portfolio increases overall portfolio returns and reduces volatility. The Investment Property Databank (IPD) UK Annual Forestry Index regularly shows annual average returns of 15–20% on commercial plantations, many of which are bought mid-rotation by large firms such as pension companies (MSCI, 2015).

Carbon markets present an opportunity for landowners to generate more income from their land, by selling the additional carbon that new woodlands will sequester, while at the same time helping mitigate the impacts of climate change. Since 2011, 250 projects covering around 16 200 ha have been registered in the UK under the Woodland Carbon Code (WCC) (www.forestry.gov.uk/carboncode). The WCC is a voluntary standard for woodland creation projects in the UK. By following a process of validation and verification (third party checks) under the WCC, woodlands are able to sell the carbon that a newly created woodland will sequester. WCC projects to date are predicted to sequester 6.0 $MtCO_2e$ over their lifetime and have been enabled with the carbon finance provided by investors. Landowners can receive around £3–£15/tCO_2e in the UK and around 70 % of the carbon rights have been sold up front. The rest are retained for future sales with anticipation of increasing prices.

Woodland creation projects are undertaken for a variety of reasons. Landowners receive payments for the carbon their woodlands will sequester. However, many woodlands will provide other benefits as well such as recreation areas or increasing the amenity value of farmland. Analysis for the Woodland Carbon Task Force (www.forestry.gov.uk/england-wctf) run by Forestry Commission England indicates that a wide variety of organisations and individuals are interested in investing in woodlands to sequester carbon. These groups include high net worth individuals, landowners, institutional investors, retail investors and other organisations looking to reduce their carbon footprint, for financial reasons and/or for corporate social responsibility.

Model and methods

Investment appraisal techniques were used to estimate the financial viability of woodland creation for a range of different woodland types. In addition to a range of assumptions on woodland types and planting costs the following data were used:

- Forestry Commission timber yield data
- WCC carbon look-up table data[1]

The financial viability of a woodland creation project with and without carbon finance has been estimated to show the additional finance generated. Assumptions, discussed in more detail below, have been made on typical grant rates by country, establishment and maintenance costs for each woodland type, size–price curves for timber, carbon prices and the discount rate.

1 Estimates of carbon sequestered are reduced by 20% for modelling precision (errors in modelling the growth potential of the woodland) and 15% for risks to permanence (such as windthrow and pests and diseases).

The results are presented as the net present value per hectare (NPV/ha) for each woodland, a metric commonly used to compare different investments. NPVs are estimated by subtracting the total (discounted) costs of a project from the total (discounted) revenues, as shown in Table 1. Discounting is a technique used to adjust for the fact that costs and benefits received now carry a higher value than equivalent costs and benefits received in the future. NPVs have been estimated at a discount rate of 3%, which broadly reflects rates used by private investors in commercial forestry. At a 3% discount rate £1 received in 40 years' time would be the equivalent of around 31p received today.

Table 1 Costs and revenues of a woodland creation project.

Costs	Source
Established costs	Internal data
Maintenance costs	
Revenues	**Source**
Grants	Grant rates for each country
Timber income	FC yield data and indicative timber prices
Carbon income	WCC look-up table data and typical prices received under WCC
Net present value = (Discounted) revenues – (Discounted) costs	

Woodland types and data

Woodland types

The analysis presented below examines investment returns for five different types of woodlands. These types are based on an expert assessment of future UK woodland types from work carried out by CJC Consulting (2014) on behalf of the Forestry Commission and Defra. The woodland types vary by factors such as species, yield class, spacing, rotation length, woodland size and region. These factors can vary considerably, resulting in numerous possible combinations of woodlands. Conservative assumptions for yield classes have been made for this analysis.

The woodland types considered here are:

- Farm woodland: managed for mixed objectives
- Broadleaved woodland: managed for game and biodiversity
- Broadleaved woodland: managed for timber
- Upland conifer: managed for timber
- Lowland conifer: managed for timber

More detailed data on these five woodland types can be found in Box 1.

Forestry Commission datasets have been used to estimate the volume of timber growth and carbon sequestration over time for the above woodland types.

