Being Bourgeois
The Emergence of Private Property in the Lab*

Marco Fabbri† & Matteo Rizzolli‡

```
Very Preliminary draft
please do not distribute or quote without authors' consent
```

Abstract

Empirical studies have long shown that humans -as well as some animal species- often respect ownership even in the absence of the rule of law. The emergence of property rights has been described by theoretical biologists (Smith, 1982) as a successful evolutionary strategy -the *bourgeois* strategy- that minimizes the expected losses in a contest for scarce resources described by the well known *Hawk and Dove* (H&D) game. However, from the theoretical point of view the *anti-bourgeois* strategy is as good as the *bourgeois* one and therefore the predominance of respect for property observed in many societies still lacks a clearcut game theoretical explanation. To further complicate things, the experimental literature that deals with the H&D game has seldom observed the emergence of any coordination, being it the *bourgeois* or the *antibourgeois* strategy in the lab. Some recent theoretical papers however (Gintis, 2007; **?**; Sherratt and Mesterton-Gibbons, 2015) hypothesize that the absolute prevalence of the *bourgeois* strategy observed in real societies can be grounded in some behavioral traits such as the endowment effect and what they called the innate sense of property. In this paper we study by mean of a controlled laboratory experiment whether some established rules of property acquisition trigger the emergence of the *bourgeois* strategy. We set up an H&D game where one subject anonymously interact with another subject randomly chosen from the group for the appropriation of a certain amount of tokens. Every couple begins the stage with either subject holding the amount. We manipulate the way this initial claim to the amount is established. In the first treatment (luck) the initial claim is assigned randomly as manna-from-heaven. In the second treatment (first possession) it is the result of a treasure hunt that mimics the rule of first possession/treasure trove. In the third treatment (labor) it is the result of a payment for having worked in a standard effort task. In all treatments we observe a majority of subjects coordinating over a *bourgeois* strategy with the first possession and labor treatments inducing more coordination than the luck one.

Keywords: property rights, Hawk & Dove, Bourgeois strategy, innate sense of property, stealing

JEL codes: C91, D23, K11, P14, P26

*We thank participants to the SONIC experimental workshops in Bologna for comments on the early design. We thank Maria Bigoni, Marco Casari, Marco Faillo, and Francesco Parisi for valuable comments. This project was funded by the Einaudi Institute of Economics and Finance 2015 Research Grant. The usual disclaimers apply.

†Erasmus University Rotterdam, fabbri@law.eur.eu

‡LUMSA University, m.rizzolli@lumsa.it

1 Introduction

The Hawk and Dove Game introduced by Smith and Parker (1976) models animal conflicts for the appropriation of scarce resources stylizing Hawks (strategy H) as being always prepared to fight to retain or gain a contested resource while Doves (strategy D) always defer and retreat if their opponent escalate the fighting. Under certain conditions both populations of Hawks and Doves can coexists however - and this is the main message of Maynard Smith (1982)- the real winners are those who adopt the -so called- *bourgeois* strategy described as *"defend aggressively when one is an owner and defer to the opponent when one is an intruder"*.Notice that, in order to work the *bourgeois* strategy needs only that players can recognize their role as either owners or intruders.

The bourgeois strategy requires players to engage in two different behaviors: *defend aggressively* when one is the owner and *defer to the opponent* when one is the intruder. The success of the Hawk and Dove paradigm can be explained also by the vast amount of of evidence in natural and social sciences of the existence of these two behaviors. For what concerns the former, we know that many animal species display territoriality: among them there are baboons (Kummer et al., 1974); damselflies (Waage, 1988) desert ants (Wenseleers et al., 2002) Ozark zigzag salamanders (Mathis et al., 2000) some colonial spiders (Hodge and Uetz, 1995), many species of birds (Krebs, 1982; Beletsky and Orians, 1987) and so on. Also humans do display a great amount of territoriality: Pape (2003) reports empirical evidence that suicide attacks are most likely carried out by persons who are trying to displace occupying invaders and Johnson and Toft (2014b,a) show how territory is central to some of the most vexing cases of todays' conflicts and wars.

More intriguingly, there is also ample evidence of both humans and animals displaying *defer to the opponent* type of behavior. Potential intruders retreat in front of simple signals such as occupancy, scent marking or song that the object or territory is 'owned' (Parker, 1974; Davies, 1978). Similarly, experimental psychologists report evidence that children at the age of two already developed a sense of property rights and they recognize and respect others' possession of an object (Fasig, 2000). Of course in the real world, laws and social norms concerning the protection of private property prevent us from observing the behavior in a purely lawless environment (Kandori, 1992; Posner, 2000; Zasu, 2007) and this makes the disentangling of these effects using observational data problematic. On the other hand, the controlled environment of a laboratory makes it possible to recreate an ad-hoc pre-institutionalized setting allowing to isolate the effects of these factors. In fact evidence emerging in economic experiments on the dictator game show that dictators respect property to some extent even if the potential reaction of the owner is ruled out by design. On this point see Faillo, Rizzolli and Tontrup (2016) and further literature cited below.

As much as the empirical evidence shows that the *bourgeois* strategy is the most widely observed in nature, it is by no mean the only Evolutionary Stable Strategy (ESS) that solves the H&D game. Eshel (2005) points out that, whenever a symmetry-breaking tag of being the owner or the intruder is introduced, there exist another ESS -the *antibourgeois* strategy- that works in the opposite way:

play Hawk when one is the intruder and play Dove when one is the owner. Furthermore, from a game theory point of view the tie-breaker does not necessarily need to be the initial role of owner but could be any other tag that establishes a certain asymmetry among the players, such as having the longer thumb (Eshel, 2005). This signal would also produce an ESS that avoid costly fight but of course it has nothing to do with property as we conceive it.

