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Evidence from Hawk-Dove Game Field Experiments

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Abstract

Lab-in-the-field Hawk-Dove game experiments were played by spouses in a rural sample of households in Southern Ethiopia where women/wives traditionally have a weak position. Randomized treatments included a 3x3 design with simultaneous, one-way signaling and sequential games as the first dimension and Pareto-efficient, Pareto-inferior and Pareto-superior (Dove;Dove) payout treatments as the second dimension, with a sequence of six game rounds per household. The experiments allow for the assessment of the presence of alternative player types, such as players that prioritize household income maximization, players that prioritize personal income, players that are Hawkish and punish their spouse at their own expense, and cooperative reciprocators (Doves) who cooperate even at the expense of household and personal income. The experiments revealed that all player types were present in the sample. Husbands played significantly less Hawkish than their wives and played gradually less Hawkish over the six game rounds, whereas wives remained Hawkish.

Keywords: Intra-household cooperation, Hawk-Dove game, Pareto-efficiency, simultaneous games, one-way signaling games, sequential games.

JEL codes: C71, C72, C93, H31, J16, Q15.

1. Introduction

Are wives less selfish than their husbands? Some experimental evidence demonstrates that women are less selfish than men (Eckel and Grossman 1996; 1998; Selten and Ockenfels 1998). Indeed, it has been claimed that African women do 60-80% of the agricultural work (UNECA 1972; FAO 1984) and produce 60-80% of the food (Momsen 1991; Mehra and Rojas 2008), whereas their husbands are perceived as selfish and lazy, wasting time and money on drinking. How strong is the evidence surrounding these roles of African men and women and how universal is it? SOFA Team and Doss (2011) show that these labor contribution and food production narratives are overstated. However, few studies have investigated intra-household selfishness and competition. Our study provides new evidence from Ethiopia on the intra-household experimental behavior of husbands and wives in games concerning the sharing of money provided in the experiments.

Intra-household decisions may not be the outcome of cooperative bargaining. Non-cooperative bargaining models, such as the separable spheres model developed by Lundberg and Pollak (1993), may be better representations of intra-household cooperation and bargaining than cooperative bargaining (Manser and Brown 1980; McElroy and Horney 1981) and collective models of households (Chiappori 1988; 1992; 1997). One important distinction is that the latter models assume Pareto-efficient intra-household outcomes, whereas the former ones allow for Pareto-inefficient solutions within households. Individual contributions to household public goods may be voluntary, and individuals may also prefer not to reveal information about their private income to their spouses, implying partial voluntary cooperation within households (Lundberg and Pollak 1993; Malapit 2012). In non-cooperative bargaining models, individual household members may choose to cooperate on some tasks but not cooperate on others. This may imply that individuals only partly share resources, and the degree of cooperation and sharing may depend on individual preferences, the bargaining power and responsibilities of the individuals, information asymmetries and communication within the household.

Recent experimental evidence from voluntary contribution mechanism-type public goods games within households has demonstrated that most individual household members prefer to keep a substantial share of an endowment even though doing so reduces total household income; see Kebede et al. (2013) for evidence from Ethiopia, Iversen et al. (2011) for evidence from Uganda, and Munro et al. (2011a, 2011b) for evidence from India and Nigeria. It appears that the married respondents often keep approximately 50% of the allocated endowment for themselves and share the other 50% with their spouses. Bezu and Holden (2013) made a similar finding using within-household dictator games in Ethiopia, where more than 60% of the husbands and wives applied the "50-50 sharing rule" to their spouses. The same study provides evidence that the spouses keep personal cash funds and, to a limited extent, expect help from their spouses in cases of urgent additional cash requirements. Additionally, personal income may not be public information within the family. Ashraf (2009) found in her study on the Philippines that 34% of husbands and 29% of wives had incomes their spouses did not know about. Allianz (2006) found that 18% of wives and 9% of husbands in the United States kept secret cash funds. Recent experimental evidence also shows that a larger share of individual incomes is pooled within the family when these individual incomes are public knowledge within the family and when there is communication before the allocation, particularly communication with the family member in charge of the family's public funds (Ashraf 2009).

Most field experiments that have investigated intra-household cooperation and bargaining have used one-shot household public goods games with private or public information (Iversen et al. 2011; Munro et al. 2011; 2011b; Kebede et al. 2013), whereas Ashraf (2009) varied the deposit amounts versus a constant cash allocation. Carlsson et al. (2012; 2013) assessed risk and time preferences separately and then jointly for spouses. The one-shot public goods games typically increased the individual contributions to the family fund by 50% as an incentive for sharing income. In reality, however, such high short-term mark-up returns from sharing cash within the family may be unrealistic. Bargaining may instead concern how to allocate a given limited fund that individuals may compete in using for their own satisfaction. Sometimes one household member obtains access to a cash inflow before the other members, and other times all household members obtain access to the inflow simultaneously, in which case they may compete for it or share it with or without pre-play communication. Such within-household games typically occur frequently such that they become sub-games within the larger game of cooperation or non-cooperation within households. The novel contribution of this paper is to perform a sequence of experiments that adds more diversity and realism to the games that household members play with one another in intra-household bargaining and cooperation. We vary the Pareto-efficiency incentives of cooperation randomly in the sequence of experiments as well as the extent to which individual decisions are simultaneous without communication, simultaneous with one-way communication or sequential with full information to the second player concerning the choice of the first player. The games are played by two persons, the husband and wife, in randomly sampled households in a sequence of six rounds. The "Lab-in-the-field" experiments are implemented in rural villages in southern Ethiopia where women and wives traditionally have a weak position and husbands are considered to be the head of household. The games are variants of the well-known Hawk-Dove game or Chicken Game, but we used the Hawk-Dove game to frame the experiments.

These experiments allow us to assess which players are more Hawkish in the competition for funds within a household, whether the more Hawkish players aim more for individual income maximization from the game or for household income maximization, and whether they are willing to punish their spouses at their own expense if he or she plays selfishly. We hypothesize that husbands, as the traditionally dominant individuals in this cultural setting, will be the more dominant and Hawkish player. Decisions in simultaneous games are made without knowing what the other player will do, and expectations and uncertainty about what the other player will do is likely to affect the decisions. With one-way signaling games, such uncertainty is reduced, which should reduce errors in expectation formation. Additionally, with sequential games, such errors in the formation of expectations are fully removed. When there are individual incentives to be Hawkish, we vary the incentives for mutual cooperation. The (Dove, Dove)=(D;D) rewards are either Pareto-efficient, Pareto-superior or Pareto-inefficient compared to (Hawk, Dove) and (Dove, Hawk) pay-outs from a household perspective[1]. We hypothesize that (D;D) outcomes are more likely when they are Pareto-superior and less likely when they are Pareto-inferior relative to the Pareto-efficient case. Such a response requires that individuals are willing to sacrifice individual income to increase household income. The random combination of these treatments with pairs of simultaneous games without pre-play signaling, simultaneous games with pre-play signaling and sequential games allows us to identify the frequency of different ‘player types’ and ‘household types’ with respect to the degree of individual selfishness, intra-household cooperation and even willingness to punish the spouse at one’s own expense. These are the unique contributions of our original design that also reveal interesting and surprising gender differences.

The first surprising finding is that wives play the game much more aggressively than we had expected. The average probability that the wife plays Hawk is $p_w(H)=0.44$, whereas the average probability that the husband plays Hawk is $p_h(H)=0.25$. These findings lead us to reject our hypothesis that men are more Hawkish than women in this patriarchal society. Second, we find that the probability of playing Hawk when (D;D) outcomes are Pareto-superior are lower than when (D;D) outcomes are Pareto-efficient or Pareto-inefficient. This finding shows that a substantial share of the households respond to variations in the Pareto-efficiency level of cooperative outcomes. In all cases, however, wives are significantly less likely to cooperate than husbands. Some ‘learning’ was observed in the games for husbands as they gradually played significantly less Hawkish over the six rounds, whereas wives showed no evidence of becoming less Hawkish during the six rounds.

In the one-way signaling games, the Hawk signal is given by 27.8% of the husbands and 48.8% of the wives when they have the chance to use one-way signaling in the simultaneous games. In the sequential games, 33.1% of the husbands and 48.8% of the wives play Hawk as first players. This shows that most players, particularly husbands, do not play very selfishly in these games because 67% of them do not take advantage of being the first mover.

