Bargaining in Common Pool Resource
Pre-analysis Plan

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1 Hypothesis

1.1 Hypothesis 1: Impact of risk

Hypothesis 1. *The presence of a resource depletion risk reduces the efficiency of the resource management.*

. *Risk aversion leads to early resource extraction.*

To conduct the analysis to confirm this hypothesis, we rely on the following variables:

. **Risk level:** Binary variable indicating whether resource depletion is stochastic (Risk = 1) or deterministic (Risk = 0).

. **Risk preference:** Measured via the BRET task, encoded as a continuous variable (number of boxes selected), or categorized into terciles (risk-averse, neutral, risk-seeking).

. **Efficiency:** Total resource extracted over all periods (group-level), normalized by the maximum possible sustainable yield.

To test this hypothesis, we rely on two methods. First, a non-parametric analysis using the Mann-Whitney U test to assess whether individual decisions in the risky setting are less effective in terms of resource management. Specifically, we compare the sum of extraction decisions at the group level:

$$\begin{aligned} H_0 &: Y_{g,\text{risk}} = Y_{g,\text{no risk}} \\ H_1 &: Y_{g,\text{risk}} < Y_{g,\text{no risk}} \end{aligned} \tag{1}$$

where $Y_{g,c}$ denotes the resource extraction of group g under condition c (either risk or no risk).

In addition, to examine the sub-hypothesis regarding risk aversion and to control for individual characteristics, we plan to estimate three regression models. All models include period fixed effects.

$$\text{Efficiency}_{igtr} = \alpha + \beta_1 \cdot \text{Risk}_g + \lambda_t + \delta_r + \epsilon_{igtr} \tag{2}$$

$$\text{Efficiency}_{igtr} = \alpha + \beta_1 \cdot \text{Risk}_g + \beta_2 \cdot \text{BRET}_{ig} + \lambda_t + \delta_r + \epsilon_{igtr} \tag{3}$$

$$\text{Efficiency}_{igtr} = \alpha + \beta_1 \cdot \text{Risk}_g + \beta_2 \cdot \text{BRET}_{ig} + \gamma \mathbf{X}_{ig} + \lambda_t + \delta_r + \epsilon_{igtr} \tag{4}$$

In the third model, $\mathbf{X}_{ig}$ denotes a vector of individual controls (e.g., age, gender, performance in NLE task). Subscripts i, g, t and r index individuals, groups, time periods and rounds, respectively.

1.2 Hypothesis 2: Impact of bargaining mechanisms

Hypothesis 2. *Bargaining mechanisms enhance the efficiency of resource management. Furthermore, bargaining with binding agreements yields higher efficiency than bargaining with non-binding arrangements.*

. *- In environments with disaster risk, heterogeneous groups reach agreement less frequently due to divergent risk preferences.*

.. *When agreements are made under risk, they tend to prioritize shorter time horizons and larger early extractions compared to settings without risk.*

To test this hypothesis, we rely on the following variables:

. **Bargaining mechanism:** Categorical variable with three levels: None, Non-binding, and Binding.

. **Agreement occurrence:** Binary variable indicating whether a group successfully reached an agreement during the bargaining stage.

. **Agreement asymmetry:** Difference between the highest and lowest proposed shares in an agreement, or alternatively, a Gini coefficient over proposed extraction shares.

. **Risk heterogeneity:** Within-group standard deviation of BRET scores or alternatively whether groups contains two risk averse, two risk seeking or a mix of players' types.

. **Extraction profile:** Early extraction defined as the total extraction in the first k periods (e.g., $k = 3$); time horizon defined as the final period in which extraction occurs.

We plan to test three sets of outcomes using the following empirical strategies:

(1) Effectiveness of Bargaining Mechanisms We evaluate whether bargaining improves resource management outcomes. Specifically, we test:

$$\text{Efficiency}_{igtr} = \alpha + \beta_1 \cdot \text{Bargaining}_g + \gamma \mathbf{X}_{ig} + \lambda_t + \delta_r + \epsilon_{igtr}$$

and compare group-level efficiency under no, non-binding, and binding mechanisms. A Kruskal-Wallis test and a post-hoc pairwise comparisons will assess whether binding mechanisms outperform non-binding ones.