Why then, among all possible ESSs that could solve the H&D game, do players -being them humans or animals- preponderantly choose the *bourgeois* one? There are several recent theoretical papers (Gintis, 2007; Eswaran and Neary, 2014; Sherratt and Mesterton-Gibbons, 2015)that try to address this question.

This paper however takes another route and tests within an experimental protocol whether the *bourgeois* strategy emerges in a lab setting once the ownership-intruder asymmetry is introduced using some well established institutions of property law. Among all the possible ways property can be acquired (purchase, will, descent, gift, confusion to name a few) we have focused on reproducing two paradigmatic ones: *first possession* and creation through *labor*. We set up an H&D game where subjects interact in groups of 6 over 30 periods. Each period is divided in two parts: in the first part tokens are allocated. In the second part each player anonymously interacts with another player randomly chosen from the group for the appropriation of a certain amount of tokens. Every matched pair begins the stage with either player holding the amount. We manipulate the way this initial allocation of tokens is established in the first part, while the second part is the same across treatments. In the first treatment (luck) the initial amount is assigned randomly to one player as manna-from-heaven. In the second treatment (first possession) the initial amount is the result of an activity that resembles a treasure hunt: the first player that finds the treasure becomes the owner. In the third treatment (labor) the initial amount is the payment for having performed a standard effort task: both players are paid based on their performance and the one who gains more enters the H&D phase as the incumbent owner. In all treatments the amount is re-assigned in every period and in both first possession and labor treatments subjects have to engage in the activities (treasure hunt and effort task) in every period.

From a theoretical point of view we shall remember that the mere establishment of the initial claim on the amount cannot predict whether subjects will coordinate over a *bourgeois* or *antibourgeois* strategy. Furthermore, a number of experimental studies that had investigated H&D theoretical properties, have found weak if no convergence toward either ESSs (see section 3 below for a literature review). To our knowledge our contribution is the first one to test whether well established and common modes of acquisition found in both civil and common property laws trigger the coordination of players on the *bourgeois* strategy within a standard H&D game. The research questions we try to answer in this paper are the following: in a H&D, once the property (or possession) of the resources at stake is explicitly assigned to one of the players but no third-party property enforcing institution exists, does individuals' behavior converge overtime toward a "bourgeois strategy" equilibrium? If so, which is (are) the mechanism(s) of property acquisition (luck, labor, first possession) that, absent any enforcing mechanism, in the view of potential intruders legitimates property rights and generates the strongest respect for incumbents' property?

The paper proceeds as following: in Section 2 we present a selected review of the literature. In section 3 we introduce the H&D game, discussing its theoretical predictions and reporting a literature review of laboratory studies that employ this game. In section 4 we present the experimental design and section 5 presents the results. We draw the conclusions in section 6.

2 Literature Review

The paper touches upon several streams of literature. Sherratt and Mesterton-Gibbons (2015) offers a state of the art review of both theoretical and empirical literature on the Hawk & Dove game as it has been used to explain the emergence of property rights. Gintis (2007) advances a theoretical argument that explains why people tend to value a good that they possess more highly than the same good when they do not possess it, a phenomenon known as "endowment effect" (Kahneman et al., 1991). The author shows that, in a contest over scarce resources among individuals of equal strength and absent any third-party protection of property rights, a "natural private property equilibrium" enforced by the individuals themselves is likely to arise. The intuition behind this result is that, given the value of the resource at stake, the endowment effect generates a disutility in giving up the resource for the actual owner that exceeds the utility gain experienced by the intruder. Therefore, since individuals' effort in the contest is endogenously determined by the private evaluation of the resource value, the model predicts that in equilibrium the actual owner devotes an effort in protecting his property greater than the effort exerted by an intruder trying to expropriating it.

On a similar line, **?** model how an *innate sense of property* rights may have emerged in humans and other animal species as a result of evolutionary forces. The authors move from Locke's (1988 [1689]) theory of property, according to which labor expended on an object creates an innate psychological claim over the object as property. This claim leads the producer to develop a stronger preference for such object vis-à-vis an interloper who seeks to appropriate it. In a potential conflict over the attribution of this object these asymmetric valuations are reflected in the owner-producer being willing to expend more effort defending his claim relative to the non-owner.

A series of recent laboratory experiments involving human subjects provide results consistent with these theories and with the aforementioned field observations. The design of these experiments considers an active subject - the dictator - that is matched with a passive player - the receiver - and each are endowed with a symmetric endowment. There are two possible variants of this "dictator game" (DG onward). In the so called "taking-only" DG[1], under full anonymity, the dictator can decide whether to defer to the opponent and leave unchanged the allocation of endowments or alter the de-facto initial allocation by taking some or all of the passive player's endowment (Korenok et al., 2013; Swope et al., 2008; Visser and Roelofs, 2011). In a second variant of the game called "free-form" DG, in addition to the actions just mentioned, the dictator could also choose to alter the initial allocation by giving some or all of his own resources to the passive player like in the standard or "give-only" DG (Krupka and Weber, 2013; List, 2007; Rizzolli and Stanca, 2012). In the game there is no legal sanction nor enforcement mechanism. Given the absence of any strategic interaction, self-interested profit maximizing dictators are predicted to (give nothing and) take the maximum possible amount of receivers' endowment[2]. The original authors' objective when introducing this experimental design

[1] Sometimes this variant of the game is also called "theft game" or "gangster game".

[2] Incidentally, in this game the taking scenario closely resembles a petty larceny type of crime and mimics well a broad category of crimes: indeed every crime where the criminal forces an un-willful transaction (see Fletcher, 1985).

is to undermine some acquired results concerning the existence of the distributional norm emerging in give-only DG. For example, results of the free-form DG show that, when the opportunity to take is added to dictators' choice set in addition to the opportunity to give, the inclination typical of the give-only DG to altruistically transfer endowment to the passive receivers disappears. Furthermore, results also show that the dictators on average take a fraction of passive players' endowment.