“Always play dove” is the most common strategy for both husbands and wives, which is played by 38.4% of the husbands and by 23.4% of the wives. “Always play Hawk” is chosen by 11.2% of the wives and by 6% of the husbands. A large share of these extremely Hawkish players have a spouse that always plays Dove. None of the households have two players that always play Hawk.

[1] Pareto-efficiency is here seen as a situation where a redistribution of income among spouses cannot render one of the spouses better off without rendering the other spouse worse off. A (D,D) = (40,40) is Pareto-efficient in the sense that the sum of income (40+40=80) is the same as (H,D) and (D,H), with sums 60+20= 20+60=80. A (D,D) = (30,30) is Pareto-inferior because 30+30=60<80, and (D,D) = (50,50) is Pareto-superior to (H,D) and (D,H) because redistribution within the household can render both spouses better off.

2. Literature review

2.1. The Hawk-Dove game

The Hawk-Dove game originates from evolutionary biology (Maynard Smith and Price 1973) and has generally been used to analyze competition over resources. Maynard Smith (1978) adapted the Hawk-Dove game to one played between relatives. Continuous and discrete forms of the game have been developed.

Whereas the Hawk-Dove game is the same as the Chicken game in terms of payoff structure, the Chicken game has more commonly been used to analyze human behavior. However, the Chicken game has also been used to analyze conflict over resources or collective action aimed at conserving limited resources, such as local commons (Balland and Platteau 1996).

The typical payoff matrix for two players is shown in Table 1, where W>Y>L>X. Often, L+W=2Y, but this is not always the case. The game has two asymmetric Nash equilibria in pure strategies, (H, D) and (D, H), and one mixed strategy with a probability of playing H.

Table 1. Basic Hawk-Dove game

Payoff matrix	H	D
H	X, X	W, L
D	L, W	Y, Y

Different approaches have been used to classify player types in games, including in the Hawk-Dove / Chicken game. Neugebauer et al. (2008) outlined the following player types in a simple simultaneous Hawk-Dove game: a) Materialist: Plays H(D) if the partner plays D(H); b) Hawk: Always plays “H”. Hawk responds to “H” with “H”, interpreted as negative reciprocity; c) Dove: Always plays “D”. Dove responds to “D” with “D”, interpreted as positive reciprocity; and d) Reciprocator: Responds to D(H) with D(H).

Neugebauer et al. in a lab experiment classified 53% of their sample as Materialist, 30% as Doves, 6% as Hawks and 5% as Reciprocators as conditional strategies given “D” played by the other player, whereas 83% responded to “H” with “D”. Overall, the researchers found that the majority of the players had materialistic preferences and that few had reciprocal preferences. The authors argue that one reason for this finding may be that there were no Pareto-gains in the Hawk-Dove game that the players played, unlike some other games that have revealed more reciprocal behavior, such as in Fehr and Gächter (2000). The authors use this to argue for the leading importance of efficiency rather than fairness in these Hawk-Dove games due to the lack of group incentives to cooperate. They also suggest that the Hawk-Dove game reveals less fairness than the Ultimatum game because the Hawk-Dove game is more competitive because the price of positive reciprocity is higher in the Hawk-Dove game.

Cabon-Dhersin and Etchart-Vincent (2012) used the following player types to assess agents in a Chicken game: a) Unconditional cooperators and b) Strategic cooperators or payoff maximizers. The authors found that players had a higher propensity to cooperate than predicted if they were strategic cooperators or payoff maximizers. Cabon-Dhersin and Etchart-Vincent (2013) showed that behavior in Chicken games is sensitive to the wording of the different alternatives in the game. A 'Hawk-Dove' framing is therefore likely to provide different results from a "Non-cooperation-Cooperation" framing or a more neutral framing, such as choice between colors. They found that women were more likely to cooperate with the 'Non-cooperative-Cooperative' framing than with a neutral framing, whereas there were no gender differences in the neutral framing.

Charness and Rabin (2002) criticize many of the standard games used to investigate inequality aversion for confounding such aversion with other factors and overstating preferences for equitable outcomes. The authors designed a set of experiments that disentangle these confounded factors of Pareto-efficiency, inequity aversion and reciprocity. They developed a general model that allows for Pareto-enhancing behavior, difference aversion and reciprocity. The model is a simple linear, two-person model of preferences that assumes that players' willingness to sacrifice for another player is characterized by three parameters: the weight on the other's payoff when he is better off, the weight when he is worse-off, and the change in weight when the other player has behaved opportunistically. Their key findings are that few players are willing to reduce inequality by reducing other players' payoffs. Pareto-damaging behavior is more common in games where inequality increased than in games where inequality decreased. A form of reciprocity they identified was named "concern withdrawal": the withdrawal of willingness to sacrifice to allocate the fair share to somebody who himself or herself is unwilling to sacrifice for the sake of fairness. They found that behavior was diverse and that a substantial share of the respondents were difference-averse, in line with Fehr and Schmidt (1999).

Fehr and Schmidt (1999) modeled fairness as self-centered inequity aversion. They attempted to explain the variation in outcomes in different experiments where egoistic (competitive and non-cooperative) preferences dominate in some experiments while social preferences (fair and cooperative) are common in other experiments. For a group of individuals who are concerned with their own inequity relative to others, this would be sufficient to explain the diverse outcomes. The authors assessed various competitive games, prisoners' dilemmas and public goods games and did not find evidence contrary to their theory. Their theory indicates that it may be more difficult to sustain cooperation in asymmetric games. However, they did not test for this possibility.

Fischbacher, Gächter and Fehr (2001) found that approximately one-third of players are free-riders and approximately half are conditionally cooperative in a one-shot public goods game.

2.2. Intra-household decisions, theory, and empirical and experimental evidence

Intra-household decisions have been analyzed using various theoretical assumptions and models. A single utility function for households was used by Gary Becker (1973; 1974; 1991) in the unitary household model and as a basis for the Rotten Kid theorem, where parents can shape the incentive structure inside within households such that a selfish child would have incentives to do what is optimal for the household. Intra-household bargaining models were introduced by Manser and Brown (1980) and McElroy and Horney (1981), where two-person households achieved cooperative bargaining solutions (Nash equilibrium) and non-cooperation implied divorce. Variants of collective models were later developed by Chiappori (1988; 1992; 1997), Browning et al. (1994) and others. These models assumed that the solution outcomes are Pareto-efficient and therefore that there are no inefficiency implications of intra-household bargaining. Chiappori (1997) derived a sharing rule for intra-household outcomes with Pareto-efficiency. Other types of models, such as the non-cooperative bargaining models developed by Warr (1983), Ulph (1988), Woolley (1988) and Lundberg and Pollak (1993; 1994), assume, however, that there can be non-cooperative solutions within households and that these solutions may be Pareto-inferior. Malapit (2012) recently developed an intra-household model that allows for cooperative and non-cooperative behavior and where household members may have incentives to hide incomes from other family members. Variants of this model include patriarchal households where the husband has decision power over the wife's income. If the husband wants the wife to contribute more to household public goods than she prefers, she has an incentive to hide a portion of her income. This incentive increases with income and the bargaining power of the husband.

The empirical evidence regarding the most appropriate assumptions and theoretical models for intra-household decisions and outcomes is growing, and the evidence in developing countries is mixed. Udry's (1996) well-known study of Burkina Faso shows that input allocation across farm plots of husbands and wives is inefficient. McPeak and Doss (2006) found that pastoralist households in northern Kenya do not reach cooperative outcomes, and Katz (1995) found behavior consistent with the non-cooperative bargaining model in Guatemala. On the other hand, Bobonis (2009) found that household expenditure in Mexico is consistent with the collective model, as do Quisumbing and Malaccio (2003) in Bangladesh, Indonesia, Ethiopia and South Africa.

A literature investigating intra-household cooperation using social experiments has recently emerged. A number of studies use variants of household public goods games to assess intra-household Pareto-efficiency, including Iversen et al. (2011) in Uganda, Kebede et al. (2013) in Ethiopia, and Munro et al. (2011a, b) in India and Nigeria. All of these studies found that individual household members are selfish and do not allocate all of their endowment to the household public account, resulting in Pareto-inefficient outcomes. Public information about individual endowments enhances the allocation of funds to the public account but does not fully eliminate inefficiency.

