# *Anarchy, Groups, and Conflict: An Experiment on the Emergence of Protective Associations*[*]


Adam C. Smith
Department of Economics
George Mason University
*a411319@gmail.com*

David B. Skarbek
Department of Economics
George Mason University
*davidskarbek@gmail.com*

Bart J. Wilson
Economic Science Institute
Chapman University
*bartwilson@gmail.com*



*Abstract*: This paper examines group formation in a setting in which participants are endowed with a commodity that can be used to either generate earnings, plunder others, or protect against plunder. In our primary treatment, participants are allowed to form groups for the purpose of pooling resources. We also conduct a baseline comparison treatment that does not allow group formation. We find that allowing subjects to form groups endogenously does not lead to more cooperation and may in fact exacerbate tendencies for conflict.



*Key Words*: Nozickian protective associations; Conflict; Anarchy; Experimental economics

*JEL Classifications*: D60; D70; D83; C92


March, 2009


[*] We thank Jeffrey Kirchner for writing the software. The data are available upon request from the authors. We also acknowledge the helpful comments of Michael Maloney, Benjamin Powell, Raymond Sauer, Daniel Sutter, Charles Thomas, Paul Wilson, Bruce Yandle and the Clemson University Workshop in Applied Economics.

## I. Introduction

We are often led to engage in activity that is detrimental to those around us and find ourselves in situations where the individual incentives before us lead to suboptimal outcomes at the social level. Indeed many of these opportunities occur in a setting where no external enforcement is available to settle the conflicts that inevitably emerge. One means of overcoming these social dilemmas is for individuals to unite as a group. By forming alliances for a common defense, groups may hope to encourage recalcitrant individuals to cease activity destructive to the social order. Such tribal behavior is inextricably linked with our development as a species. When viewed through the critical lens of history, Rousseau's "noble savage" is an artificial construct, for man has never existed as an island apart from his peers.

There is much to be said of human achievement through the combined efforts of the group. A quick read through Joel Mokyr's narrative history of human invention and creativity leaves one marveling at the wealth humans have created since classical antiquity (1990). The grandeur of these achievements is blemished, however, by the equally amazing propensity of man to wage wars and commit mass genocide. As Matt Ridley succinctly summarizes, "[w]e may be among the most collaborative social creatures on the planet, but we are also the most belligerent" (1997, p. 193). It is this tension between cooperation and conflict within the context of group formation that we examine more closely in this paper. Using the laboratory method, we conduct a "heuristic experiment" to examine, as Hirshleifer (2001) puts it, the manner, form, and degree to which "[c]ooperation, with a few obvious exceptions, occurs only in the shadow of conflict" (p. 11).[1]

We draw largely upon the work of Nozick (1974) in developing an interactive framework in which subjects can pool resources as a group for the purposes of both predation and protection of endowments of an income-generating asset. Following Nozick, we will call these groups "protective associations." We allow subjects to engage in free form communication using an online interface. Relative to the canonical laboratory experiment in economics, we impose a minimal structure on our participants to examine a variety of complex strategies that subjects develop to solve the problems they face. Our goal is to observe what institutions, if any, arise

[1] Smith (1982) explains that "[h]euristic or exploratory experiments are used to provide empirical probes of new topics of inquiry….It is through exploratory probes of new phenomena that attention may be redirected, old belief systems may be reexamined, and new scientific questions may be asked" (p. 272-273). This is a fitting description of our motivation for this paper. Using the laboratory method of inquiry our aim is to develop new ways of understanding questions in political philosophy and constitutional economics.

endogenously out of a myriad of possibilities to produce a social order within a group of individuals seeking to attain their own subjective ends.[2]

## II. Protective Associations

Nozick articulates a theory of how social order could emerge from anarchy through the formation of protective associations[3]. He suggests "Groups of individuals may form mutual-protection associations: all will answer the call of any member for defense or for the enforcement of his rights…Alliances are designed to allow partners to share risk and resources, gain knowledge, and obtain access to markets" (p. 12). He poses several dilemmas that could mitigate the productive efforts of the association. First, protective associations may be forced to deal with "cantankerous or paranoid members" along with those who would use the power of the protective association to violate the rights of others. Second, groups will need to resolve internal conflict between its own members to avoid "each calling upon his fellow members to come to his aid". Third, groups will need to make efficient use of the division of labor and exchange. Finally, groups must decide on what prices or services to provide for those who may desire more extensive or elaborate protection (p. 12-13).