Nevertheless, two puzzling (and in many respect overlooked) results arise from this experimental findings. First, it is true that in the take-only as well as in the give-only or free-form DG dictators do not allocate to themselves the full endowment at stake in the game, so violating in both cases the standard game-theoretical prediction. However, dictators allocate to themselves significantly *less* in the taking scenario than in the giving scenario (Korenok et al., 2013; Krupka and Weber, 2013; Swope et al., 2008; Visser and Roelofs, 2011), This result is surprising because "*[the] finding that the cold prickle of taking exceeds that warm glow of giving in dictator games is opposite to Andreoni's original finding in public good games.*" (Korenok et al., 2013, pp. 496)

A second puzzling result comes from the comparison of DG where players acquire endowments by means of different sources. In a series of contributions, the results of a giving-only dictator game with windfall money is compared with treatments where the endowment is assigned to the dictator based on an effort task (Cappelen et al., 2013; Jakiela, 2011; List, 2007; Oxoby and Spraggon, 2008). The results show that when dictators earn their endowment they are less prone to share it with the receiver. **?** and List (2007) confirm this finding also for the free-form DG, reporting that dictators are also less likely to take money earned through labor by a passive receiver. This result is surprising because, if the introduction of a labor-framed environment for earning the endowment crowds out dictators' altruistic behavior in the giving scenario, then in the taking scenario we should expect that the labor-frame produces the same crowding-out effect, resulting in *more* thefts taking place.

Indeed, both these findings cannot be explained by the models of social preferences currently investigated by experimental economics as noted by -inter alia- List (2007); Bardsley (2008); Cappelen et al. (2013). On the other hand, the results are perfectly consistent with the models of Gintis (2007) and **?** postulating the existence of an "innate sense of property". Indeed, according to the authors' theory, the reason why dictators avert taking is because their preferences have endogenously developed a deference to opponent's property rights whose legitimacy has been acquired through labor, even if these rights are not established nor protected by institutional factors.

3 The *Hawk-Dove* game

Figure 1: The *Hawk-Dove* Game

Player2 / Player1	H	D
H	$\frac{v-c}{2}$; $\frac{v-c}{2}$	v ; 0
D	0 ; v	$\frac{v-a}{2}$; $\frac{v-a}{2}$

In this work we are interested in verify the dynamic evolution of individuals' behavior in a pre-institutionalized two-agent contest over scarce resources. To this end, we decide to implement a 2 x 2 bimatrix H&D , where a player has the choice between contend the resource aggressively (Hawk) or retreat, avoiding so the risk of a costly conflict escalation (Dove). We focus on a H&D because it maps closely the strategic setting object of interest of this study that is common to a variety of social life situations. In the game, the cost of a fight c for the agents is assumed to be higher than the value v of the resources contended. Moreover, parties bear the cost a for sharing the resource with the contendant. The cost a is assumed to be smaller than c and v. Figure 1 summarizes the payoff matrix of an H&D.

However, despite the game simplicity, predictions of the equilibrium outcomes are difficult, since there are multiple Nash equilibria (NE from now on) and the equilibrium selection criterion does not readily solve the ambiguity. Assuming multiple repetitions with anonymous players randomly matched, H&D is commonly analyzed using two approaches. Standard game theoretical analysis assumes fully rational players and finds that H&D has two asymmetric NE in pure strategy (H-D and D-H) and an interior solution with a NE in mix strategy, where agents play strategy H with probability p[3]. However, this approach provides no indication regarding which equilibrium will be selected among the set of possible NE.

Given the weak predictive ability of the standard analysis, scholars often resort to an evolutionary approach in order to refine equilibrium selection. The evolutionary approach assumes non-rational players whose actions replicate the payoff-maximizing strategy[4]. Therefore, this approach predicts

[3] A possible way of interpreting a mix strategy solution is the following. Assume that the predicted equilibrium is to play H with probability p. Imagine that each agent chooses his strategy by randomly witH&Drawing a ticket from an urn containing letter "H" or "D" tickets and playing accordingly. The proportion of H ticket in the urn is established by the agent. Assume that in period n the fraction of letter H ticket in the urn is $k > p$. Hence, by equilibrium definition, the average return for agents playing D will be higher than the return of those playing H. Since peers' actions are observable, in period n+1 agents will acquire the information regarding strategy D highest profitability and adjust upward the proportion of letter D tickets in the urn. As a consequence, in period n+1some agent will switch from strategy H to D on average. The process of adjusting and switching will continue in subsequent periods until the proportion of letter H ticket will become equal to the predicted fraction p. At this point, no adjustment of ticket proportion will take place since any deviation from p would reduce payoff. An alternative interpretation of the NE in mix strategy is the Harsanyi's "purification approach" (Harsanyi, 1973). According to this approach, a fraction of agents "specializes" itself in playing always one strategy. Through evolution, some players will keep switching strategy attempting to imitate the most successful players until a fraction p of agents always play H while the remaining (1-p) agents always play D.

[4] Two interpretations of the evolutionary approach are possible. In the biological interpretation, players replicate the

that agents' behavior evolves overtime selecting among a set of NE the one(s) that is "evolutionary stable" (ES onward). In the H&D framework, if the population is composed by identical players the the evolutionary approach predicts that there is an unique ES equilibrium and that players' behavior will converge toward the symmetric mix strategy NE (an interior solution).