Planting and establishment costs

The costs of establishing woodlands can vary significantly depending on the location, woodland type and operations that need to be undertaken. Reasonable costs have been applied based on data available to the Forestry Commission and expert opinion provided by foresters. These range from £3 400/ha to £7 700/ha for planting and establishment phase costs (usually 15 years) for the five woodland types considered. These costs could easily be higher or lower, for example where more or fewer fencing or spiral tree guards are needed due to grazing animals such as deer and rabbits. A summary of the costs used to model the five woodland types can be found in Box 2.

Grant rates

Grant rates have been applied at 80% of capital establishment costs in England and Wales, in line with Countryside Stewardship

Box 1 Information on woodland types

Woodland type	Species	Yield class	Spacing (m)	Rotation (years)	Gross area (ha)	Location
Farm woodland: managed for mixed objectives	Sycamore/alder/birch (65%), Douglas fir (25%), open space (10%)	10, 18	2.5	Indefinite	3	Northern England
Broadleaved woodland: managed for game and biodiversity	Sycamore/birch (45%), oak (45%), open space (10%)	8, 6	2.5	Indefinite	5	Wales
Broadleaved woodland: managed for timber	Oak (45%), birch (45%), open space (10%)	4, 8	1.7	100	5	Southern Scotland
Upland conifer: managed for timber	Sitka spruce (90%), open space (10%)	14	1.7	52	50	Northern Scotland
Lowland conifer: managed for timber	Douglas fir (90%), open space (10%)	16	1.7	55	10	Eastern England

Box 2 Planting and establishment costs

Operations included in each of the five woodland types were drainage, fencing, insurance, plan preparation costs, beating up, plants and planting costs, general maintenance, ground preparation, establishment phase maintenance costs and weeding. The three broadleaved sites also contained costs for marking out, stakes, tubing and spiral guards. The two commercial (conifer) sites also contained costs for roading. The table below summarises the undiscounted costs for the planting and establishment phase (15 years) and the total lifetime of the whole woodland, as well as per hectare for broad comparisons.

Woodland type	Whole woodland		Per hectare	
	Total lifetime costs	Planting and establishment costs	Total lifetime costs	Planting and establishment costs
Farm woodland: managed for mixed objectives	£41 600	£23 100	£13 900	£7 700
Broadleaved woodland: managed for game and biodiversity	£49 300	£20 000	£9 900	£4 000
Broadleaved woodland: managed for timber	£66 900	£35 600	£13 400	£7 100
Upland conifer: managed for timber	£342 600	£170 900	£6 900	£3 400
Lowland conifer: managed for timber	£96 600	£51 700	£9 700	£5 200

grant rates (based on information from the Forestry Commission Grants and Licensing team). Maintenance payments of £200/ha for 10 years have also been included. In Scotland 80% of establishment and maintenance costs have been applied. In addition, landowners can usually retain farming subsidies, such as the basic payment, for a number of years following woodland creation. These have not been included.

Timber prices

Box 3 shows the size–price curves applied for typical softwood (conifer) and hardwood (broadleaved) harvests. A further set of prices is also included for 'quality hardwoods' as the price of hardwood timber can vary significantly depending on the end-product quality as a result of the management regime.

Carbon prices

The analysis is based on carbon prices of £3, £6 and £9/tCO_2e paid up front to the landowners, via a project developer, for woodland creation. These prices broadly reflect a range of prices paid at present (2017). The Department for Business, Energy & Industrial Strategy publishes annually updated figures (previously produced by DECC) that reflect the cost of reducing emissions in order to meet UK climate change targets. A price of £60/tCO_2e has also been included to indicate this wider value of carbon sequestration to society. In reality, market prices are significantly short of this level but it does indicate the scale of benefit that investment in woodland creation provides to society.

Additional revenue sources

There are a number of other potential financial benefits for landowners creating woodlands. There may be additional benefits to farms from scaling back on activity no longer required and from shelter provided by woodlands. The presence of woodlands on farms has been shown to add to overall property values and many woodland owners also derive income from game shooting (John Clegg Consulting, 1993). Planting woodlands near rivers could also improve local water qualities and/or reduce water flows and risks of flooding, which can attract further grant funding and in some cases payments from water utility companies. None of these sources of income have been included in this analysis.

