Extended Abstract
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Paper/Poster Title	**Economic incentives for woodland creation on farmland in the UK.**

Abstract prepared for presentation at the 98th Annual Conference of The Agricultural Economics Society will be held at The University of Edinburgh, UK, 18th - 20th March 2024.

Abstract	***200 words max***
How best to incentivize landowners to create new woodland on farmland is an important question, given domestic policy objectives of net zero and preventing on-going biodiversity losses. In this paper, we use an economic decision-making model linked to a spatially-explicit ecological model to show how UK farmers would respond to two different economic incentives: a payment for actions (plant woodland) and a payment for modelled results (where payments depend on predicted impacts on focus woodland bird species). We compare the ecological and economic effectiveness of these policy options, and evaluate impacts across a range of alternative biodiversity indicators, across two case study landscapes in England and Scotland. A novel feature of this work is that we explicitly account for both patch-level and landscape-level drivers of biodiversity change, based on a species abundance model which controls both for total woodland area in the landscape as well as woodland characteristics at the patch level. Spatial heterogeneity in the opportunity costs of woodland creation to farmers are also accounted for, using an agent-based modelling approach.	

Keywords	Economic incentives, biodiversity, farm woodland, spatial heterogeneity
JEL Code	Q1, Q2, Q5 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***

How best to incentivize landowners to invest in higher outputs of public goods is an important policy question. We focus on two public goods which are the subject of much current policy debate: achieving net zero greenhouse gas emissions; and meeting the Kunming-Montreal global biodiversity agreement targets. In the UK, expanding woodland cover is an important part of the net zero strategy. However, much of the land on which woodland could be created is privately owned. Farmers thus need to be offered a sufficient financial incentive, through some kind of PES or agri-environment scheme, to agree to change from current agricultural land use to woodland creation. The dominant policy design over the last 20 years has been payment for actions, for example under Countryside Stewardship, the Sustainable Farming Initiative, and the vast majority of EU Pillar 2 agri-environment schemes.

However, payment for results has emerged as an interesting alternative to payment for actions. Since payment for *actual* results risks a low participation rate due to higher uncertainty for farmers, payment for *modelled* results has been proposed by Bartkowski et al (2021) as an attractive alternative. Simpson et al (2023) investigate this option for grassland waders in the UK. We extend this work by (i) comparing results between two landscapes with differing spatial correlations between opportunity costs and ecological potential, since this spatial correlation is key to explaining how to efficiently allocate contracts across space (ii)

focusing on woodland creation and biodiversity outcomes on woodland birds as the public goods of interest and (iii) explicitly incorporating landscape-level effects and temporal spillovers on species abundance in our ecological modelling.

Methodology	***100 – 250 words***

We represent two case study UK landscapes (central Scotland and the English Midlands) as a grid of 1km by 1km (100 hectare) parcels. Our model focuses on changing land-use decisions within parcels currently being used for agriculture. Each parcel is assumed to represent an agent (land manager) who decides how best to manage their parcel. We assume agents maximise profits, and the default land use for agricultural land parcels is either crop or livestock production (on improved grassland). However, agents can choose to enrol land parcels into a woodland creation scheme and receive either: (i) a subsidy payment for each hectare of woodland planted, or (ii) a payment related to the predicted impact of woodland planting on three different woodland bird species on their land. We model each agent as choosing the best use of their land by comparing the returns (profits) from maintaining current farming practices with these economic incentives for woodland creation.

Changing land management decisions at the parcel level are expected to affect biodiversity outcomes both within the parcel and the surrounding landscape. To explore this, we estimate a species distribution model to predict the presence/absence of three bird species for each parcel across the full landscape. This ecological model takes into account (i) where the new woodland is created (ii) the size of this woodland (iii) the area of woodland in a 3km area around the focus patch, to take account of potential spatial spillovers, and (iv) changes in woodland in the landscape over the last 100 years, to take account of possible temporal spillovers. This allows us to study how three indicator woodland bird species respond to both parcel-level and landscape-level land cover decisions. These species are chosen as representative of differences in ecological response to woodland at both the patch and landscape level.

We fix the total budget available for each policy option (pay for actions or pay for modelled results) as being equal, then simulate both the economic outcomes (net financial effects on participating farmers) and ecological outcomes (changes in predicted species abundance) of payment for actions compared to payment for modelled results. This enables us to compute the relative cost-effectiveness of the two policy alternatives.

Results	***100 – 250 words***

A key parameter likely to determine the relative cost-effectiveness of policy options is argued to be the spatial correlation between opportunity costs of conservation (here, woodland creation) and some measure of environmental benefit (here, the predicted change in the probability of species presence for each of the three indicator species. We compute these spatial correlations, and find them to differ significantly between the English and Scottish case study sites. Our findings on payment for actions are based on a payment for woodland planting which is calculated from mean opportunity costs in the English and Scottish case studies, plus a notional fixed planting grant of £500/ha.. This base payment rate is then increased in 6 increments to trace out a supply response from the farmers in each landscape. We then show (i) where woodland is created as a result of each policy option being implemented (ii) the overall economic impacts of each policy, and how these are distributed across participating farmers (iii) the predicted effects on abundance in each location for 3 woodland specialist bird species. Having obtained the predicted change in species presence for each of the three indicator species, we then apply the same budgetary spend to a payment for modelled results policy, as in Simpson et al (2023).

Discussion and Conclusion

100 – 250 words

How best to incentivise land managers to change land use to move us closer to the twin policy goals of net zero and biodiversity conservation is an important question. In this paper, we show how an ecological-economic modelling framework can be used to compare two alternative economic incentives: a payment for actions (plant woodlands on farmland) and a payment for modelled results policy, where farmers receive payments which vary spatially according to the predicted impact of their actions (woodland creation) on a biodiversity indicator. We show that these two policy options differ in the cost-effectiveness for a given budgetary cost; and that their comparative performance varies in a predictable way based on the spatial correlation of opportunity costs and environmental benefits.

Such insights are valuable as the UK develops both its biodiversity policy response to the Kumming-Montreal protocol targets, and its lane use for net zero policy. As the European Union also faces these twin policy challenges, we argue that our work has relevance beyond the UK farm sector.