Some of the interesting and perhaps surprising gender-related findings relevant to our study include those of Iversen et al. (2011), who found that women contribute less to the household common pool than men. Kebede et al. (2013) found that husbands in Ethiopia trust their wives to behave better than they actually do, whereas their wives trust their husbands to behave worse than they actually do. Munro et al. (2011a) found that higher autonomy of women in households in southern India is associated with higher intra-household inefficiency than it is in northern India, where women are less empowered and autonomous. Munro et al. (2011b) found that second wives have fewer advantages than first wives in polygamous households in northern Nigeria and that polygamous men do better than monogamous men in family public goods games. Overall, polygamous and monogamous households are equally inefficient.

Robinson (2012) used experiments with random small income shocks over a period of eight weeks in 142 poor rural households in western Kenya and found that men increase their personal consumption in response to personal shocks, but their expenditures are not affected by their wives' positive income shocks. Wives' expenditures did not increase in the same way after personal income shocks. The findings indicate limited insurance in the households and intra-household inefficiency.

Ashraf (2009) assessed financial management for 146 married couple households in The Philippines, with private or public information and without pre-play communication as the treatments. In the household public good experiments, individuals can decide to keep the fund for themselves or allocate it to a joint account or the spouse's account. Public information results in a larger share of the fund being allocated to the joint account. Pre-play communication exerts a similar effect such that communication with the person who has the responsibility for the joint account matters for and increases the response of the other person, independent of gender.

Another type of experiment assess intra-household bargaining power using individual and joint experiments that involve choices between risky options that reveal the risk preferences of respondents. By first assessing individual risk preferences and subsequently assessing risk preference outcomes in joint decisions, one may be able to assess who has stronger influence over joint decisions in a household. Carlsson et al. (2013) used such an experiment in a random sample of rural households in China. They found that the joint decision was close to the husband's decisions but that wives who contribute more to family income and/or are members of the Communist party have a stronger influence over joint decisions. Similarly, Carlsson et al. (2012) used inter-temporal experiments separately for husbands and wives and then jointly to assess the strength of influence over joint decisions in households. With data from rural households in China, the authors found in 99% of the cases that husbands had a stronger influence over such choices than their wives.

3. Experimental design and implementation

3.1. Treatments

The Hawk-Dove experiment used a 3x3 randomized design of paired games where husbands and wives in a random order played each of the paired games. The first treatment category of paired games related to whether the game was 1a) simultaneous, 1b) a one-way signaling game or 1c) a sequential game. These treatments provide variation in the information about what the other player will do. The one-way signaling game strengthens the basis for expectation formation compared to the simultaneous game. The sequential game removes uncertainty about what the first player will do. However, the fact that all games are played in pairs means that one game is always followed by an identical "pay-back game".

The second treatment category was whether the (D;D) outcome of the game was 2a) Pareto-efficient, 2b) Pareto-inferior or 2c) Pareto-superior relative to the (H;D) and (D;H) outcomes. The three pay-out matrices are presented in Table 2. These treatments create variation in incentives to cooperate in the game such that there is a trade-off in Matrix 3 between individual pay-out and household pay-out, creating a stronger social dilemma. Playing Hawk in Matrix 1 does not affect efficiency if the spouse plays Dove. If both spouses play Hawk, (H;H), this has a strong negative effect both on individual and household returns. The risk of (H;H) outcome should be reduced with one-way signaling games and sequential games. Matrix 2 reduces incentives to play Dove because (D;D) is Pareto-inferior.

Table 2. The three pay-out matrices with Pareto-efficient, Pareto-inferior and Pareto-superior (D;D) outcomes.

Payoff matrix 1	H	D
H	0, 0	60, 20
D	20, 60	40, 40

Payoff matrix 2	H	D
H	0, 0	60, 20
D	20, 60	30, 30

Payoff matrix 3	H	D
H	0, 0	60, 20
D	20, 60	50, 50

The sequences of both treatment categories were randomized across households. This facilitates separate assessment of these treatment categories as well as assessment of interactions. However, husbands and wives in the same household had the same sequence of six games (3 pairs). In the paired one-way signaling and sequential games within each household the orders of these games among the spouses were randomized.

An example of the game protocol is found in Appendix 1. The sequence of games also allows learning and expectation updating based on the behavior of the other player in earlier games.

3.2. Implementation

The "lab in the field" experiments were arranged such that the husband and wife were placed in the same room with their backs to one another and were communicating with one experimental assistant each. The spouses communicated by pointing at the board with the matrix in front of them based on the instructions from the experimental assistants (pointing to H or D to indicate their choices). The husband was always the row player and the wife was always the column player. They were told who the row player was and who the column player was and that the first number in each of the interior cells was the pay-out to the row player and the second number was the pay-out to the column player in Ethiopian Birr. One of the six games was randomly selected for real pay-out after all of the games had been played. The players received the respective amounts based on their decisions in that game. The numbers in the matrices in Table 1 were in Ethiopian Birr[2] (ETB). In the one-way signaling and the sequential games, a coin was tossed to decide who would play first in each of the paired games. In the one-way signaling games, one player was allowed to send a signal to the other player (through the experimental assistants) indicating what he or she planned to play. The signal was sent once per player. The game was afterwards played as a simultaneous game, and the player did not have to play what he or she had signaled. A couple of "warm-up" games were played to ensure that the players understood the pay-out matrix and the consequences of alternative decisions.

These artefactual field experiments were organized in a central place in the village where the players could play undisturbed. Communication among players who had played and others who were waiting to play was prevented by having those who had not played wait in a separate place and asking those who had played to leave without talking to those who had not yet played. The games were played in each village on only one day.

Participation in the experiments was partly a reward for participation in a survey that involved detailed interviews with both husbands and wives. The payments from the experiments were partially a compensation for the time spent in repeated interviews and were therefore clearly earned. The households had already been exposed to some other experiments, including dictator games played with each of the spouses.

[2] 1 US$=18 ETB at the time of the experiments. A daily wage rate for an unskilled worker was approximately 20 ETB at the time of the experiment.

3.3. Location of experiments

The experiments were played with a sample of 471 married couples in rural areas in southern Ethiopia located across five districts in the Oromia and SNNP regions. The sample represented three ethnic groups (Oromo, Sidama and Wollaita), each with their own language. The ethnic groups also belonged to three different religions: Muslim, Protestant Christian and Coptic-Orthodox Christian. They were mainly farming households but there was substantial variation in their production systems ranging from cash crop-oriented households to subsistence-oriented ones and from cereal crop producers to perennial crop producers. There was substantial variation in distance to the markets and degree of market integration. Approximately 15% of the sample was polygamous. All households had participated in a survey that had been conducted in 2007 and 2012 and focused on women's land rights and the possible impacts of a policy reform that introduced land registration and joint land certification of husbands and wives. It is believed that this reform will strengthen the land rights of women and their intra-household positions. Women in southern Ethiopia traditionally have a weak position, and in the past, women were considered more like the property of their husbands and his family, as evidenced by the expectation that, if a woman's husband dies, she must marry his brother (Holden and Tefera 2008; Bezu and Holden 2013). The inheritance system is patri-lineal with a patri-local marriage system such that upon marriage, a woman must move to her husband's village.

4. Theory and Analytical Strategy

4.1. Preferences and choices

Household preference orders for the alternative outcomes provide insights into the extent of the autonomy and selfishness of spouses, whether they maximize individual income or family income and/or have altruistic preferences regarding the outcomes for their spouses. This is illustrated as follows.

An autonomous selfish person (personal income maximizer) without control over the spouse's income will rank the prospects as follows:

$$U_i(60; U_j(20)) > U_i(50; U_j(50)) > U_i(30; U_j(30)) > U_i(20; U_j(60)) > U_i(0; U_j(0))$$

because $U_i\left(U_j\left(x_j > 0\right)\right) = 0$

Such marriage partners are willing to sacrifice household income for personal gain.

A pure household income maximizer in households that share income and/or with very altruistic preferences toward spouses will rank the prospects as follows:

$$U_i(50; U_j(50)) > U_i(60; U_j(20)) \approx U_i(20; U_j(60)) > U_i(30; U_j(30)) > U_i(0; U_j(0))$$

Such individuals may assign equal weight to personal income and the income of the spouse such that $U_i\left(50; U_j(50)\right) = U_i(50+50)$. In reality, spouses may have a combination of these preferences such that marginal utility of personal income is higher than marginal utility of spouse's income but this may also depend on the extent to which such incomes are shared by the spouses after the experiment because the income in these are experiments cannot be kept secret from the spouses. A person may first aim to maximize household income but may subsequently prefer to control more of this income himself or herself. This should yield household Pareto-efficient outcomes but with selfish responses when it does not lead to household Pareto-inefficiency.