Carbon value of the woodland types

Table 2 shows the amount of claimable carbon sequestered by the different woodland types, based on the yield classes shown in Box 1, and its value at selected carbon prices. Even at low carbon prices it is possible to generate a significant amount of additional income from sales of voluntary carbon credits. The carbon sequestration that can be claimed for commercial woodlands is generally lower. Not all of the carbon sequestered can be claimed

Table 2 Carbon value of woodland.

Woodland type	Area	Claimable tCO_2 sequestered		Carbon value of woodland/ha			
	ha	per ha	total	£3	£6	£9	£60
Farm woodland	3	450	1 300	£1 300	£2 700	£4 000	£26 900
Broadleaved woodland (G/B)	5	330	1 700	£1 000	£2 000	£3 000	£20 000
Broadleaved woodland (T)	5	200	1 000	£600	£1 200	£1 800	£12 300
Upland conifer	50	130	6 300	£400	£800	£1 100	£7 600
Lowland conifer	10	240	2 400	£700	£1 400	£2 200	£14 400

Note: rounding has been applied to the tCO_2 and carbon value figures.

Box 3 Timber prices

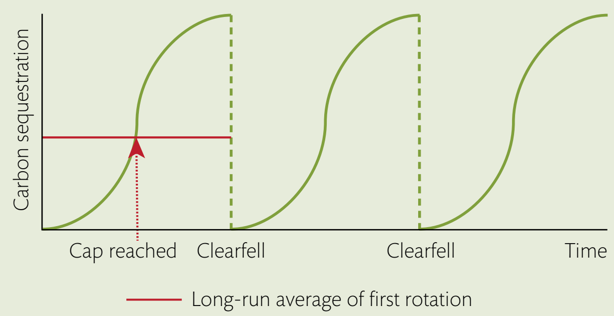
The table below shows the price-size curves used for softwood, hardwood and higher quality productive hardwood in this Note.

Softwood		Hardwood		Quality hardwood			
Size (m^3)	Price (£/m^3)	Size (m^3)	Price (£/m^3)	Size (m^3)	Price (£/m^3)	Size (m^3)	Price (£/m^3)
0.10	5.0	0.1	6.0	0.1	12.00	1.7	65.75
0.15	7.0	0.2	11.0	0.2	13.50	1.8	67.50
0.20	10.0	0.3	13.0	0.3	15.00	1.9	67.50
0.25	14.0	0.4	15.5	0.4	15.00	2.0	77.00
0.30	17.5	0.5	17.5	0.5	15.00	2.1	77.00
0.35	21.0	0.6	19.0	0.6	15.00	2.2	78.75
0.40+	22.0	0.7	20.5	0.7	24.00	2.3	78.75
		0.8	22.0	0.8	33.00	2.4	78.75
		0.9	23.0	0.9	39.00	2.5	80.50
		1.0	24.0	1.0	48.50	2.6	80.50
		1.1	25.5	1.1	54.50	2.7	80.50
		1.2	26.5	1.2	60.50	2.8	82.25
		1.3	27.5	1.3	60.50	2.9	84.00
		1.4	28.5	1.4	60.50	3.0+	85.75
		1.5	29.5	1.5	64.00		
		1.6+	30.0	1.6	65.75		

when the woodland is felled because felling releases carbon, eventually, back into the atmosphere. Therefore, the amount of sequestration that can be claimed for commercial woodland is capped at the average amount of carbon in the woodland over the rotation. This is typically about 30–50% of the cumulative total of the first rotation, as shown in the graph in Box 4. Although the amount of claimable carbon is lower, the cap is reached much sooner than for projects that are not clearfelled, enabling shorter projects. Sequestration for non-commercial woodlands is based on the cumulative level after 100 years.

All of the examples in Table 2 show the amount of claimable carbon sequestered, adjusted downwards by 20% for precision and 15% for permanence in line with WCC guidance[1].