(2) Agreement Frequency and Risk Heterogeneity We assess whether risk heterogeneity reduces agreement frequency under risk using logistic regression:

$$\Pr(\text{Agreement}_g = 1) = \text{logit}^{-1}(\alpha + \beta_1 \cdot \text{Risk}_g + \beta_2 \cdot \text{RiskHeterogeneity}_g + \beta_3 \cdot \text{Bargaining}_g + \epsilon_g)$$

We expect $\beta_2 < 0$ under the risk condition, indicating lower agreement rates in heterogeneous groups.

1.3 Hypothesis 3: Social and moral preferences

Hypothesis 3. *Individuals with higher inequality aversion and Kantian preferences reach more egalitarian agreements. They also breach non-binding agreements less frequently than others.*

We rely on the model from Bayle (2025) to estimate individual-level parameters for inequality aversion (θ_i^{IA}) and Kantian preferences (θ_i^K). These parameters are used to evaluate whether individuals with stronger pro-social preferences:

. Propose more egalitarian offers during bargaining;

. Are associated with higher group-level agreement rates;

. Are less likely to breach non-binding agreements.

(1) Egalitarian offers We estimate the following model:

$$\text{Egalitarian offers}_{i,r} = \alpha + \beta_1 \cdot \theta_i^{IA} + \beta_2 \cdot \theta_i^K + \gamma' \mathbf{X}_i + \delta_r + \epsilon_{ir}$$

where $\mathbf{X}_i$ includes control variables such as risk preference (BRET), demographics, or prior experience.

(2) Agreement Frequency At the group level, we test whether average levels of θ^{IA} and θ^K predict agreement success:

$$\Pr(\text{Agreement}_g = 1) = \text{logit}^{-1}\left(\alpha + \beta_1 \cdot \theta_{i,g}^{IA} + \beta_2 \cdot \theta_{i,g}^K + \beta_3 \cdot \text{Risk}_g + \epsilon_g\right)$$

(3) Defection in Non-binding Agreements We test whether individuals with higher pro-social parameters are less likely to breach a non-binding agreement:

$$\text{Defect}_{igr} = \alpha + \beta_1 \cdot \theta_i^{IA} + \beta_2 \cdot \theta_i^{K} + \gamma' \mathbf{X}_i + \lambda_g + \delta_r + \epsilon_{ir}$$

where Defect_i is a binary variable equal to 1 if individual i deviated from a non-binding agreement, and λ_g captures group fixed effects.

1.4 Interaction between risk and social preferences

In addition to the hypotheses outlined above, we aim to explore how risk preferences and inequality aversion interact in the context of bargaining.

When risk preferences are heterogeneous within a group, risk-seeking individuals may prefer agreements that prioritize delayed extraction, while risk-averse individuals tend to favor higher short-term extractions to hedge against uncertainty. This divergence in risk preferences can make reaching a mutually satisfactory agreement more difficult.

However, in groups with low levels of inequality aversion, players may be more willing to accept asymmetric agreements if doing so allows the group to accommodate diverging risk preferences. In this context, inequality tolerance may act as a form of bargaining flexibility, enabling compromise between players with otherwise incompatible extraction strategies.

We plan to explore this interaction descriptively and through interaction terms in regression models.

2 Additional tests

We will also employ the following supplementary tests to support our analyses:

- t-test for pairwise comparisons between two groups (environment without risk vs with risk, risk averse vs risk tolerant individuals) for differences in extraction decisions.
- ANOVA test for comparisons between three groups (extraction only, non-binding bargaining, binding bargaining) for differences in extraction decisions.
- Fisher's exact test for comparisons in differences in distributions of extraction across periods between groups (environment without risk vs with risk, risk averse vs risk tolerant individuals, extraction only vs NBB vs BB).
- Jonckheere's trend test to detect ordered differences across mechanisms. Specifically, we will verify if there is an increasing trend in early extraction from *BB*, to *NBB*, then to *extraction only*.
- Chi-square test to detect dominance of equal gains in bargaining agreements (treatments NF, NR, BF, BR). As both sides have equal bargaining positions, we expect the agreed extraction in each period to give both sides the same number of points.