Extremely inequity-averse persons may rank the prospects as follows:

$$U_i(50; U_j(50)) > U_i(40; U_j(40)) > U_i(30; U_j(30)) > U_i(0; U_j(0)) > U_i(60; U_j(20))$$

and $U_i(0; U_j(0)) > U_i(20; U_j(60))$

Such persons will always respond to Dove with Dove and to Hawk with Hawk games if they already know the decision of the spouse.

In games with simultaneous decisions, including games with one-way signaling, responses will be based on personal preferences and expectations about what the spouse will do. This may lead to a Nash equilibrium in mixed strategies for selfish players in households with no income sharing using the matrix in Table 1. Here, the choice of the selfish player *i* is based on the expected probability that player *j* will play Hawk, ($E_i p_j = \alpha$). The personal income-maximizing player *i* will play Dove if

$$\propto > \frac{W-Y}{(W-X)+(L-Y)}$$

This implies that player *i* should play Dove if α > 0.6 when Y=30, if α > 0.5 when Y=40, and if α > 033 when Y=50. With accurate expectations and selfish rational respondents we should expect average probabilities to be close to these cut-off points in the simultaneous games. The accuracy of the expectations should be higher in the one-way signaling games and in later games than in earlier games due to learning about the behavior of the spouse. Persons with more Hawkish (selfish) spouses should themselves play less Hawkish *ceteris paribus* with a single game perspective. Additionally, selfish players with more Dovish spouses are more likely to play Hawk. The dynamic pattern of the responses in a sequence of games is less clear and depends on the interaction between individual preferences, changes in expectations over the series of games, and the actual responses of the two spouses in earlier games. Repeated games are open to complex strategies, including punishment responses ("tit-for-tat"), and "nasty" and "conditional cooperation" responses.

Individuals who want to maximize household return with Matrix 1 and Matrix 3 should always play Dove when there is uncertainty about what the other player will do. With Matrix 2, such a player should play Hawk only if the expected probability that the other player plays Hawk is less than 0.25. A player emphasizing equal sharing would respond to Dove with Dove and may even respond to Hawk with Hawk if he or she dislikes unequal outcomes sufficiently enough to be willing to sacrifice individual and household income for the sake of equal sharing. However, with husbands and wives playing together and knowing the outcomes of the game, we cannot rule out post-play pooling or the transfer of individual pay-outs. This fact should create stronger incentives to maximize household income from the games.

Cultural norms have been identified as important reference points in the theoretical models of intra-household cooperation, particularly in non-cooperative games. Several empirical studies and experiments have revealed that non-cooperative behavior and Pareto-inefficient solutions are common, as seen in our review. Our games were implemented in a setting with strong patriarchal traditions where wives are subordinate to their husbands. At the same time, there have been some recent policy interventions that have emphasized the strengthening of women's rights. Based on this, we have formulated the following hypotheses:

H1. Husbands behave more like hawks and women behave more like doves in the simultaneous HD game (selfish men hypothesis).

H2. In one-way signaling and sequential HD games, the first player will choose to play Hawk (selfish individual hypothesis).

H3. Both players are more likely to play Dove when the (D;D) outcome is Pareto-superior rather than when it is exactly Pareto-efficient, and when it is exactly Pareto-efficient rather than when it is Pareto-inefficient (household income maximization hypothesis).

H4. There is learning in the games such that the frequency of (H;H) outcomes declines through the games for those who aim to maximize household income, whereas more selfish individuals will move toward the optimal switch points in mixed games given the expectations of what the spouse will do based on earlier game rounds.

4.2. Identification of player types

The games were first analyzed by assessing the responses of husbands and wives in all games and then in sub-sets of the games conditional on the different treatments and where relevant, conditional on the responses of the spouse. The distributions of responses and the probabilities of responses with standard errors were used to assess the significance of differences between husbands and wives. Linear probability models with household random effects and household fixed effects were used to jointly assess the effects of the randomized treatments as well as the correlated responses of the spouses.

We use the experiments to assess the extent to which the following types of players can be identified:

1) Persons that are willing to seek personal gain at the expense of the household gain:

    These are identified as persons who choose Hawk in games where (D,D) is Pareto-superior to (H,D) and (D,H) for the household.

2) Persons that are willing to seek personal gain at the expense of the spouse gain:

    These are identified as persons who play Hawk in Pareto-efficient (D,D) games

3) Hawks. Persons who are willing to punish their spouses at their own expense. These are persons who reduce inequality by reducing the pay-off to their spouse as well as to themselves (Charness and Rabin (2002). These persons can be identified as:
    a. Persons who always play Hawk.
    b. Persons who respond to Hawk with Hawk in sequential games.
    c. Persons who respond to Hawk with Hawk in one-way signaling games.
4) Doves (cooperative reciprocators). Persons who always cooperate even when doing so sacrifices household and personal income.

4.3. Econometric analysis

Non-parametric models are used to assess the changes in probabilities of playing Hawk across the six game rounds for husbands and wives separately, first for all game types and then for the different treatments. These models were also used to assess expected payouts to husbands and wives given their actual choices.

Linear probability models with household random effects and household fixed effects are used to assess the relative effects of the various treatments. Such models are also used to assess correlations with district dummies and various household and farm characteristics.

Negative binomial regressions were used to assess factors correlated with the number of times each player played Hawk out of six game rounds. This model was particularly used to assess whether and how access to joint land certificates was correlated with the behavior in the games.

5. Experimental results

5.1. Descriptive results

The data presented are from Hawk-Dove game field experiments with 471 households, with six games per household run in a randomized sequence. Table 3 summarizes the results from all experiments with all households.

Table 3. Results from all experiments for all households

Husbands' choice		Wives' choice		
	Stats	Hawk	Dove	Total
Hawk	N	164	545	709
	Row %	**23.1**	76.9	100
	Column %	**13.3**	**34.3**	**25.1**
Dove	N	1,073	1,044	2,117
	Row %	**50.7**	49.3	100
	Column %	86.7	65.7	74.9
Total	N	1,237	1,589	2,826
	Row %	**43.8**	56.2	100
	Column %	100	100	100

We see in Table 3 that 25.1% of the husbands' choices were Hawk and 43.8% of the wives' responses were hawk, showing that wives played more aggressively than their husbands. In 13.3% of the games where the wives played Hawk, the husbands also played Hawk, whereas the wives played Hawk in 23.1% of the cases when the husbands played Hawk. In 50.7% of the games in which the husbands played Dove, the wives played Hawk in 50.7%, whereas the husbands played Hawk in 34.3% of the cases when the wives played Dove.

We will now examine the responses in the simultaneous games.

Table 4 presents the responses in the simultaneous games where the players must respond based on their anticipated responses of the other party. This resulted in a higher share of Hawk-Hawk responses, with 22.5% of the husbands' responses and 37.9% of the wives' responses being Hawk when the spouse played Hawk. Both husbands and wives played less Hawkish on average than is optimal for purely selfish players in mixed strategy.

Table 4. Outcomes from the simultaneous games

Husbands' choice		Wives' choice		
	Stats	Hawk	Dove	Total
Hawk	N	92	151	243
	Row %	**37.9**	62.1	100
	Column %	**22.5**	28.2	**25.7**
Dove	N	317	384	701
	Row %	45.2	54.8	100
	Column %	77.5	71.8	74.3
Total	N	409	535	944
	Row %	**43.3**	56.7	100
	Column %	100	100	100

Table 5 summarizes the probabilities of husbands and wives playing Hawk in the different Pareto-efficiency treatments with standard errors of the means. Wives were highly significantly more likely to play Hawk in all three Pareto-efficiency treatments. Even in the Pareto-superior (D,D) treatment wives were more likely to play Hawk (32.9%) than their husbands were likely to play Hawk in the Pareto-inferior (D,D) treatment (30.1%).