Box 4 Long-run average of carbon sequestered



The graph shows a typical profile of carbon sequestration over time for commercial woodland. WCC projects for rotational woodlands are able to claim the average level of the first rotation of sequestration as shown by the red line. This is typically around 30–50% of the full amount of that first rotation, and can be claimed in the first rotation up to the point at which the average level is reached.

Results

Table 3 shows the NPV/ha at a range of carbon prices (£/tCO_2e), with 100% paid up front, for the five woodland types. Key aspects of each woodland type are discussed in turn below.

Table 3 NPV per hectare.

Woodland type	NPV/ha at each carbon price £/tCO_2e					Threshold price
	£0	£3	£6	£9	£60	
Farm woodland	-£1 500	-£200	£1 200	£2 500	£25 400	£3.34
Broadleaved woodland (G/B)	-£900	£100	£1 100	£2 100	£19 100	£2.80
Broadleaved woodland (T)	-£2 300	-£1 600	-£1 000	-£400	£10 000	£8.01
Upland conifer	£1 000	£1 400	£1 800	£2 200	£8 600	£ –
Lowland conifer	£1 000	£1 700	£2 500	£3 200	£15 400	£ –

Farm woodland

Farm woodlands offer an opportunity to generate upfront income from carbon as well as further revenue flows from thinning the woodland in the future for woodfuel. A 3 ha mixed woodland in northern England could be expected to sequester 450 tCO_2e/ha over 100 years. This example assumes higher establishment costs due to the need for tubing during the establishment of the woodland to protect the trees from wildlife. Therefore, positive returns are generated at a 'threshold price' of £3.34 tCO_2e. Excluding tubing and associated labour costs would increase the returns from this woodland. At higher carbon prices this woodland performs very well due to the higher amounts of carbon sequestered.

Broadleaved woodland – game and biodiversity

A broadleaved woodland managed for game and biodiversity can generate upfront carbon income as well as timber revenue from thinning the woodland. The woodland could also add amenity value to the holding and opportunities for game-related income. As highlighted earlier, neither of these benefits have been included in this analysis. A 5 ha woodland in Wales would be expected to sequester around 330 tCO_2e/ha over 80 years[2]. Positive returns for this woodland are generated at a threshold price of £2.80 tCO_2e. Carbon payments make a significant difference to the NPV – at higher carbon prices this woodland generates returns comparable to the commercial options below.

Broadleaved woodland – timber

A broadleaved woodland managed for timber in southern Scotland could be able to claim around 200 tCO_2e/ha on a 100-year rotation. Because of the longer timeframe, the discount rate heavily impacts the future value of the harvested hardwood. Positive returns are generated from a 'threshold price' of £11.03/tCO_2e, based on grants at 80% of establishment costs. If higher timber prices are used, more reflective of the price of quality hardwood, the threshold price drops to £8.01/ tCO_2e. Alternatively, relaxing assumptions that a high level of annual maintenance is required over the 100 years would also improve the returns for this woodland.

Upland conifer

Upland conifers offer a significant investment opportunity, which can be further enhanced with carbon funding. A 50 ha Sitka spruce plantation in northern Scotland could be able to claim 130 tCO_2e/ha over a 52-year rotation. The results in Table 3 show positive returns at all carbon prices based on planting and establishment costs of approximately £3 400/ha and receiving standard grants of around 80%. At £3/tCO_2e income from carbon increases the NPV/ha by around 40%.

2 Timber yield models for sycamore, alder, birch only enable estimation up to 80 years.

Lowland conifer

Lowland conifers offer a significant investment opportunity, which can be further enhanced with carbon funding. A 10 ha Douglas fir plantation in eastern England could be able to claim 240 tCO_2e/ha over a 55-year rotation. The results in Table 3 show positive returns at all carbon prices based on planting and establishment costs of approximately £5 200/ha and receiving standard grants of around 80%. At £3/tCO_2e income from carbon increases the NPV/ha by around 70%.

