Optimal policies to promote large carnivore conservation in a spatially heterogeneous landscape

Andrew Miller, miller.5776@osu.edu

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The Ohio State University, Department of Agricultural, Environmental and Development Economics

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Andrew Miller, Daniela Miteva, Sathya Gopalakrishnan

Introduction

- Human-wildlife conflict prevalent with large carnivores due to the effect that they can have on livestock.
- While these species have net social benefits, the costs are borne locally while the benefits are global, exacerbating the problem.
- This issue has been at the forefront recently, e.g. Colorado voting to allow wolves to recolonize the state.
- What is the solution to this problem? Transfers via a third party such as a wildlife service agency.

Payments to promote conservation

Ex-post payments:
- Compensate farmers for confirmed losses
- Very widely used
- Issues: transaction costs, pricing, loss of habitat, "moral hazard"

Ex-ante ("performance" payments)
- Compensate farmers for existence of wildlife
- A type of payment for ecosystem service (PES)
- Aligns the incentives of the wildlife service and the farmer.
- Has been shown to be theoretically superior to ex-post compensation (Skonhoft, 2017; Skonhoft
- and Solstad, 2020).

Issues:
- What measure should be used to determine the payout?
- How will the payouts vary over space?
- How good does the "performance" measure need to be?

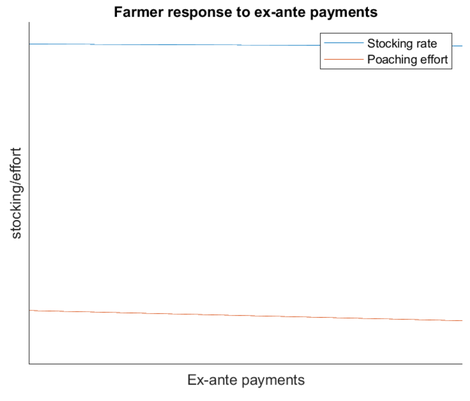


Figure 1: Farmer's response to a range of ex-ante payments by the wildlife service. Both stocking rate and poaching effort are slightly decreasing in the payment amount.

Objectives

How does error in the performance measure affect the optimal payment policy?

This research answers two questions:
1. How do the farmers respond relative to the types of payments?
2. How does the optimal policy change as the distance between the true carnivore observation and the performance measure increases?

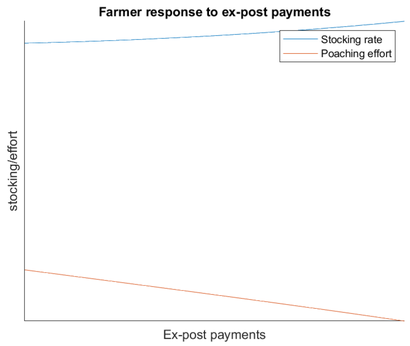


Figure 2: Farmer's response given levels of ex-post payments. Stocking rate is increasing in the amount of ex-post payments, and poaching effort is decreasing in the amount of ex-post payments.

Methods

Model

- The farmers act independently as first movers, each solving the problem, each maximizing profit given her landscape characteristics, distance from the carnivore central location and choosing the stocking rate and level of poaching.
- The farmer's optimization problem can be solved as a function of ex-ante and ex-post payments and parameters.
- The Wildlife Service minimizes its budget, subject to two constraints:
  1. The average farmer is not made worse off (in profit) by the carnivores.
  2. The carnivore population, net poaching results, are maintained at or above a certain level set by policymakers.
- The farmer response function can be fed into the wildlife service problem so that the wildlife service problem can be solved.
- The model was solved with increasing variance in the error term of the observed versus true wolf distribution.

Results

Farmer response

- The model was solved analytically to obtain the farmers response to any given policy scheme.
- Figure 1 shows the effect of increasing ex-ante payments on the farmers response function. The farmer responds by reducing both stocking rate and poaching effort slightly.
- Figure 2 shows that the farmer reacts to increasing ex-post payments by increasing her stocking rate and decreasing her poaching effort.

Wildlife Service Cost Minimization Problem

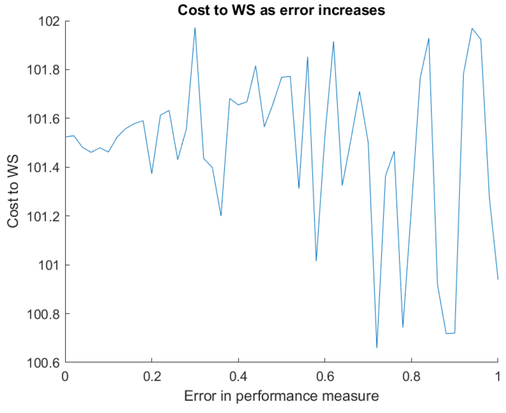
- The cost minimization problem of the wildlife service was solved numerically using Matlab's "fmincon" function (MathWorks, 2019).
- Figure 3 reports the results of a simulation, where the variance of the unobserved portion of the carnivore population was increased. As the variance of this parameter increases, so does the variance in the optimal ex-post payment. However, the optimal ex-ante payment stayed essentially stable.
- Figure 4 shows that the variance in the wildlife service's budget also increases as the variance in the error between the observed wolf distribution and the true wolf distribution increases.

Figure 3: Results from the solution of the wildlife service cost minimization problem.

Discussion

Implications, limitations, and future work

- We have created a one-period model to analyze the incentives faced by livestock producers facing payments to promote conservation.
- This work implies that wildlife service agencies should consider moving their budgets to ex-ante payments, or a policy mix with predominately ex-ante payments and some amount of ex-post payments.
- A limitation of the current model is that it is static in time. A more realistic model would include multi-period decision making, especially if farmers believe that poaching in this time period will lead to reduced depredation in the future.
- While the results of the model were simulated using the best available parameters, the results should be tested empirically to validate these results.



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