Table 5. Pareto-efficiency treatments and responses in all games

		Probability of playing hawk	
Matrix type	Stats.	Husband	Wife
Pareto-efficient (DD=40.40)	Mean	0.26	0.47
	St. Err.	0.014	0.016
	N	939	939
Pareto-inferior (DD=30,30)	Mean	0.30	0.51
	St. Err.	0.015	0.016
	N	939	939
Pareto-superior (DD=50,50)	Mean	0.19	0.33
	St. Err.	0.013	0.015
	N	948	948
Total	Mean	0.25	0.44
	St. Err.	0.008	0.009
	N	2826	2826

A further disaggregation of the probabilities of playing Hawk by Payout Matrix type and Game type for husbands and wives is presented in Table 5. Wives had a highly significant higher probability of playing Hawk in all game combinations than their husbands. This is the most surprising finding in our study and strongly rejects our hypothesis that men and husbands play more like Hawks in this male dominated society and that women are less selfish and more concerned with the family outcome. However, as heads of households, the husbands have a broader responsibility for the households, and they are supposed to support and protect their family. This may be one possible explanation for these results. Wives played more aggressively and closer to the optimal selfish mixed strategy in the one-way signaling games, whereas husbands played less selfish in these games than in the simultaneous games. This result indicates that husbands are relatively more focused on maximizing household income, whereas wives are more concerned with maximizing personal income. However, wives become less Hawkish in games with Pareto-superior (D;D) outcomes, showing that many wives become less selfish when it will benefit the household.

Table 6. Pareto-efficiency treatments, type of game and responses by gender

		Simultaneous games Probability of playing hawk		One-way signaling game Probability of playing hawk		Sequential game Probability of playing hawk	
Matrix type	Stats.	Husband	Wife	Husband	Wife	Husband	Wife
(DD=40.40)	Mean	0.26	0.43	0.21	0.51	0.34	0.48
	St. Err.	0.024	0.027	0.022	0.027	0.029	0.031
	N	341	341	338	338	260	260
(DD=30,30)	Mean	0.31	0.52	0.27	0.55	0.32	0.48
	St. Err.	0.027	0.029	0.025	0.028	0.026	0.028
	N	293	293	317	317	329	329
(DD=50,50)	Mean	0.21	0.36	0.22	0.28	0.15	0.35
	St. Err.	0.023	0.027	0.025	0.026	0.019	0.025
	N	310	310	286	286	352	352
Total	Mean	0.26	0.43	0.23	0.45	0.26	0.43
	St. Err.	0.014	0.016	0.014	0.016	0.014	0.016
	N	944	944	941	941	941	941

Note: The figures in the table are the probabilities of playing hawk above the standard error of this probability and the sample size behind the probability estimate.

The one-way signaling games require a further inspection of signaling behavior and how this signaling behavior relates to the actual responses (do players play as they signaled?) as well as to the responses of the player receiving the signal (what is the response to the signal?[3]). Table 7 presents an overview of the signaling responses of husbands and wives.

Table 7. Choice of signal by signaling players in one-way signaling games

		Signal given Hawk	Dove	Total
Player signaling				
Husband	N	128	333	461
	Row %	27.8	72.2	100
Wife	N	230	241	471
	Row %	48.8	51.2	100
Total	N	358	574	932
	Row %	38.4	61.6	100

We see that husbands signaled Hawk in 27.8% of their responses, whereas wives signaled Hawk in 48.8% of the responses.

Table 8 provides the response probabilities for playing Hawk of both husbands and wives given who the signaling player is and her or her signal. We see that there was a 66.9% probability that a husband who signaled Hawk actually played Hawk, and an 89.8% probability that a wife who signaled Hawk actually played Hawk. We also see that 18.9% of the wives responded to the Hawk signal from their husband by playing Hawk themselves, whereas 11.9% of the husbands

[3] We do not observe whether they trust the signal.

responded to the Hawk signal by playing Hawk themselves. Additionally, we see that wives are more likely to respond to Dove signals by playing Hawk because 48.8% of the wives responded to Dove with Hawk, whereas only 32.8% of the husbands responded to Dove with Hawk.

Table 8. Signaling and responses by husbands and wives

Signaling player and signal	Stats	Husband choice Hawk=1, Dove=0	Wife choice Hawk=1, Dove=0
Husband signals Hawk	Mean	0.669	0.189
	St. Err.	0.042	0.035
	N	127	127
Husband signals Dove	Mean	0.073	0.488
	St. Err.	0.014	0.028
	N	328	328
Wife signals Hawk	Mean	0.119	0.898
	St. Err.	0.022	0.020
	N	226	226
Wife signals Dove	Mean	0.328	0.109
	St. Err.	0.030	0.020
	N	238	238

The responses in the sequential games are likely to depend strongly on who has the advantage of playing first in these games. Table 9 provides the responses for the sequential games where the husband played first and the wives responded after learning what the husband played. Table 10 contains the responses for the sequential games where the wife played first.

Table 9. Sequential games: Husband plays first

		Choice of wife		
Choice of husband	Stats	Hawk	Dove	Total
Hawk	N	17	137	154
	Row %	**11.0**	89.0	100
	Column %	10	46.1	**33.0**
Dove	N	153	160	313
	Row %	48.9	51.1	100
	Column %	90	53.9	67.0
Total	N	170	297	467
	Row %	36.4	63.6	100
	Column %	100	100	100

Table 10. Sequential games: Wife plays first

		Choice of wife		
Choice of husband	Stats	Hawk	Dove	Total
Hawk	N	17	79	96
	Row %	17.7	82.3	100
	Column %	**7.5**	32.9	20.5
Dove	N	211	161	372
	Row %	56.7	43.3	100
	Column %	92.5	67.1	79.5
Total	N	228	240	468
	Row %	**48.7**	51.3	100
	Column %	100	100	100

Table 9 shows that 33% of the husbands played Hawk when they played first, and 11% of the wives responded to Hawk with Hawk. Table 10 shows that 48.7% of the wives played Hawk when playing first and 7.5% of the husbands responded to Hawk with Hawk.

The response probabilities in Table 11 for the responses in the sequential games are subdivided by who plays first and by Matrix type (Pareto-efficiency of (D;D) payouts)).

Table 11. Pareto-efficiency treatments in sequential games by who plays first.

Sequential games	Husbands play first		Wives play first	
Matrix type	Husband	Wife	Husband	Wife
Pareto-efficient	0.434	0.395	0.256	0.558
(D,D)=(40,40)	0.044	0.043	0.039	0.044
	129	129	129	129
Pareto-inferior	0.401	0.383	0.256	0.563
(D,D)=(30,30)	0.039	0.038	0.035	0.039
	162	162	160	160
Pareto-superior	0.187	0.327	0.116	0.366
(D,D)=(50,50)	0.030	0.036	0.025	0.037
	171	171	172	172
Total	0.331	0.366	0.204	0.488
	0.022	0.022	0.019	0.023
	462	462	461	461

Note: The figures are the probability of playing hawk above the standard error of this probability and the sample size behind the estimate.

A striking finding shown in Table 11 is that both husbands and wives respond substantially to the Pareto-superior (D;D) payout matrix type by reducing the extent to which they play Hawk as first players. This matrix types decreases from 43.4% to 18.7% for husbands and from 58.8% to 36.6% for wives. However, this shows that more wives than husbands are willing to sacrifice household income to increase personal gain.

5.2. Results of player types

We provide a summary of 'player types' based on the game responses of husbands and wives in Table 12.

Table 12. Identification of 'player types' based on game responses

Player type	Stats	Husbands	Wives
Player preferring personal gain at the expense of household gain: Playing Hawk in Pareto-superior (D,D) outcome games	Frequency	0.190	0.329
	St. Error	0.013	0.015
	N	948	948
Player preferring personal gain at the expense of spouse gain: Playing Hawk in Pareto-efficient (D,D) outcome games	Frequency	0.262	0.471
	St. Error	0.014	0.016
	N	939	939
Player punishing spouse even at own expense: Responding to signal Hawk with Hawk in one-way signaling games	Frequency	0.119	0.189
	St. Error	0.022	0.035
	N	226	127
Player punishing spouse even at own expense: Responding to Hawk with Hawk in sequential games	Frequency	0.071	0.111
	St. Error	0.017	0.025
	N	225	153
Pareto-inefficient reciprocal cooperation in sequential games: Dove response to Dove by first player	Frequency	0.500	0.392
	St. Error	0.060	0.050
	N	70	97
Pareto-inefficient reciprocal cooperation in one-way signaling games	Frequency	0.452	0.418
	St. Error	0.064	0.047
	N	62	110

We found highly significant differences between husbands and wives in all three categories of "player types". In the experiments, 32.9% of the wives and 19% of the husbands preferred personal gain at the expense of household gain. Furthermore, 47.1% of the wives and 26.2% of the husbands preferred personal gain at the expense of their spouse when personal gain did not affect the total income of the household. Finally, we assessed the extent to which spouses were willing to punish one another to achieve more equitable income, even by sacrificing their own income. We observed that 18.9% of the wives and 11.9% of the husbands responded to Hawk signals in one-way signaling games by playing Hawk. In the sequential games, 11.1% of the wives and 7.1% of the husbands responded to Hawk signals with Hawk.

