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Fairness and Reciprocity in the Hawk-Dove Game

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Fairness and Reciprocity in the Hawk-Dove game [‡]

by

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Abstract

We study fairness and reciprocity in a Hawk-Dove game. This allows us to test various models in one framework. We observe a large extent of selfish and rational behavior. Our results are inconsistent with leading models in this field.

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1. Introduction

Economic theory traditionally assumes that agents only care about their own material well being. This has frequently been criticized, based on notions of fairness and/or reciprocity (for a survey, see Fehr and Schmidt, forthcoming). Much of this research has used public-good contribution games. We experimentally study both fairness and reciprocity in a simple simultaneous-move surplus-division game: the Hawk-Dove game. We test for the occurrence of both positive and negative reciprocity. To do so, we elicit conditional strategies using the Becker-deGroot-Marschak (1964) mechanism.

There are two approaches to fairness and reciprocity in the literature. The 'outcome-approach' assumes that people are concerned about the final distribution of income between themselves and fellow players (*e.g.*, Fehr and Schmidt, 1999, Bolton and Ockenfels, 2000). In this view, a player may take costly actions to bring about a more equal income distribution. The 'process-approach' focuses on players' attitudes towards the process yielding the distribution of incomes (*e.g.*, Rabin, 1993, Dufwenberg and Kirchsteiger, 1998, Falk and Fischbacher, 1999, Charness and Rabin 2001). Actions are evaluated on the basis of what the player could alternatively have done (but did not do).

For our game a player is predicted to behave the same way, irrespective of whether fairness or reciprocity is the driving force or whether preferences are outcome- or process-oriented. Moreover, his behavior and preferences will be different from those of a player with no other regarding preferences. Our main result is that most subjects revealed self-interested preferences and behaved in a money-maximizing manner.

2. The Dove-Hawk game

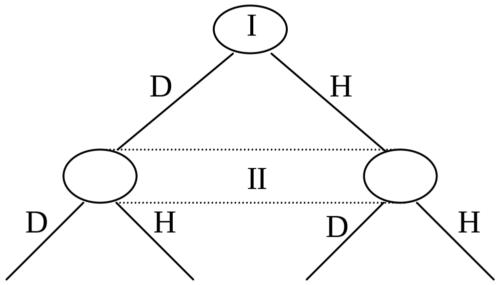
The extensive form of the game considered is given in Figure 1. Two players have to divide a pie of size one (Poulsen, 2001). Decisions are simultaneous: if both play action *D (Dove)*, the pie is split equally. If one player plays *D* and the other *H (Hawk)*, the pie is split unequally, with the hawk-player taking three quarters. Finally, if both play *H* (*i.e.*, disagreement) neither gets a share and payoffs are zero.

If the players only care about material payoffs, the game has two asymmetric Nash equilibria in pure strategies, (D,H) and (H,D), with an unequal split, and a mixed strategy equilibrium in which each player mixes between *D* and *H* with equal probabilities.

We distinguish the following player types:

- *M: Materialist:* plays H(D) if the partner plays D(H).
- *H: Hawk:* plays H as a dominant strategy. Hawk responds to 'H' with 'H', which can be interpreted as negative reciprocity.
- *D: Dove:* plays D as a dominant strategy. Dove responds to 'D' with 'D', which can be interpreted as positive reciprocity.
- *R: Reciprocator:* responds to D (H) with D (H).

Figure 1: The Hawk-Dove Game*



1/2	Mat:	1/4	3/4	0
1/2		3/4	1/4	0
	F/S:	$1/4 - \alpha_1/2$	$3/4 - \beta_1/2$	
		$3/4 - \beta_2/2$	$1/4 - \alpha_2/2$	
	B/O:	$a_1/4 - b_1/32$	$3a_1/4 - b_1/32$	
		$3a_2/4 - b_2/32$	$a_2/4 - b_2/32$	

*mat=material payoffs; F/S: Fehr-Schmidt payoffs; B/O: Bolton-Ockenfels payoffs.