Nevertheless, predictions concerning ES equilibrium change if an identifiable "uncorrelated asymmetry" between players is introduced. Specifically, an uncorrelated asymmetry implies all members involved in a H&D game are identical except for an arbitrary and payoff-irrelevant feature that makes possible to sort the population in two groups. Examples of such uncorrelated asymmetry might be labeling some players "row" vs. "column" or "red" vs. "yellow". While from a standard game theoretical perspective the introductions of such labels is irrelevant, according to the evolutionary approach the uncorrelated asymmetry makes possible for individual behavior to be conditioned to the presence of this asymmetry. As a consequence, the strategy that overtime gains popularity among one group will differ from the one adopted by the other group. Therefore, if an uncorrelated asymmetry is present, the evolutionary approach predicts that population dynamics in H&D evolve toward one of the two pure strategy asymmetric NE (a corner solution)

On the other hand, when an uncorrelated asymmetry is introduced, evolutionary game theory does not provide a equilibrium selection criterion among the two ES NE. Indeed, from Smith and Price (1973) onward, the biological tradition associates the concept of uncorrelated asymmetry in the H&D with territorial incumbency of one of the agents. According to this interpretation, the owner or possessor of a resource will display a tendency to adopt an hawkish strategy and a potential intruder will defer to owner's possession - the so called "bourgeois strategy". However, from a game-theoretical perspective, incumbency does not provide any specific solution for the selection criteria: the "anti-bourgeois equilibrium", where an incumbent always defers to the intruder, is equally stable and even theoretically robust to the introduction of a certain range of "swapping costs" (Mesterton-Gibbons and Sherratt, 2014). Indeed, biologists report that the anti-bourgeois equilibrium, while less common than the mirroring bourgeois equilibrium, is established in some animal species (see for example Faillo et al. (2016)).

4 The Experiment

Figure 2: Payoffs Table

Player2 / Player1	H	D
H	-25; -25	50; 0
D	0; 50	15; 15

highest payoff strategy attempting to achieve reproductive success. The social interpretation of this approach implies that agents gather information regarding the optimal strategy by observing peers' performances.

The payoff matrix that we implement for our H&D is reported in Figure 2. We set the parameter $v = 50$, c $= 100$ and $a = 20$. Given these parameter values, the game has a symmetric NE in mix strategy where agents choose strategy H with probability $p = \frac{7}{12}$. The per capita payoff of the mix equilibrium is then $pH + (1-p)D = 7.5$. This interior solution is inefficient, in that its payoff falls short of $\frac{v}{2} = 25$, the per capita payoff when the strategy profiles (H;H) and (D;D) never occur. Specifically, the symmetric NE yields a rather low efficiency of $\frac{3}{10}$.

The game has also two asymmetric NE in pure strategy H-D and D-H, both of which are efficient. Payoffs in the two pure NE result in a highly inequitable (50;0). We decided for this payoff specification in order to challenge the theoretical hypothesis that agents will achieve coordination, with the owner of the resource playing H and the potential expropriator playing D. Indeed, these payoff provide strong incentives for non-owner to resist convergence toward the bourgeois strategy.

Each experimental session is composed of 30 rounds. Each round is divided in two parts. At the beginning of the first part of each round, subjects are randomly re-matched with one of the other group members (stranger matching). In the first part of the round, one of the two paired subjects becomes the owner of 50 experimental monetary units ("tokens" that will be converted in cash at the end of the experiment) according to a procedure that differs between the treatment, as described in the next subsection. In the second part of the round, subjects play the H&D. The 50 tokens contended during the game are those that the Owner gained in the first part of the round. If players choose actions H-H, the 50 tokens are lost and additional 25 tokens are subtracted from the total payoff of each subject. Hence, in each round participants could either maintain their endowment identical or instead losing or gaining tokens [5].

In each round, subjects face the same payoff matrix as in Figure 2. In order to avoid introducing a second uncorrelated asymmetry, all the player see themselves as "row players". In each period they can choose between action "Hawk" (labeled "A", in order to maintain a neutral language) and "Dove" (labeled "B"). At the end of each round, participants receive the following information:

- Player opponent's choice (and thus payoff for the round);
- Same group players' aggregate behavior in that session both in the last round and on average for all rounds so far (e.g. in last round 30% of the players choose H; on average so far, 23% of the players choose H);
- The aggregate behavior in the session of "owner" and "non-owner" separately, both in the last round and on average for all rounds up to that point;
- The total and average individual payoff for all rounds up to that point;
- The average payoff of all players in the same group of six up to that point;
- The average payoffs collected by "owners" and "non owners" in the group up to that point;

At the beginning of each section, subjects acquire an initial endowment through a procedure that differs according to the treatment, as described in the next subsection.

[5]Participants are informed that, in the case their endowment falls below zero before the last round, they are requested to leave the experiment and will receive only the participation fee.

4.1 Treatments

In each round of all treatments, couples of participants randomly matched play an H-D game to contend an identical amount of tokens belonging to one of the two players. The difference between treatments consists in the way one of the two player becomes the owner of the contestable resources. Figure 3 summarizes our treatments. We investigate three possible channels of property acquisition in three separate effect treatments.

In the first treatment, that we named "Manna from Heaven", the computer randomly assigns to one of the two players (the "owner") in each couple an endowment $v = 50$ tokens, while the other player (the "intruder") does not receives tokens.

In the second treatment, the "Labor Treatment", at the beginning of each round participants have to perform an individual effort task. Each participant has one minute of time to move the cursors of numbered sliders on the position indicated by the computer. The participant in the couple that positions the highest number of cursors gains the 50 tokens. Since this activity does not require any particular ability or knowledge to be completed, it is likely that participants perceive the endowment gained through individual performance to be correlated with individual effort.[6]

In the last effect treatment, that we named "First Possession", the two players in a couple participate in a treasure trove contest in order to gain the 50 tokens. Participants see the computer screen divided into 42 squares. Hidden behind one of the squares there is a code composed by numbers and letters. Participants have to click on the square in order to verify if it contains the code. When a participant finds a code, he has to type it in a special "register" available on the screen. The first participant in the couple that registers the code gains the 50 tokens. This channel of property acquisition implies a mix of luck (uncover the "right" square) and individual ability (being faster than the competitors in registering the codes). Endowment acquired through this contest closely resemble the acquisition of property through first possession. This channel of property acquisition is recognized in virtually any legal systems .