Another type of inefficient behavior are (D;D) responses in Matrix type 2, where such responses are Pareto-inferior. In combination with sequential games and one-way signaling games, these responses appear as inefficient cooperative reciprocators that emphasize cooperative reciprocation more than personal benefit and household efficiency. We see in Table 12 that 50% of the husbands and 39.2% of the wives were inefficient cooperative reciprocators in sequential games, and 45.2% of the husbands and 41.8% were inefficient cooperative reciprocators in one-way signaling games.

An overview of reciprocal Hawkishness is presented in Table 13. We see that there were 52 households that always played (D;D) and were cooperative reciprocators. Fifty-four (11.2%) of the wives and 29 (6.0%) of the husbands always played Hawk. Forty-six (9.5%) of the wives and 14 (2.9%) of the husbands always played Hawk with the spouse always playing Dove. "Always play dove" was the most common strategy for both husbands and wives and was played by 185 (38.4%) of the husbands and 113 (23.4%) of the wives.

Table 13. Cross-tabulation of number of times spouses played Hawk against each other

No of times husband played Hawk	No of times wife played Hawk								
	0	1	2	3	4	5	6	Total	%
0	**52**	11	21	13	18	24	**46**	**185**	**38.4**
1	14	13	17	30	21	15	4	114	23.7
2	20	7	19	14	9	8	3	80	16.6
3	4	12	10	9	6	3	0	44	9.1
4	6	1	5	5	3	0	1	21	4.4
5	3	3	2	1	0	0	0	9	1.9
6	**14**	9	4	1	1	0	0	**29**	**6.0**
Total	**113**	56	78	73	58	50	**54**	482	100.0
%	**23.4**	11.6	16.2	15.1	12.0	10.4	**11.2**	100.0	

5.3. Non-parametric regressions

Figure 1 shows the probabilities of playing Hawk with 95% confidence intervals in each game round for husbands and wives. It illustrates the large gap between husbands and wives and that the gap increases over the six game rounds because husbands play less aggressively over those rounds, whereas wives first show a weak tendency to play tougher. However, this tendency declines a bit toward the last rounds.

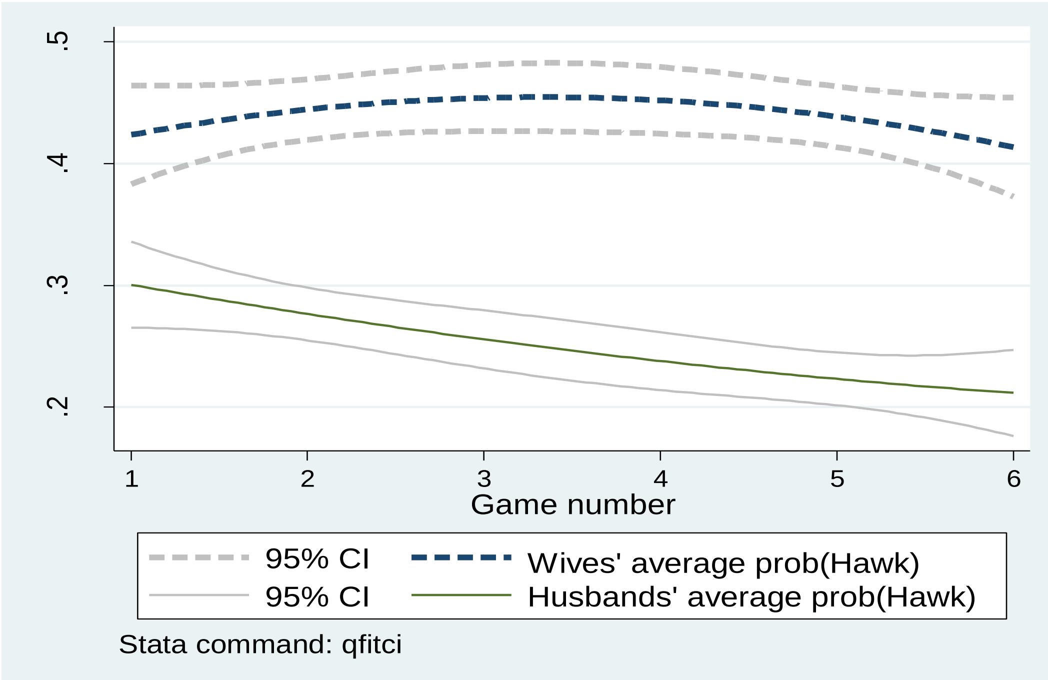

Figure 1. Probability of playing Hawk by husbands and wives by game number.

Figures 2 (wives) and 3 (husbands) illustrate the effects of the variation in the (D;D) treatments over the six game rounds. For the wives, the Pareto-superior (50;50) and Pareto-efficient (40;40) (D;D) treatments are stable across game rounds. The Pareto-inefficient (30;30) outcomes show an increase in the probability of playing Hawk in the early rounds but declines toward the end. We have no explanation for this pattern. For husbands, the Pareto-efficient (40;40) treatment shows a weak increase over game rounds. The Pareto-inferior (30;30) treatment shows the strongest decline over game rounds, and the Pareto-superior (50;50) treatment shows a decline over game rounds. These effects indicate that husbands are more concerned with household efficiency and may have understood that less selfish behavior benefits household efficiency despite the wife obtaining a larger share of the income.

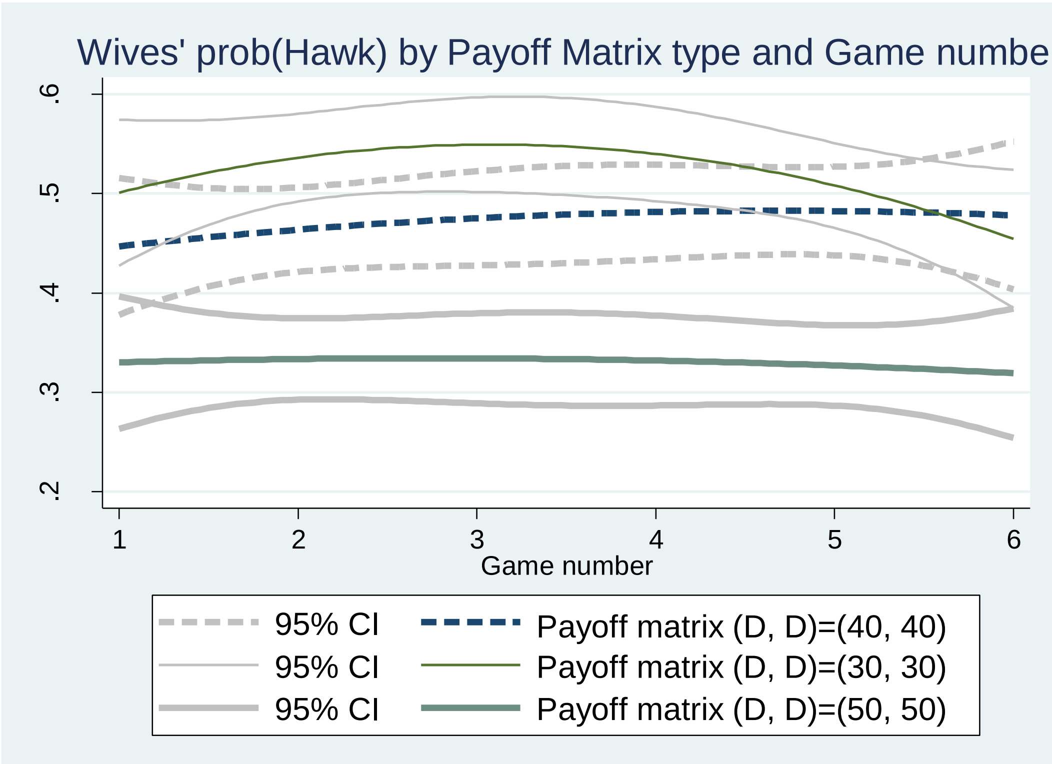

Figure 2. Wives' probabilities of playing Hawk by Payoff Matrix type and game number