One way to include a notion of fairness or reciprocity into the game is by using Fehr and Schmidt's (1999) model, in which *inequity averse* players dislike inequality. The utility function of player i={1,2} is:

$$U_i(x_i,x_j)=x_i-\alpha_i \max[x_j-x_i,0]-\beta_i \max[x_i-x_j,0],\ \alpha_i\geq\beta_i,\ \beta_i\in[0,1) \qquad (1)$$

where x_i (x_j) denotes the payoff to player *i (j), i,j*={1,2}, $i\neq j$. A difference in payoffs decreases utility, the disutility being relatively greater if disadvantageous ($x_i<x_j$) than if advantageous ($x_i>x_j$).[1] The (utility) payoffs of the Hawk-Dove game with Fehr/Schmidt preferences are given in figure 1. The model accounts for three of the player types distinguished above. For $\alpha,\beta<0.5$, the M-type emerges; $\alpha>0.5$, $\beta<0.5$ gives the H-type and $\alpha>\beta>0.5$ yields the R-type.[2] The equilibrium of the game now depends on the types playing it, and the information players have about the other's type. For example, for a game between a R and D [H], who know each other's type, (D,D) [(H,H)] is the unique pure strategy equilibrium.

Bolton and Ockenfels' (2000) alternative model posits a utility function where i's utility depends on his share of the pie, σ_i. An 'unfair' share is evaluated negatively:

$$U_i(x_i,\sigma_i)=a_i x_i-(1/2)b_i\left[\sigma_i-1/2\right]^2,\ \alpha_i>0,\ \beta_i>0. \qquad (2)$$

The corresponding payoffs in the Hawk-Dove game are shown in figure 1. For $a_i > 8b_i$, the preferences are of the M-type; $0<a_i<8b_i$, yields an R-type. H- and D-types are not predicted by the model.

Both Fehr/Schmidt and Bolton/Ockenfels adopt the outcome-approach to fairness and reciprocity. As for the process- approache, precise predictions are quite involved due to the general

[1] Fehr and Schmidt exclude altruistic preferences, *i.e.*, $\alpha_i<\beta_i$.
[2] The intermediate cases where α=1/2 and/or β=1/2 are straightforward cases of indifference.

structure of these models. They generally support the R-type, however: individuals who perceive H (D) as a hostile (friendly) action will respond to it with H (D). Hence, both approaches work in the same direction in this game. Specifically, all models can account for the existence of R-types. This makes the Hawk-Dove game an ideal candidate for the purpose of studying the role of reciprocity without needing to choose a particular model of it.

3. Experimental Design

94 students participated in a computerized experiment[3] in June 2001 at the 'ESSE' laboratory at the University of Bari. Students were mainly Economics undergraduates. Experiments lasted 35 minutes and average payoff was 10,000 ITL (≈€5). The pie to be divided was 20,000 ITL.

The experiment consisted of three stages. First, subjects were asked to submit any number between 0 and 100, corresponding to the probability of playing *H*.[4] Second, subjects were informed that their action determined in stage 1 was their *initial action*. They were then asked to submit a conditional strategy (numbers between 0 and 100) dependent on the action of the partner. Payoffs were determined as follows. One of the players in each pair was randomly chosen. Her initial action was recorded, after which her partner's response was derived from his conditional strategy. Next, the first player's response to this response was determined on the basis of her conditional strategy. 200 iterations were conducted in this way. If the number of *D*-responses exceeded the number of *H*-responses the *final action* of the subject was *D*, otherwise it was *H*. In case of an equal number (50 each) of *D* and *H*, the *final action* was determined randomly.[5] Finally, in stage 3 subjects were asked to rank the possible outcomes (D,D),(D,H),(H,D) and (H,H) according to their preferences. No salient rewards were connected to this choice. Therefore, we will refer to this choice as the subjects' *stated preferences* while we refer to the second stage choice as *revealed preferences*.

4. Experimental Results

Stage 1

5 participants (5%) submitted a 50-50 mix of *D* and *H* (the mixed strategy equilibrium). Most submitted a pure strategy: 41 (44%) submitted *D* and 24 (26%) submitted *H. 24* subjects (26%) submitted a different mixed strategy than 50-50. A two-tailed Wilcoxon signed ranks test rejects the hypothesis that subjects mix *D* and *H* with equal probabilities: *D* is played significantly more frequently than *H* (p=.043).

[3] Programmed with Urs Fischbacher's Z-Tree.

