CS 236R Project Proposal
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Overview

We plan to take a mechanism design–approach to address the problem of allocating **Payments for Ecosystem Services (PES)**. These are payments made to landholders to take environmentally-friendly actions such as preserving forests, reducing use of pesticides, or eliminating toxic emissions. PES are an attempt to capture the **positive externalities** of natural systems such as clean air, biodiversity, and forests. Without external intervention, the situation can be described by the tragedy of the commons [Hardin 1968].

PES is widely implemented by governments and NGOs around the world. There are over 550 PES programs globally with an estimated $36–42 billion in annual transactions [Salzman et al. 2018]. These include the UN-REDD program, which aims to reduce carbon emissions by providing payments to reduce deforestation while promoting sustainable development. PES programs have also been shown to provide broader societal benefits by strengthening social relationships and a sense of community [Alix-Garcia et al. 2018].

Related work

There has been significant literature from the perspective of environmental management to demonstrate the effectiveness of PES programs. One randomized controlled trial conducted in Uganda demonstrated that villages where a PES program was implemented had only 4.2% decline in tree cover after two years compared to 9.1% in control villages [Jayachandran 2017].

Ecosystem services encompass water, biodiversity, and forestry, which are examples of renewable natural capital. The challenge in renewable natural capital markets is the presence of externalities, both positive and negative. Market design can be used to address these externalities. Specific challenges with renewable natural capital markets (compared to other capital markets) are (a) heterogeneity, (b) high cost of monitoring and transactions, and (c) complementarities [Teytelboym 2019]. We plan to address the third challenge in formulating our theoretical model. That is, that natural capital (like uncut forest cover) has greater value when left untouched in large, contiguous blocks of land.

The public goods model has been used to model similar situations of non-cooperative outcomes in a social dilemma. Our problem differs from this model because there is no shared resource, such as a lake for fishing. Instead, we are trying to motivate private, individual landowners to take socially-optimal actions.

Goals

We are driven by the question of how to maximize PES outcomes under budget constraints. Informed by related work and previous studies, we want to build a simple model for PES and develop theory to create a solution. With this model we plan to test different mechanism designs allowing us to investigate optimal budget allocation to maximize the effectiveness of PES (i.e., maximize return on investment). Our model will rely on a few assumptions such as, for instance, knowledge on the utility function distribution of agents. We aim to formalize proofs with regard to objective maximization for our budget allocation mechanism. Building on such simple and provably optimal model, we intend to relax some assumptions and study variations of model parameters in simulation. For instance, considering different agent utility functions might yield further insights into how to optimize PES when dealing with non-risk-neutral agents [Chawla et al. 2018].

Time, resources, and interest permitting, we might run a small Mechanical Turk in which we compare an original "game" before PES with an improved "game" after our PES mechanism has been applied (a preliminary experiment limited to some 20 participants working for 1h each, i.e., to a budget of $500).

Project steps

- Understand previous PES studies in detail (2 weeks), open questions include:
    - Are there any datasets from PES field experiments available?
    - How is paying for positive externalities different from paying for not having negative externalities?
    - How do public good models work and how will our PES model be different?
    - Has there been evidence for a crowd-out effect in PES, i.e., vanishing intrinsic motivation of people to preserve ecosystems because of external monetary incentives?
    - Since there is no cost of participating in PES, why is not everyone participating? Are there neighbor/group effects such as psychological group pressure to participate?
- Build simple model and proof mechanism (2 weeks)
- Explore model in simulation, find further qualitative insights (e.g., scaling laws) (2 weeks)
- Prepare presentation, write report (1 week)

References

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