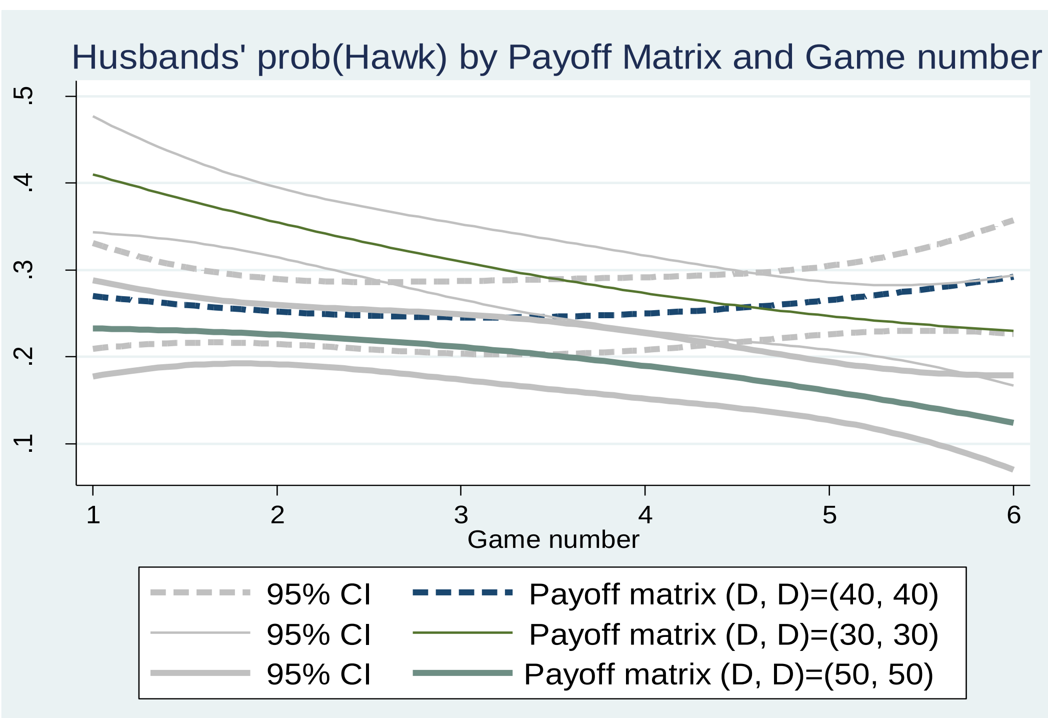

Figure 3. Husbands' probabilities of playing Hawk by Payoff Matrix type and game number

Figure 4 shows the expected payout distributions of husbands and wives given their strategic decisions across games. We see that the wives benefit from their more aggressive decisions and have a higher average expected return. This is also demonstrated in Table 14 where the distributions of expected payouts are cross-tabulated for husbands and wives. Table 15 shows the realized payouts based on the random draw of one game round per household.

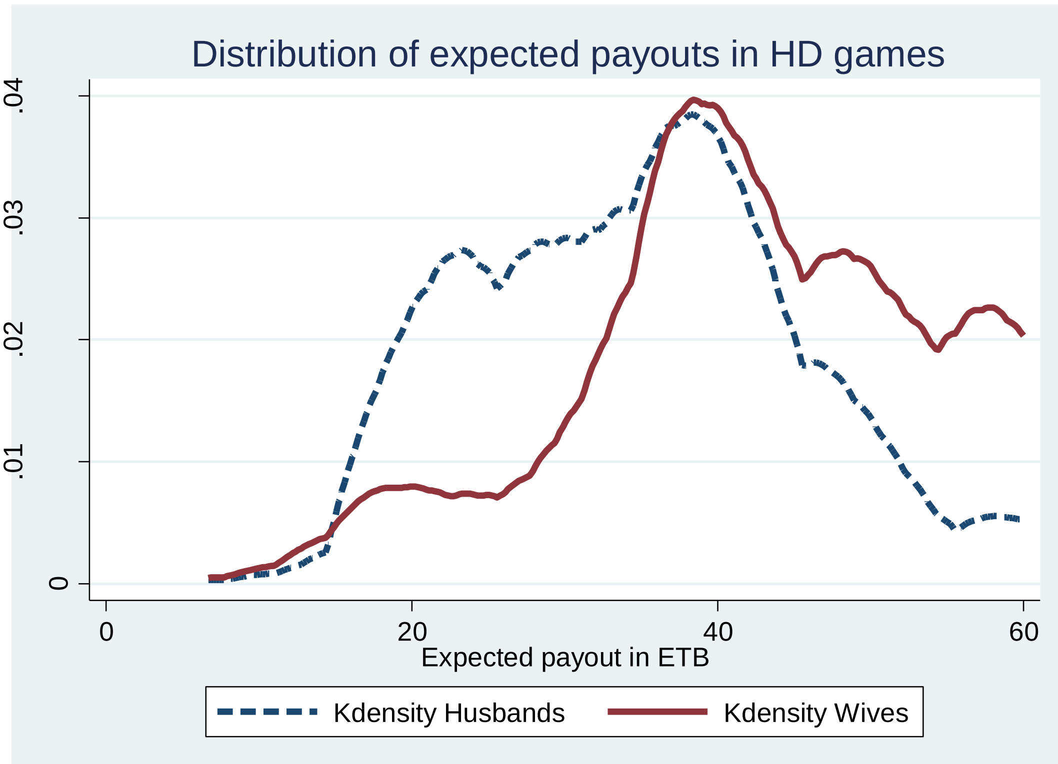

Figure 4. Expected payout distribution for husbands and wives over six game rounds given decisions of both spouses

Table 14. Distribution of payouts for spouses given their choices in all game rounds if all games had been real (six rounds per household)

Husbands' expected return, ETB	Wives' expected return, ETB						
	0	20	30	40	50	60	Total
0	164	0	0	0	0	0	164
20	0	0	0	0	0	1,073	1,073
30	0	0	235	0	0	0	235
40	0	0	0	312	0	0	312
50	0	0	0	0	497	0	497
60	0	545	0	0	0	0	545
Total	164	545	235	312	497	1,073	2,826

Table 15. Distribution of real payouts from randomly selected real game rounds in households

	Wives' payout, ETB						
Husbands' payout, ETB	0	20	30	40	50	60	Total
0	18	0	0	0	0	0	18
20	0	0	0	0	0	161	161
30	0	0	35	0	0	0	35
40	0	0	0	53	0	0	53
50	0	0	0	0	107	0	107
60	0	97	0	0	0	0	97
Total	18	97	35	53	107	161	471

5.4. Parametric regression results

Table 16 presents the results from linear probability models with household random effects and household fixed effects where the variables on the right include the various treatments and dummies for the game round to test the significance of dynamic changes over game rounds. We see that the Pareto-superior (D;D) treatment had a stronger marginal (negative) effect on the probability of playing Hawk than the marginal (positive) Pareto-inferior (D;D) treatment, particularly so for wives. The negative trend over game rounds was also significant for husbands in line with the findings in the non-parametric graphs. There were strong and highly significant effects of the signals given in the one way signaling games. Being in the signaling position gave that player more power if he or she chose to signal Hawk, which reduced the probability that the spouse would play Hawk. Playing Hawk as the first player in the sequential games had an even stronger negative marginal effect on the spouse, as expected.

Table 16. Linear probability models of playing Hawk with household random effects and household fixed effects.

