An experiment on ecological restoration

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Extended Abstract

Traditionally, environmental policies and regulations mainly focus on the prevention and mitigation of damage, to minimize negative effects on the environment. However, the global and local threats of the climate, biodiversity, and pollution crises are soliciting a profound revision of norms and resource management. Among the most impactful measures that could come at hand, ecological restoration and the efforts to recover damaged or polluted ecosystems are probably one of the most overlooked yet promising ones (Akhtar-Khavari and Richardson, 2019), attracting the attention of international and national regulatory bodies, with 2021-2030 declared as the UN Decade on Ecosystem Restoration.

Etymologically, "restoration" is about "building up again", and it evokes at least two temporal framings: the present, when the activity is implemented, and a generic past when conditions were different. According to the Society for Ecological Restoration, ecological restoration is "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed", and aims to "move a degraded ecosystem to a trajectory of recovery that allows adaptation to local and global changes, as well as the persistence and evolution of its component species" (Gann et al., 2019).

In general, restorative activities can encompass a variety of interventions, from returning an ecosystem to its historical conditions, to deliberately creating "novel ecosystems" (Higgs, 2003). They can be implemented in rural or urban contexts and can occur across a variety of scales: from very localized areas to mega-projects, from afforestation to the remediation of riverbanks (Allison et al., 2017), supporting the ecological health of ecosystems, and also – often – contributing to adaptation to the climate crisis. Overall, the research shows that the current implementation of restoration activities is scattered, uncoordinated, and often inadequate, being ill-equipped in ensuring ecological recovery where pollution is pervasive. Indeed, in most cases, projects suffer from different hindering factors such as limited legal reach, low political support, misguided incentives, information asymmetries and lack of coordination among stakeholders (Cortina-Segarra et al., 2021).

Once viewed as a bottom-up collective action problem, restoration might be hampered by the free-riding problem that is typical of public goods. Indeed, agents might be tempted to exploit the restoration activities provided by others. However, socio-institutional and behavioral factors might compensate for this lack of incentive for the provision of restoration initiatives. These factors make restoration differ from public good provision. The main structural difference depends on the circumstance that the possibility of restoring occurs after the environmental good has already been exploited and the community that could be interested in its restoration is either witness of the exploitation or responsible for it. This circumstance might activate several motivations hampering or sustaining restoration. A negative reciprocity and a sense of loss connected to the displacement of the social norms that should have helped the community preserve the environmental resource in the past; a new sense of responsibility and a renewed sense of belonging to a shared identity are just some examples of such motivations.

In this paper, we adopt an experimental approach to measure individual willingness to restore a common pool of resources previously subject to exploitation. Our design consists of two stages. In the first stage, after subjects are matched into groups composed of three members, they play an extraction game. They decide how much to extract from the common pool and what they extract is added to their initial endowment. In the second stage, subjects play a public good game in which they can add to what remains from the extraction made in the first stage certain amount to restore the common pool. After these two decisions, participants are paid what they kept from their endowment, what they extracted, and the return from what remains after restoration in the common pool which is multiplied by a certain coefficient and divided equally among the three members of the group.

Our two-stage game can be formalized as follows. Let n denote the group size, Y is i's endowment and P the common pool resource. The payoff of a player i is:

$$U_i = Y+e_i+\beta(P-\textstyle\sum_{j=1...i...n} e_j)-c_i+\alpha_{pgg}(\sum_{j=1...i...n} c_j)+\alpha_{eg}(P-\sum_{j=1...i...n} e_j)]$$

with $0 \geq \alpha, \beta < 1$ and $\alpha_{pgg} \leq \alpha_{eg}$.

The Nash Equilibrium of this game is *full extraction* in Stage 1 and *no restoration* in Stage 2 since, by backward induction:

- 2^{nd} stage: Optimal contribution is $c_i = 0$.
- 1^{st} stage: Optimal extraction is $e_i = MAX$ if $\alpha + \beta < 1$.

The treatments of the experiment are obtained by setting $\beta = 0$ and varying the marginal per capital return of restoration (i.e. α_{pgg}) as compared to the return that subjects obtain from what remains in the pool after extraction (i.e., α_{eg}). Specifically, we will set two treatments, one in which $\alpha_{pgg} = \alpha_{eg}$ and one in which $\alpha_{pgg} \geq \alpha_{eg}$, to investigate whether subjects scale restoration up after the increase in its efficiency. Moreover, to control for a potential order effect, the two treatments are also run by inverting the order of Stage 1 and Stage 2 – i.e. the restoration game first, and the extraction game afterward – with the adequate manipulation of marginal per capita returns so that the standard and the inverted conditions differ only with respect to the order of the two games. Finally, the last treatment is run, when subjects only play the restoration game, to measure to what extent being responsible for extraction affects restoration decisions.