Sensitivity analysis

The costs and benefits of woodland creation can vary significantly on a site by site basis. This section explores how the NPV is affected by varying the following factors: carbon prices, discount rates, yield class, whether third parties are involved in project development, and rotation length.

Carbon prices

Ex-post carbon payments

Projects can choose to retain some or all of the carbon credits in anticipation of rising future demand rather than selling all available credits at the start of the project. At a discount rate of 3% there would need to be an average annual increase in carbon prices of greater than 3% over the project life in order to generate a greater return. While such persistent increases might be unrealistic for more established markets such as timber, carbon markets are still developing and 3% increases do not appear unrealistic when compared with estimated increases in DECC carbon values.

EU ETS prices

Carbon credits from woodland creation in the UK are not currently eligible to be traded in markets such as the EU Emissions Trading Scheme (EU ETS). However, should this change in the future it is worth considering how EU ETS prices would affect returns from woodland creation. The average price in 2015 and 2016 has been €6.22/tCO_2e (http://uk.investing.com/commodities/carbon-emissions-historical-data accessed 28 April 2017). At present exchange rates (approximately £1 = €1.17 as at 28 April 2017) this is around £5.30/tCO_2e. Table 3 above suggests that four out of the five woodland types would be expected to make substantial returns at this price, although it is important to note that both the EU ETS price and the £/€ exchange rate fluctuate considerably. The EU ETS price has varied between €3.92 and €8.78 in 2015 and 2016 and the exchange rate was as high as £1 = €1.31 in 2016.

Discount rates

The analysis in Table 3 used a discount rate of 3%. Table 4 shows the NPV/ha at a higher, 5%, discount rate along with threshold prices where relevant. At a carbon price of £6–9/ tCO_2e four out of the five woodlands generate a positive NPV.

Table 4 NPV per hectare at a 5% discount rate.

Woodland type	NPV/ha at each carbon price £/tCO_2e					Threshold price
	£0	£3	£6	£9	£60	
Farm woodland	-£1 800	-£300	£900	£2 200	£25 100	£4.00
Broadleaved woodland (G/B)	-£700	£300	£1 300	£2 300	£19 300	£2.08
Broadleaved woodland (T)	-£1 900	£1 300	-£700	-£100	£10 300	£9.30
Upland conifer	£300	£700	£1 100	£1 500	£7 900	£ –
Lowland conifer	-£300	£400	£1 200	£1 900	£14 100	£1.18

Yield class

Table 5 shows how the NPV increases for each woodland type when woodland is planted on high quality land. The yield classes have been increased from the moderate yield classes in Box 1 to the higher end of yield classes for which data is available (12 for sycamore, alder or birch, 8 for oak, and 24 for Douglas fir or Sitka spruce). The NPVs increase dramatically due to the extra carbon sequestered and extra revenue from timber. Carbon sequestration increases by 30–70% for the conifer options and 20–40% for the broadleaved options. At a carbon price of £3 this generates £200–£300/ha more carbon revenue than the core results as well as substantially increasing the revenue from timber.

Table 5 NPV per hectare at higher yield classes.

Woodland type	NPV/ha at each carbon price £/tCO_2e				Threshold price
	£0	£3	£6	£9	
Farm woodland	-£600	£1 000	£2 600	£4 200	£1.11
Broadleaved woodland (G/B)	-£200	£1 100	£2 300	£3 600	£0.39
Broadleaved woodland (T)	-£1 100	-£300	£500	£1 400	£4.07
Upland conifer	£3 900	£4 600	£5 200	£5 800	£ –
Lowland conifer	£3 600	£4 500	£5 500	£6 400	£ –

Projects with no third party project developer

Some WCC projects have no project developer. In this situation the landowner bears all the costs of validating the project at the outset and regularly monitoring and verifying the project over its lifetime, as well as the cost of using the UK Woodland Carbon Registry. By following this approach it can be possible for the landowner to receive a higher price per tonne of carbon dioxide. To give an example, the extra costs of validating and verifying a single project are typically £730 in years 0 and 5 and every 10 years thereafter. For the 80-year broadleaved game and biodiversity option this amounts to £6570. The cost of using the UK Woodland Carbon Registry at 9p/tCO_2e would be £150. Altogether, this raises the threshold price from £2.80 to £4.67, as shown in Table 3. If a self-developed project was able to receive a higher price, of £15/tCO_2e, the NPV/ha would rise to £3 400/ha.