4.2 Procedure

We conducted 13 laboratory sessions with 18 subjects each[7], for a total of 222 participants (46% female). In order to increase the number of independent observations while maintaining a low probability of repeated interactions among the same pair of subjects, in each session participants were split in three groups of six participants each and interactions took place only within members of the same group. Each subject participated to one session only.

The experiment was conducted using computer interfaces at CESARE lab of Luiss Guido Carli university. To program the experiment we used the software Z-tree (Fischbacher, 2007). Participants

[6] One possible downside of this procedure is that it might generate some income effects: assuming diminishing marginal utility of money, participants that were able to collect larger initial endowments might systematically behave differently than the initially less wealthy participants. This in turn might create problems of comparability with the first treatment, where each participant is endowed with the same amount of tokens. In order to maintain the comparability between treatments, one solution is to reduce the variance in the quantity of endowment that participants are able to collect. That implies allowing a sufficiently long time to complete the effort task, in such a way that a high fraction of players will acquire the full endowment. A second possibility is to assign the initial endowments unevenly also in the Benchmark and Manna from Heaven treatments, allocating them according to a distribution that replicates the same mean and variance of that of the Labor and First Possession treatments.

[7] Two sessions of the "Treasure" treatment had 12 subjects.

Figure 3: Treatments

Treatment Name	Channel of Property Acquisition	Explanation
"Manna from Heaven"	Random assigned by the experimenter at the beginning of each round	• Random matching each period • The randomly selected player becomes owner of v units • HD game with v units of owner endowment at stake
"Effort"	Slider task for one minute at the beginning of each round. The player in a couple that positions the highest number of slides gain the property	• Random matching each period • The most productive in the couple becomes owner of v units • HD game with v units of owner endowment at stake
"First possession"	Treasure trove game at the beginning of each period. The player in the couple that finds the resource and register it becomes the owner property	• Random matching each period • The player who founds the v units becomes the owne • HD game with v units of owner endowment at stake

were for the vast majority graduate and undergraduate students of the University and were recruited using the online system ORSEE (Greiner, 2004).

At the beginning of each session, instructions were read aloud by the experimenter[8] in order to ensure common knowledge. Before the experiment started, all the participants had to answer correctly some control questions. Subjects were informed that the answers to the control questions are not payoff relevant. Throughout the reading of the instructions and the control questions stage, participants had the possibility to privately ask questions to the experimenter. After the experiment conclusion, each subject was request to fill in a questionnaire reporting socio-demographic characteristics. Communication among participants was not allowed during the experiment.

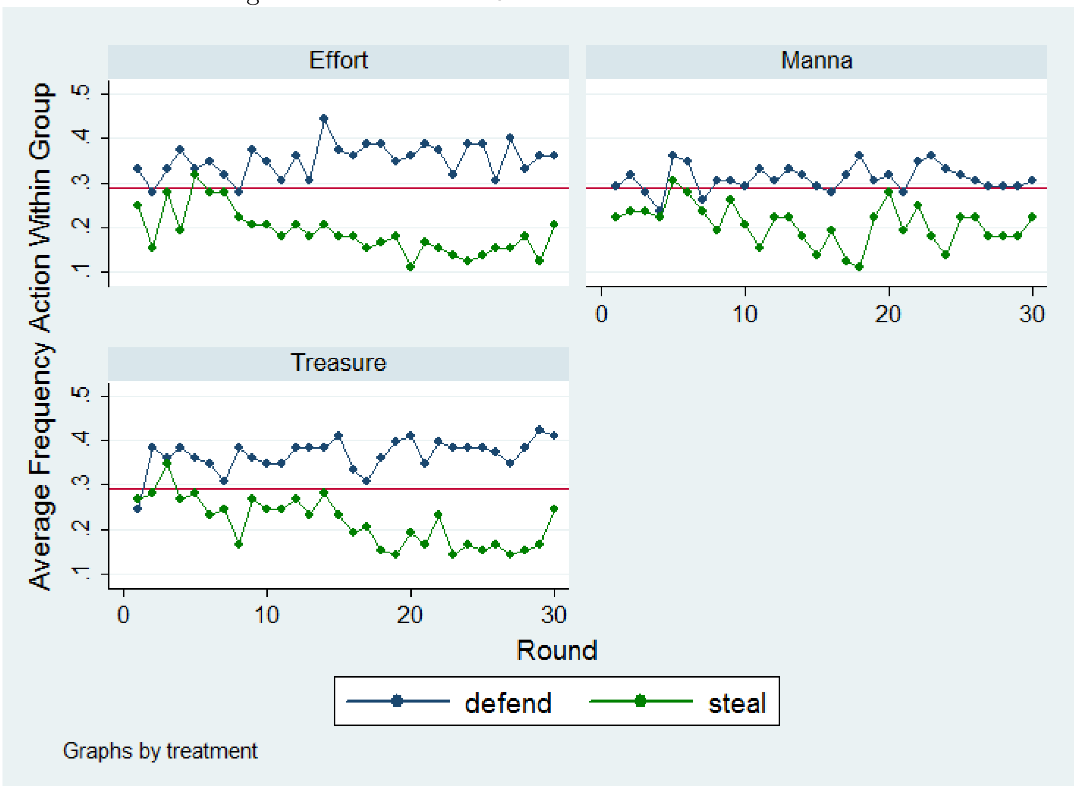
Each session lasted approximately 70 minutes. During the experiments, subjects' endowment and payoff were expressed in tokens. Each token was then converted in Euro at the rate of 50 tokens for one Euro. Participants earned on average Euro 19, including a Euro 5 show up fee. In order to guarantee anonymity, cash payments were distributed individually and in private at the end of the session.