	Husband choice HH RE	Wife choice HH RE	Husband choice HH FE	Wife choice HH FE
Pareto-inferior (D,D) treatment, dummy	0.047***	0.040**	0.047***	0.040**
Pareto-superior (D,D) treatment, dummy	-0.062****	-0.108****	-0.063****	-0.117****
Game round 2, dummy	-0.024	0.024	-0.023	0.023
Game round 3, dummy	-0.041**	0.011	-0.043**	0.01
Game round 4, dummy	-0.072****	0.040*	-0.073****	0.041*
Game round 5, dummy	-0.049**	-0.016	-0.051**	-0.010
Game round 6, dummy	-0.097****	0.008	-0.098****	0.003
Polygamous household, dummy	0.015	0.044		
Signaling game, dummy	-0.048	0.018	-0.02	-0.037
Sequential game, dummy	-0.130**	0.107	-0.076	0.027
Signaling game, husband signaling	-0.104	0.015	-0.106**	0.074
Signaling game, wife signaling	0.099	-0.265**	0.072	-0.128
Husband signaling hawk	0.467****	-0.248****	0.374****	-0.266****
Wife signaling hawk	-0.165****	0.618****	-0.170****	0.455****
Sequential game, husband first	-0.072	-0.064	-0.091	0.014
Sequential game, wife first	0.181***	-0.452****	0.127**	-0.283**
Sequential game, husband first plays hawk	0.831****	-0.297****	0.726****	-0.301****
Sequential game, wife first plays hawk	-0.185****	0.819****	-0.185****	0.640****
Wife's choice	-0.075****		-0.052***	
Husband's choice		-0.099****		-0.065***
Constant	0.337****	0.463****	0.331****	0.466****
Prob > chi2	0.000	0.000	0.000	0.000
R-squared			0.260	0.264
Number of observations	2826	2826	2826	2826

Note: Models show average marginal effects for probability of playing Hawk. The (D,D)=(40,40) treatment served as the baseline for assessing the Pareto-superior (D,D)=(50,50) and the Pareto-inferior (D,D)=(30,30) treatments. Standard errors corrected for clustering at household level. Significance levels: *: significant at 10%, **: significant at 5%, ***: significant at 1%, ****: significant at 0.1% level.

6. Discussion

We used the games to test a number of key hypotheses that we now discuss. The first hypothesis (H1) states that husbands behave more like Hawks and wives more like Doves in the simultaneous HD game. We strongly reject this hypothesis. Wives played more Hawkish, on average, in all variants of the HD game. Both husbands and wives played less Hawkish, on average, than would be optimal for purely selfish players in mixed strategy.

The second hypothesis (H2) stated that the first player will play Hawk in one-way signaling and sequential HD games. This hypothesis builds on the assumption that the spouses are selfish and/or do not trust their spouses to not be selfish if they do not play Hawk when in an advantageous position. We found that only 27.8% of the husbands and 48.8% of the wives signaled Hawk when they had the chance to use one-way signaling in the simultaneous games. In the sequential games, 33.1% of the husbands and 48.8% of the wives played Hawk as first players (Table 15). Thus, the second hypothesis may be rejected for the majority of players. It is evident that the majority of players, and a larger majority of husbands, are less selfish than indicated by the hypothesis.

The third hypothesis (H3) stated that both players are more likely to play Dove when the (D;D) outcome is Pareto-superior versus exactly Pareto-efficient, and when it is exactly Pareto-efficient versus Pareto-inefficient. This hypothesis builds on the assumption that players are concerned with household income and do not play purely selfishly. We found substantial evidence in line with this hypothesis for average household and individual responses of husbands and wives. Table 15 shows that the probability of playing Hawk was reduced by 6% to 12% for husbands and wives when comparing the Pareto-efficient (D;D)=(40;40) treatment with the Pareto-superior (D;D)=(50;50) treatment. Likewise, the probability of playing Hawk was reduced by 4% to 5% when moving from Pareto-inferior (D;D)=(30;30) treatments to (D;D)=(40;40) treatments. Both effects were significant, and the first effect was highly significant (at 0.1% level). However, there were also players and households that chose Pareto-inefficient solutions in sequential and one-way signaling games as cooperative reciprocators or to punish their spouses at their own expense.

Hypothesis H4 stated that there is learning in the games such that the frequency of (H;H) outcomes declines through the games for those who aim to maximize household income, whereas more selfish individuals will move toward the optimal switch points in mixed games given the expectations of what the spouse will do based on earlier game rounds. We found that the husbands who played less selfishly than the wives tended also to play less Hawkish over the six game rounds (Table 15 and Figure 1). Wives played closer to the selfish mixed strategy, and this did not change significantly through the six games. Husbands who were household heads appeared to take their roles seriously because they were in charge of household income. Thus, these husbands played, on average, less selfishly, as expected.

Conclusions

To our knowledge, this is the first paper to use variants of the Hawk-Dove game to assess intra-household coordination, bargaining and Pareto-efficiency outcomes. The unique randomized combination of paired simultaneous, one-way signaling and sequenced models with Pareto-efficient, Pareto-inferior, and Pareto-superior (D;D) treatments provide new insights about strategic intra-household reactions to alternative treatments. The sequence of six games per household allows the identification of alternative player types and the extent to which they aim to maximize personal income and household income and to which they are cooperative reciprocators (Doves) that sacrifice personal and household income for the sake of cooperation, or to which they are Hawks willing to punish their spouses at the expense of household and personal income.

To summarize, the experiments revealed diverse player types, including players who prioritized household income over personal income (more common among husbands), players who maximized personal income at the expense of household income (more common among wives), players who always played Hawk (more common among wives), players who were willing to punish their spouses even if that meant sacrificing personal income, and players who always played Dove (cooperative reciprocators), even at the expense of household and personal income. There was a tendency for more aggressive players to render their spouses less aggressive such that only one of the spouses in a household played very Hawkish.

Overall, the results show that non-cooperative bargaining is common within households, resulting in Pareto-inefficient outcomes. The type of models that rely on Pareto-efficiency in the households cannot therefore be considered good universal approximations of household behavior. Our findings thus partially support the findings in recent experimental studies using the one-shot Voluntary Contribution Mechanism in intra-household public goods games with our more general Hawk-Dove game. Our Hawk-Dove game is a multiple equilibrium coordination game with varying Pareto-efficiency benefits from cooperation. The variation in communication in simultaneous games combined with sequential games with six rounds allowed for learning and expectation formation and revealed substantial variation of player types with surprising gender differences.

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Appendix. Experimental protocol

1. Hawk-Dove games with husbands and wives (2-person games)

Instructions. There will be a sequence of six games where husband and wife will play against each other. One of the games (determined randomly after they have been played) will be real and lead to pay-out based on the decisions of both players in that specific game. Two of the games will be simultaneous without the player knowing, only anticipating, what the spouse will do. Two other games will be played allowing one of the players to send a signal to the other about what s/he plans to do (but this does not mean that the player necessarily has to do so) and then the actual decisions are simultaneous. The signals will be sent once by each player. The third pair of games will be played sequentially, where each player starts once. The order of these three pairs of games will be randomized.

One or two initial "warm-up" hypothetical games should be played first to ensure that the players understand the payout matrix and the consequences of alternative decisions. The players should be made aware who the "row player" is and who is the "column player" and that the first number in each of the interior cells is the payout for the row player, while the second number is the payout for the column player. The household head is the row player and the spouse (or co-player) is the column player. The numbers represent Ethiopian Birr that they may win.

Name of row player:_____________________ Name of column player:_________________________

Household position of row player:______Household position of column player:________
Position: 1=Male head, 2= Female head, 3= Spouse, 4=Son, 5=Daughter, 6=Other, specify:_________________

<u>Game 1</u>:
Type of game: 1=Simultaneous

Payout matrix 1	H	D
H	0, 0	60, 20
D	20, 60	40, 40

Circle the choice of the players in the matrix

<u>Game 2:</u>
Type of game: 1=Simultaneous

Payout matrix 1	H	D
H	0, 0	60, 20
D	20, 60	40, 40

Circle the choice of the players in the matrix

Game 3:

Type of game: 2= One way signal game

- Toss a coin to determine the first person to signal a choice. 1=Head=Row player, 2=Tail=Column player.
- Winner signal (pointing) through interviewer.

Signal from player(circle): 1=H, 2= D

Payout matrix 2	H	D
H	0, 0	60, 20
D	20, 60	30, 30

Circle the actual choice of the players in the matrix

Game 4:

Type of game: 2= One way signal game

- Loser from the toss above signal (H or D) through interviewer. 1=Head=Row player, 2=Tail=Column player

Signal from player (circle): 1=H, 2=D

Payout matrix 2	H	D
H	0, 0	60, 20
D	20, 60	30, 30

Circle the choice of the players in the matrix

Game 5:

Type of game: 3= Sequential game

- Toss a coin to determine the first person to play the game.
- **First player is (circle): 1=Head=Row player, 2=Tail=Column player**

Payout matrix 3	H	D
H	0, 0	60, 20
D	20, 60	50, 50

Circle the choice of the players in the matrix

Game 6:

Type of game: 3= Sequential game

- Loser from the previous coin toss will be the first player
- **First player is**: **1 =Head=Row player, 2=Tail=Column player**

Payout matrix 3	H	D
H	0, 0	60, 20
D	20, 60	50, 50

Circle the choice of the players in the matrix

Throw a die, or pull a card (1 of 6) to determine which of the games 1-6 will be used for payout.

Outcome:_______