Rotation length

This section considers the implications of carbon revenue on the rotation length of woodlands. Table 6 shows the present value of the revenue from timber only and from both timber and carbon (at £3/tCO_2e). Results are shown per hectare based on the Sitka spruce yield class 14 from the upland conifer model and on the Douglas fir yield class 16 from the lowland conifer model and at discount rates of 3% and 5%. As would be expected, including carbon revenue always results in a greater per hectare value at each rotation length than not including carbon revenue. However, the table also shows that when carbon revenue is included the rotation length that generates the greatest revenue (in bold type) is five years longer for both species at both discount rates at £3/tCO_2e.

Table 6 Present value of timber and carbon revenue for different rotations.

Rotation length (years)			42	47	52	57	62	67
Sitka spruce	3%	Timber	£2 200	£2 490	£2 710	£2 820	**£2 850**	£2 820
		Timber and carbon £3/tCO_2e	£2 520	£2 910	£3 130	£3 340	£3 360	**£3 420**
	5%	Timber	£1 000	£1 060	**£1 080**	£1 060	£1 020	£970
		Timber and carbon £3/tCO_2e	£1 320	£1 480	£1 500	**£1 580**	£1 540	£1 570
Rotation length (years)			45	50	55	60	65	70
Douglas fir	3%	Timber	£3 060	£3 290	£3 440	£3 510	**£3 530**	£3 500
		Timber and carbon £3/tCO_2e	£3 560	£3 910	£4 160	£4 230	£4 250	**£4 310**
	5%	Timber	£1 360	**£1 380**	£1 370	£1 340	£1 300	£1 250
		Timber and carbon £3/tCO_2e	£1 860	£2 000	**£2 090**	£2 060	£2 020	£2 060

In other words, longer rotation lengths are financially more beneficial when carbon revenues are included as the extra carbon revenue from increasing the rotation length offsets any potential reduction, through discounting, in revenues from timber. Generally speaking, the higher the carbon price, the longer the implied increase in rotation length.

This analysis presents results over a single rotation. There are also economic models that analyse the optimal rotation length of woodlands over a series of infinite rotations. Results from Saraev, Edwards and Valatin (forthcoming) also show that over numerous rotations higher carbon values imply longer rotation lengths.

Conclusions

This Research Note has analysed the financial returns of woodland creation projects in light of recent developments of the voluntary carbon market in the UK. It is possible to develop hundreds of potential scenarios for woodland creation based on different combinations of species types, growth rates, discount rates, grants, timber prices and planting costs. This Note has analysed the returns from five woodland types that broadly reflect some key woodland types in the UK, based on conservative assumptions around the costs and revenues involved.

Overall, carbon finance was shown to add £400–1300 per hectare at £3/tCO_2e and £1100–4 000 at £9/tCO_2e. The results, as shown in Table 3, demonstrate the potential for carbon revenues to make significant improvements to the financial returns of each woodland type at prices of £3–9/tCO_2e. Broadleaved woodlands generally benefitted more from the inclusion of carbon revenue due to their longer timeframes and higher levels of carbon sequestration. However, the results for rotational conifers also showed an increase on already positive returns with the inclusion of carbon revenues.

Sensitivity analysis was undertaken on a number of aspects including carbon prices, discount rates, yield class, whether third parties are involved in project development, and rotation length. Woodland creation on better quality land with a higher yield class was shown to significantly increase the CO_2 sequestered and therefore the overall NPV. The results shown in Table 5 were £1000 to £3100 higher per hectare than the main analysis results shown in Table 3 at a price of £3/tCO_2e. Analysis also showed that carbon (and overall) revenues can be increased by increasing the rotation length on commercial woodlands. In the examples shown, a five-year increase was implied at £3/tCO_2e, which would be expected to increase at higher carbon prices.

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