5 Results

We begin the analysis by checking if the assignment of property rights over the tokens that are contended during the H-D game affects participants' likelihood to choose the aggressive Hawk strategy. If being the owner rather than the intruder has no effect on subjects' choices, evolutionary game theory predicts that subjects will converge to a NE in mix strategy where they play H with probability .58.

[8]To keep constant any disturbance coming from eventual demand effect, the experimenter remained the same in all the session.

Figure 4: Evolution of Owners and Intruders Behaviors

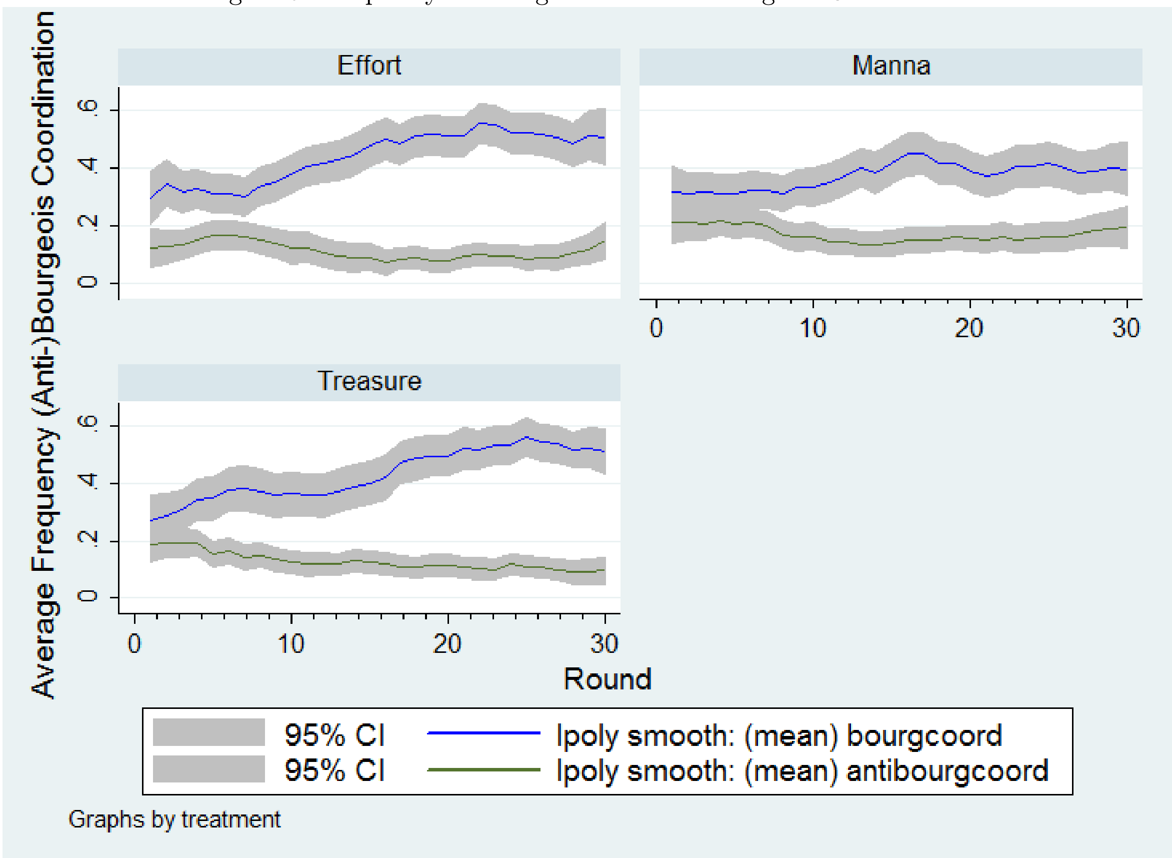


Conversely, if subjects perceive the assignment of property rights as a signal that helps achieving coordination, then they will evolve toward one of the two NE in pure strategy. Therefore, in this second case we should observe one type of subjects always playing one strategy and the other type playing the opposite strategy (e.g. convergence either toward a "Bourgeois" equilibrium when Owners play H and Intruders play D or an "Anti-Bourgeois" equilibrium if the opposite happens).

We generate the dummy variables "defend" and "steal" that take value 1 respectively when a subject is Owner and play Hawk and when a subject is Intruder and plays Hawk. We start by initially adopt a conservative approach and we consider as a unit of observation the groups of six players interacting within a session. For each group, we calculate the average frequency in each period of Owners playing Hawk (dummy defend=1) and Intruders playing Hawk (dummy steal=1). Figure 3 plots the results. If the assignment of property rights has no effect on players' choices, we expect owners and intruders to choose the strategy Hawk with the same probability equal to .58. Therefore, in a group of six players interacting throughout a session, we expect the dummies defend and steal to be both equal to 1 with an average frequency of .29.

