Russell Ackoff Doctoral Student Awards for Research on Human Decision Processes
Research Grant Proposal

Project title: **Asymmetric Payoffs and Cooperation in Inter-Dependent Security and Prisoner's Dilemma Games**
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Motivation:

Most studies of social dilemmas have used symmetric payoffs, in which the gains and losses faced by one player are the same as the gains and losses faced by another player. However, in real life payoffs are often skewed one way or the other: countries and firms may be of different sizes and have differing alternatives. One such example could be found in health-care where young, healthy individuals have less incentive to buy a health insurance than, for example, middle aged individuals. However, as the young exit the risk pool, premiums go up, making insurance less profitable for middle-aged individuals. The final outcomes for all participants depend on the rate of insurance take-up as well as on the actual need for health-care resources. In the current study, the impact of payoff asymmetry is estimated using deterministic Prisoner's Dilemma and stochastic Interdependent Security games.

The one shot Prisoner's Dilemma is a standard tool used to examine social preferences. The simplest version of the game features two-players with symmetric payoffs. Both players have the option to Defect or Cooperate. The Nash equilibrium[2] in this game is for both players to Defect. The Defect-Defect equilibrium is deficient – both players would have been better off if both cooperated. Cooperation rates in one-shot Prisoner's Dilemma games vary between 20% and 38% (Cooper et al. 1994). Anh et al. (2007) find that payoff asymmetry decreases the rates of cooperation in one-shot simultaneous prisoner's dilemma games, but the role of asymmetry in multi-stage and non-deterministic games has not been systematically explored. In repeated symmetric Prisoner's Dilemma games, cooperation increases, often above 50% (Kunreuther et al. 2009), but it is unclear whether the shadow of the future affects cooperation in the same way in the presence of a-priori inequality.

Interdependent security (IDS) games model situations, in which each player may choose whether or not to mitigate her risks by investing in protection. Each player's risks are also dependent on other players' investment, as risks could spill over from one player to another. Kunreuther et al. (2009) shows the results of an IDS game, in which the Nash equilibrium for risk-neutral parties is *not* to invest in protection. However, each party's expected value is higher when they both invest than when they do not. When full feedback is provided, participants invest in protection in 25% to 38% of the rounds dependent on the probability of the loss. The current study plans to use procedures very similar to those of Kunreuther et al. (2009), except for expected losses which will differ between the two players in each pair. This will allow us to use the original results as a control for the new asymmetric payoff conditions.

Decrease in cooperation with asymmetry is well-grounded in theory. Fehr & Schmidt (1999) develop a model that explains behavior in dictator and ultimatum games. The model features asymmetric equality preferences: agents derive disutility from inequality in payoffs, and the

[1] Jason Dana is Pavel Atansov's academic advisor, not a primary advisor on this project.
2 The Nash equilibrium represents the combination of dominant strategies of the two players. Defecting is the dominant strategy, as it always brings a higher payoff than cooperating, independent of the other player's strategy.

disutility is higher from disadvantageous payoffs than for advantageous payoffs. According to this model, individuals would take steps to decrease inequality, even when such steps are not in their immediate self-interest. In such situations, players are expected to defect when they start from a disadvantaged initial position.

Hypotheses:
H1: Cooperation and investment in protection will be lower when losses are asymmetrically distributed.
H2: Opportunities for equalization of payoffs, in which the player who gains more from protection can cover part of the cost of protection for the disadvantaged player, will lead to increased cooperation and expansion of total net gains. Such transfers will occur more often in the prisoner's dilemma condition.

Proposed study:
As mentioned above, the study will use methodology similar to Kunreuther et al. (2009), in which each participant plays several (3 to 10) super-games consisting of 10 rounds each. Participants are re-paired every super-game. At the beginning of a supergame each subject is given either 300 talers, which they can invest in protection. Each person received $8-12 for participation, and one of the pairs is randomly chosen to receive additional payment, converting 10 talers into a dollar.

The payoffs of the current game are described below. The current plan includes 40 participants per condition.
Condition 1: Asymmetric prisoner's dilemma (A-PD). Participants in this condition are paired so that one receives Y_1=270 and the other Y_2=330 talers. Cost of investing in protection is c=12 talers for each. Loss is L_1=9 or L_2=11 and occurs when one player does not invest. Loss of 17 and 15 talers occurs when both players fail to invest.
Condition 2: Asymmetric Stochastic IDS with Full Feedback (A-IDS). Participants in this condition are paired so that one receives Y_1=270 and the other Y_2=330 talers. Cost of investing in protection is again c=12 talers for both players. Loss occurs with probability p (p=0.2 will be used in the current game).[3] Losses will be L_1=45 or L_2=55. A more general version of condition 2 payoffs is shown in Table 1.
Condition 3: Same as condition 1, except player 2 has the opportunity to "tip" player 1 at the beginning of each round by transferring 1 taler before investment decisions are made.
Condition 4: Same as condition 2, except player 2 has the opportunity to "tip" player 1 at the beginning of each round by transferring 1 taler before investment decisions are made.

Table 1: Expected Returns Associated with Investing and Not Investing in Security, asymmetric payoffs.

		Player 2 (P_2) S	Player 2 (P_2) N
Player 1 (P_1)	**S**	Y_1-c, Y_2-c	Y_1-c-qL_1, Y_2 -pL_2
	N	Y_1-pL_1, Y_2-c-qL_2	$Y_1 - [pL_1 + (1-p)\, qL_1], Y_2 - [pL_2 + (1-p)qL_2]$

[3] An additional condition could be added to determine behavior in conditions of very low (p<.1) or high (p=0.6) probability loss. These conditions are not currently added as adding them would increase the budget beyond $3,000.

Legend:
Y= income per round for each player. $Y_2 > Y_1$.
c = cost of protection, same for both players; c > pL for both players.
p = probability of loss, dependent on one's own investment in protection.
q = probability of contagion, loss caused by the other player's lack of investment in protection.
L = amount of loss. $L_2 > L_1$.

Timeline:
Design and pilot – March-April 2010
Data Collection – May-October 2010
Study report – January 2011

References:

Ahn, T., Lee, M. , Ruttan, L., Walker, J. (2007) Asymmetric payoffs in simultaneous and sequential prisoner's dilemma games. *Public Choice*, 132, pp. 353–366.

Cooper, R., DeJong, D., Forsythe & Ross, T. (1994) Cooperation without Reputation: Experimental Evidence from Prisoner's Dilemma Games. *Games and Economic Behavior, 12*, 187-218.

Kunreuther, H. & Heal, G. (2003) Interdependent Security, *Journal of Risk and Uncertainty, 26*, 231-249.

Kunreuther, H., Silvasi, G., Bradlow, E., Small, D. (2009) Bayesian analysis of deterministic and stochastic prisoner's dilemma games. *Judgment and Decision Making,* 4:5, pp. 363-384.