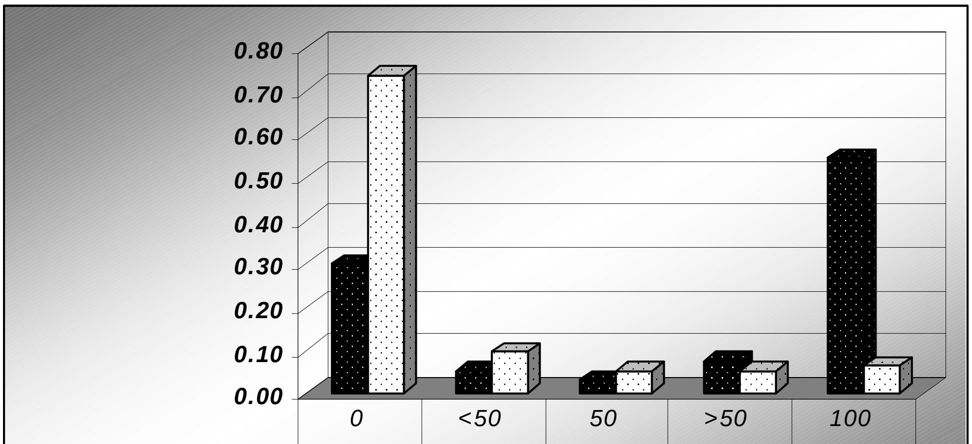
[4] A random draw, $y \in \{1,.., 100\}$ determined whether their action was *D* or *H*: let x be the number submitted. If x<y (y≤x) the subject's action was *D*(*H*).

[5] It was explained to subjects that a pure strategy choice (i.e., 0 or 100) would determine their responses and final action with certainty.

Stage 2

Figure 2 gives the conditional strategies submitted.

Figure 2: Conditional Strategies



	0	<50	50	>50	100
cond. strat. given D	0.30	0.05	0.03	0.07	0.54
cond. strat. given H	0.73	0.10	0.05	0.05	0.06

*The numbers bars) indicate the fraction of subjects choosing strategy ‘0’, [1,49], 50, [51,99], 100.

54% of the subjects responded to D with H (chose ‘100’). 73% chose D in response to H. In both cases, Wilcoxon tests reject the null-hypothesis of equal likelihood of playing H or D. Using the conditional strategies, subjects can be classified into the types distinguished above.[6] 53% are classified as M-types, 30% as D; 6% as H and 5% as R. We could not classify the remaining subjects (5%) because they chose to play D and H with equal probability. Note that 83% reply to H with D. Furthermore, 70% of our observations can find support in the Fehr/Schmidt model (which excludes the possibility of D-types) and 64% can be explained by Bolton/Ockenfels (which does not allow for D or H types).

Stage 3

87% of the stated preferences were M-type, 11% were D and 2% were H. No R-type preferences were reported. Given that neither Fehr/Schmidt nor Bolton/Ockenfels supports D-types, these models do not explain the data better than the standard rational model. Finally, most subjects who did not choose a materialistic best reply behavior in stage 2 state their preference profile at stage 3 inconsistently with their revealed preferences (most deviate by stating materialistic preferences).

5. Conclusions

The Hawk-Dove game enables us to measure reciprocity as defined in various models in one experimental set-up. Particularly, Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) predict reciprocal behavior in the sense that a player should respond to H(D) by H(D). A majority of players in our experiments show materialistic preferences, however. The only other large group plays D in response to either move, implying a preference profile not predicted by either model. Though the response to D with D may be interpreted as positive reciprocity, the fact that these subjects also respond to H with D makes it hard to see their whole preference profile as reciprocal.

One possible explanation for these results lies in the strategy-method used. Brandts and Charness (1998) found that experimental outcomes might vary substantially when playing 'hot' or 'cold' (as here). Another possible explanation may lie in the fact that 'cooperative' play (D) does not bring about any Pareto-gains in the Hawk-Dove game. There were no incentives for subjects who wished to maximize group payoff to cooperate (contrary to the games by Fehr and Gaechter, 2000). These possible explanations are subject of future research.

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[6] Subjects are classified as choosing 'H' ('D') if their submitted strategy > (<) 50.