Figure 4 shows the results of our sample. We can notice that the assignment of property rights generates differences in the strategy chosen by players. In first rounds of each of the three treatments, the frequency of Owners and Intruders choosing Hawk is close to the theoretical prediction (the red horizontal line). A series of t-tests for the comparison of means confirms that the frequency of the variables defend and steal equal to 1 is statistically equal in each treatment up to period 11. However,

Figure 5: Frequency of Bourgeois vs. Anti-Bourgeois Coordination

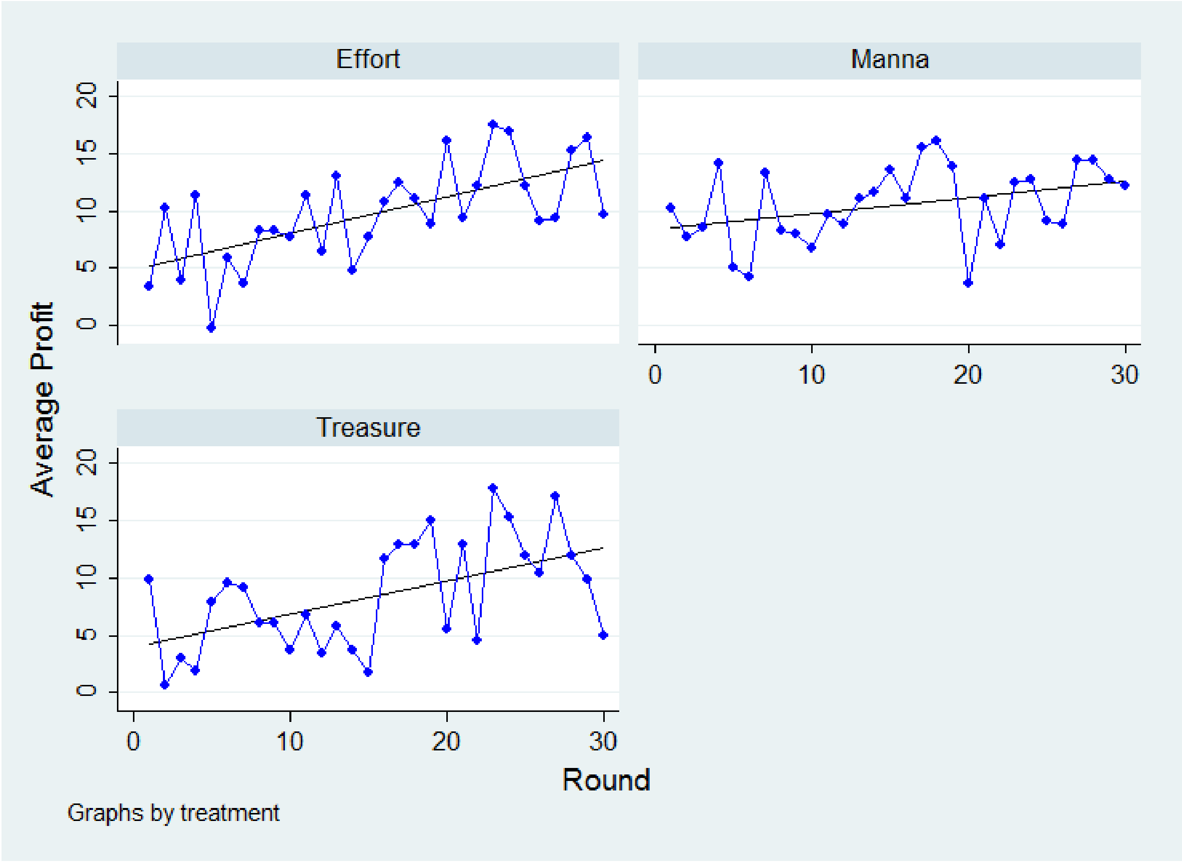


after the first periods of the experiment, differences starts to emerge between treatments.

In the Effort treatment, from period 12 onward a series of t-test shows that the frequency of defend=1 becomes significantly higher that the frequency of steal=1 at the 5% level or better. The same happens to subjects in the Treasure treatment, albeit only from period 18 onward. Conversely, in the Manna treatment the difference between the frequency of defend=1 and steal=1, albeit always positive, is never statistically different from zero.

We proceed by analyzing the ability of participants to coordinate on a pure strategy NE. We generate the dummy variables "bourgcoord" and "antibourgcoord" that take value 1 when the pair of subjects interacting in a round coordinates respectively on the strategies Owner-play-H & Intruder-play-D and the symmetric Owner-play-D & Intruder-play-H. Figure 5 plots the Kernel function and relative confidence intervals of the two variables. While coordination in the three treatments seems to happen predominantly on the Bourgeois strategy, nonetheless the frequency of subjects in the Manna treatment coordinating on the Anti-bourgeois strategy remains higher than in the other two treatments and does not decrease overtime. Conversely. subjects in Effort and Treasure, while in the initial rounds of the experiment on average behave similarly to those in the Manna treatment, after period 10 seems to clearly coordinate toward a Bourgeois strategy and to progressively abandon the Anti-bourgeois strategy.

Figure 6: Profit



6 Conclusions

To be added

References

Bardsley, Nicholas, "Dictator game giving: altruism or artefact?," *Experimental Economics*, 2008, *11* (2), 122–133.

Beletsky, L.D. and G.H. Orians, "Territoriality among male red-winged blackbirds," *Behavioral Ecology and Sociobiology*, 1987, *20* (1), 21–34.

Cappelen, Alexander W., Ulrik H. Nielsen, Erik Ø. Sørensen, Bertil Tungodden, and Jean-Robert Tyran, "Give and take in dictator games," *Economics Letters*, 2013, *118* (2), 280 – 283.

Davies, Nick B, "Territorial defence in the speckled wood butterfly (Pararge aegeria): the resident always wins," *Animal Behaviour*, 1978, *26*, 138–147.

Eshel, Ilan, "Asymmetric population games and the legacy of Maynard Smith: From evolution to game theory and back?," *Theoretical population biology*, 2005, *68* (1), 11–17.

Eswaran, Mukesh and Hugh M Neary, "An economic theory of the evolutionary emergence of property rights," *American Economic Journal: Microeconomics*, 2014, *6* (3), 203–226.

