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Risk in payoff-equivalent appropriation and provision games

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ABSTRACT

Probabilistic risk is examined within appropriation and provision games. Using a menu design, subjects make decisions in multiple one-shot situations where the individual return or the group return is a random variable. Adding risk over the benefits of cooperation is found to significantly affect subjects' decisions only in situations in the provision game type where the individual return is probabilistic. In those decision situations, cooperation increases.

1. Introduction

Individuals often appropriate from common-pool resources and provide to public goods without knowing the exact return from their actions. One example is a sport fishery in Lake Michigan where the fluctuation in salmon population depends on seasonal die-offs of their major food source, alewives. Another example is the benefit from donations to preserve endangered species, which depends on multiple exogenous variables including changing weather patterns. Individuals' response to the relative risk associated with probabilistic marginal benefits and costs may differ across types of social dilemmas.

This study examines two types of games that are payoff equivalent under conditions of certainty and risk neutrality. The appropriation game type ("Take" frame) and the provision game type ("Give" frame) differ in regard to the initial endowment of resources within a group. In an appropriation game (AG), group members appropriate resources from an endowed group fund to their individual funds. In a provision game (PG), group members are privately endowed with resources in their individual funds and provide resources to the group fund. Exogenous environmental risk is introduced in the laboratory through probabilistic returns. In the risky individual (RI) condition, the individual-fund return is a random variable. In the risky group (RG) condition, the group-fund return is a random variable. In the no risk (NR) condition, individual and group returns are deterministic.

As summarized in Gachter et al. (2014) and Cox and Stoddard (2015), evidence for differences between appropriation and provision games with NR is mixed. Experiments with one-shot games find no differences (Cartwright, 2016; Cox et al., 2013; Cubitt et al., 2011; Dufwenberg et al., 2011). This study broadens this literature by investigating the behavioral effect of risk between one-shot appropriation and provision games. The main finding is risk has a stronger effect on cooperation levels in the provision game type than in the appropriation game type, most strikingly by increasing cooperation levels with RI.

A closely related study by Gangadharan and Nemes (2009) examines exogenous RI and RG in repeated provision games. They find the highest cooperation levels with RI compared to RG and NR. Other studies also examined RG in repeated provision games. Dickinson (1998) finds cooperation levels decrease in early rounds of a game with RG. Stoddard (2015) finds a negative impact of RG on cooperation that is sensitive to the order in which subjects experience risk. Levati and Morone (2013) find a negative response of RG on cooperation may depend on the parameterization

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of marginal benefits.[1] In sum, the literature finds exogenous RG decreases cooperation levels compared to NR. However, this finding is sensitive to experimental design and parameterization. Further, with RI compared to NR, cooperation levels increase in provision games. This study extends the literature by comparing payoff-equivalent appropriation and provision games in exogenously risky decision situations.[2]

2. Experimental design and procedures

Within each type of game, appropriation and provision games, a menu of six one-shot treatments are investigated. Three treatments utilize high marginal benefits from the group fund (HB) and three treatments low marginal benefits from the group fund (LB). For a given benefit level, one treatment implements RI, one treatment RG, and one treatment NR.

In the appropriation game type, the group fund is initially endowed with 100 tokens and each group member's individual fund begins with 0 tokens. Each group member can appropriate between 0 and 25 tokens from the group fund to his/her individual fund. In the provision game type, the group fund is initially endowed with 0 tokens and each group member's individual fund begins with 25 tokens. Each group member can contribute between 0 and 25 tokens from his/her individual fund to the group fund. In each game, tokens in a group member's individual fund earn a private individual-fund return for that member. Tokens in the group fund generate a group-fund return which is divided equally between group members. The games are parameterized such that the expected values of returns in RI and RG equal those in NR. The parameterizations are displayed in Table 1.

Cox et al. (2013) provide a formal proof showing appropriation and provision games are payoff equivalent in NR. The own-income maximizing dominant strategy in each game is for each group member to have the maximum number of tokens in his/her individual fund. The social optimum in each game is for all tokens to be in the group fund. Assuming risk-neutral preferences, the implementation of risk does not change the Nash equilibrium and social optimum. Dickinson (1998) shows that in provision games, assuming positive cooperation levels to the group fund in NR, risk-averse subjects decrease cooperation levels to the group fund in RG. By a similar argument, risk-averse subjects increase cooperation levels to the group fund in RI. Further, because the (expected) group-fund return is 2.4, well above 1, the social optimum would not change for risk-averse subjects.[3]

Hypothesis 1. Cooperation levels in the provision game type will be lower in RG compared to NR.

Hypothesis 2. Cooperation levels in the provision game type will be higher in RI compared to NR.

By the payoff-equivalence of appropriation and provision games, the predictions for risk-averse subjects could extend to the appropriation game type. Alternatively, appropriation and provision games may interact with risk in interesting ways not yet

Table 1
Treatments, parameters, and sample size.

Game type	Decision situation	Treatment (Abbreviated)	IF return	GF return	(Expected) MPCR	Subjects, groups, & sessions
Appropriation	1	No Risk-High Benefit (AG-NR-HB)	1	2.4	0.6	48 subjects
	2	Risky IF-High Benefit (AG-RI-HB)	0 or 2, with equal probability	2.4	0.6	
	3	Risky GF-High Benefit (AG-RG-HB)	1	0 or 4.8, with equal probability	0.6	
	4	No Risk-Low Benefit (AG-NR-LB)	1	1.2	0.3	
	5	Risky IF-Low Benefit (AG-RI-LB)	0 or 2, with equal probability	1.2	0.3	
	6	Risky GF-Low Benefit (AG-RG-LB)	1	0 or 2.4, with equal probability	0.3	
Provision	1	No Risk-High Benefit (PG -NR-HB)	1	2.4	0.6	56 subjects
	2	Risky IF-High Benefit (PG -RI-HB)	0 or 2, with equal probability	2.4	0.6	
	3	Risky GF-High Benefit (PG -RG-HB)	1	0 or 4.8, with equal probability	0.6	
	4	No Risk-Low Benefit (PG -NR-LB)	1	1.2	0.3	
	5	Risky IF-Low Benefit (PG -RI-LB)	0 or 2, with equal probability	1.2	0.3	
	6	Risky GF-Low Benefit (PG-RG-LB)	1	0 or 2.4, with equal probability	0.3	

[1] In an early study, Fisher et al. (1995) examine risk in a provision game. Fischbacher et al. (2014) and Stoddard et al. (2014) also study risk in provision games where the aggregate group-fund return is deterministic, but the allocation of the group fund within a group is probabilistic.

[2] While exogenous probabilistic risk is the focus in this study, there are other studies that also examine endogenous risk in appropriation games (Walker and Gardner, 1992; Blanco et al., 2016b, 2017) and in provision games (Dickinson, 1998; Gangadharan and Nemes, 2009). For further discussion of the differences between games with endogenous and exogenous risk, see Blanco et al. (2017).

[3] If the group collectively had extreme risk-averse preferences, it is theoretically possible for the social optimum to be zero tokens in the group account in RG.