Faillo, Marco, Matteo Rizzolli, and Stephan Tontrup, "Thou shalt not steal (from hard-working people) An experiment exploring our respect for property," 2016.

Fasig, Lauren G, "Toddlers' Understanding of Ownership: Implications for Self-Concept Development," *Social Development*, 2000, *9* (3), 370–382.

Fischbacher, Urs, "z-Tree: Zurich toolbox for ready-made economic experiments," *Experimental economics*, 2007, *10* (2), 171–178.

Fletcher, George P., "A Transaction Theory of Crime?," *Columbia Law Review*, 1985, *85* (5), 921–930.

Gintis, Herbert, "The evolution of private property," *Journal of Economic Behavior & Organization*, 2007, *64* (1), 1 – 16.

Greiner, Ben, "The online recruitment system orsee 2.0-a guide for the organization of experiments in economics," *University of Cologne, Working paper series in economics*, 2004, *10* (23), 63–104.

Harsanyi, John C, "Games with randomly disturbed payoffs: A new rationale for mixed-strategy equilibrium points," *International Journal of Game Theory*, 1973, *2* (1), 1–23.

Hodge, M.A. and G.W. Uetz, "A comparison of agonistic behaviour of colonial web-building spiders from desert and tropical habitats," *Animal Behaviour*, 1995, *50* (4), 963–972.

Jakiela, Pamela, "Social Preferences and Fairness Norms as Informal Institutions: Experimental Evidence," *American Economic Review*, 2011, *101* (3), 509–13.

Johnson, Dominic DP and Monica Duffy Toft, "Bringing "Geo" Back into Politics: Evolution, Territoriality and the Contest over Ukraine," *Cliodynamics: The Journal of Quantitative History and Cultural Evolution*, 2014, *5* (1).

_ and _ , "Grounds for war: The evolution of territorial conflict," *International Security*, 2014, *38* (3), 7–38.

Kahneman, Daniel, Jack L. Knetsch, and Richard H. Thaler, "The Endowment Effect, Loss Aversion, and Status Quo Bias: Anomalies," *Journal of Economic Perspectives*, 1991, *5* (1), 193–206.

Kandori, M., "Social norms and community enforcement," *The Review of Economic Studies*, 1992, *59* (1), 63–80.

Korenok, Oleg, Edward L Millner, and Laura Razzolini, "Taking, giving, and impure altruism in dictator games," *Experimental Economics*, 2013, pp. 1–13.

Krebs, J.R., "Territorial defence in the great tit (Parus major): do residents always win?," *Behavioral Ecology and Sociobiology*, 1982, *11* (3), 185–194.

Krupka, Erin L and Roberto A Weber, "Identifying social norms using coordination games: Why does dictator game sharing vary?," *Journal of the European Economic Association*, 2013, *11* (3), 495–524.

Kummer, H., W. Gotz, and W. Angst, "Triadic differentiation: an inhibitory process protecting pair bonds in baboons," *Behaviour*, 1974, *49* (1), 62–87.

List, Jonh A., "On the interpretation of giving in dictator games," *Journal of Political Economy*, 2007, *115* (3), 482–493.

Locke, John, *Second treatise of government* number 31, Hackett Publishing, 1980.

Mathis, A., D.W. Schmidt, and K.A. Medley, "The influence of residency status on agonistic behavior of male and female Ozark zigzag salamanders Plethodon angusticlavius," *American Midland Naturalist*, 2000, pp. 245–249.

Mesterton-Gibbons, Mike and Tom N Sherratt, "Bourgeois versus anti-Bourgeois: a model of infinite regress," *Animal Behaviour*, 2014, *89*, 171–183.

Oxoby, Robert J and John Spraggon, "Mine and yours: Property rights in dictator games," *Journal of Economic Behavior & Organization*, 2008, *65* (3), 703–713.

Pape, R.A., "The strategic logic of suicide terrorism," *American Political Science Review*, 2003, *97* (03), 343–361.

Parker, Geoffrey A, "Assessment strategy and the evolution of fighting behaviour," *Journal of theoretical Biology*, 1974, *47* (1), 223–243.

Posner, Eric A., *Law and social norms*, Cambridge, Mass.: Harvard University Press, 2000.

Rizzolli, Matteo and Luca Stanca, "Judicial errors and crime deterrence: theory and experimental evidence," *Journal of Law and Economics*, 2012, *55* (2), 311–338.

Sherratt, Thomas N and Mike Mesterton-Gibbons, "The evolution of respect for property," *Journal of evolutionary biology*, 2015.

Smith, J Maynard and GR Price, "lhe Logic of Animal Conflict," *Nature*, 1973, *246*, 15.

Smith, J.M., *Evolution and the Theory of Games*, Cambridge Univ Pr, 1982.

Smith, John Maynard and Geoffrey A Parker, "The logic of asymmetric contests," *Animal behaviour*, 1976, *24* (1), 159–175.

Swope, Kurtis, John Cadigan, Pamela Schmitt, and Robert Shupp, "Social position and distributive justice: Experimental evidence," *Southern Economic Journal*, 2008, pp. 811–818.

Visser, Michael S and Matthew R Roelofs, "Heterogeneous preferences for altruism: gender and personality, social status, giving and taking," *Experimental Economics*, 2011, *14* (4), 490–506.

Waage, J.K., "Confusion over residency and the escalation of damselfly territorial disputes," *Animal Behaviour*, 1988, *36* (2), 586–595.

Wenseleers, T., J. Billen, and A. Hefetz, "Territorial marking in the desert ant Cataglyphis niger: Does it pay to play bourgeois?," *Journal of Insect Behavior*, 2002, *15* (1), 85–93.

Zasu, Yoshinobu, "Sanctions by Social Norms and the Law: Substitutes or Complements?," *Journal of Legal Studies*, 2007, *36*, 379–396.