Nozick also recognizes the potential for conflict between groups. He posits three potential resolutions to such conflicts. First, members of a losing protective association may try to join the winning protective association. Second, the protective associations may use geographic location to isolate themselves from other groups. Third, protective associations may

[2] A critic might ask how we could know whether protective associations historically developed this way. Clearly, we do not know nor claim to be shedding light on this question. We have an example and technique to ask a question about how people build social orders. Wherever, however, or if ever protective associations originated in history, people, from the Aborigines in Australia to the Sámi people of Lapland, had to create a social system to cope with conflict. The structure of this social order necessarily reflected the cultural legacies of the tribe and clearly depended upon the geographic, physical, and economic settings that they faced. Likewise in our experiment, subjects must create their own social order within the novel context in which we place them.

[3] Protective associations can be translated into a large domain of groups historically. Families, tribes, clans, cooperatives, corporations and political action committees all take on certain characteristics of protective associations. For the purposes of this study, protective associations are defined as groups that form as a response to a dilemma where incentives lead individuals to act counter to the interests of the community as a whole.

be equally matched and will come to a tacit agreement not to fight or to resolve conflicts in a more peaceful manner. Nozick argues that eventually, however, the largest protective association in a local area will subsume all other protective associations through force or contract. This "invisible-hand process," by which spontaneous forces create one overarching group, emerges because the most efficient group is able to attract new members due to its superior benefits, and it will "buy-in" outside members into its ranks in order to militate against further predation against its current members.

As a thought experiment, the use of protective associations within economics has largely been utilized to compare the merits of private and public law enforcement.[4] As this literature is mostly peripheral to the purposes of this paper, only a few related points will be mentioned.[5] Friedman (1989) argues that protective associations would bring about more efficient enforcement of law, and would prevent conflicts with each other through contract. Protective associations have a monetary interest in stability and therefore the protracted costs of conflict outweigh the benefits of contracting with other associations to avoid this conflict. Friedman, therefore, suggests that a stable equilibrium should emerge in the long run as the opportunity cost of conflict is too great.

Cowen (1992) argues that the assertion of a stable equilibrium involving a multitude of protective associations ignores the underlying factors that will instead lead these associations inexorably to monopoly. He maintains that protective associations would benefit from network externalities, which would cause a collapse from a multitude of protective associations into several or even one. After this collapse, the inefficiencies associated with the group's monopolistic hold on protection will arise. In response Caplan & Stringham (2001) maintain that associations would have difficulty overcoming the obstacle of collusion that all oligopolies face. They argue that the incentive to collude will be overcome by the incentive to renege and offer more competitive services.

---

[4] In a highly original piece, Becker & Stigler (1974) argue that bringing more law enforcement into the realm of the market instead of the public domain would provide enforcers with better incentives to accommodate their respective clients. While this argument has been criticized (see Landes & Posner 1979; Cowen 1992; and Sutter 1995), several arguments have been made in defense of protective associations as a viable alternative to the public provision of law enforcement (Friedman 1989, 1994; Caplan & Stringham 2001).

[5] Research on protective associations relates more broadly to the literature examining how and to what extent self-enforcing exchange can achieve social cooperation. This includes research on private law enforcement (Friedman 1989; Benson 1990; Stringham 2007), community and commercial dispute resolution (Ellickson 2005), international trade (Grief 1993; Leeson 2007a, 2007b, 2008), and property rights in the historical context of the American western frontier (Anderson and Hill 2004).

Finally, several papers are worth noting from the economic analysis of conflict literature. These papers emphasize the stability of various forms of "anarchy" given certain conditions (e.g. Skaperdas 1992; Hirshleifer 1995; and see Duffy and Kim 2005 for an interesting experimental application of this research). Drawing on these initial models, a few efforts have been made to incorporate coalition formation into the analysis. Skaperdas (1998) examines the formation of alliances within conflict. He finds that coalitions will emerge if there are increasing returns to pooling resources used for appropriation. Noh (2002) introduces the problem of distribution and collective action within the alliance. He still finds that alliances are feasible given certain assumptions regarding these intra-group costs and the returns to pooling resources. Esteban and Sakovics (2003) find, however, that the conditions necessary for a "grand coalition" to emerge are more stringent than the previous literature. Within the parameters of their model, they find that the costs of intra-group conflict will outweigh the benefits of inter-group cooperation.

## III. Experimental Design and Procedures

### A. Environment and Institutional Parameters

Our experimental design is built upon the design and procedures in Powell & Wilson (2008). Six subjects are endowed with a number of units of a commodity *x* that earns \$0.00077 every second that it is designated as an earnings unit *e*. Prior to receiving this endowment, each subject takes a short quiz that includes questions drawn from SAT exams. The quiz is meant to invoke a sense of entitlement towards their endowments. Previous experimental work indicates that this procedure does indeed generate a sense of an earned property right (see e.g. Hoffman and Spitzer, 1982, 1985; Hoffman et al., 1994; and Cherry et al., 2002). The endowments of *x* are: 19, 21, 23, 25, 27, and 29 with the subject scoring highest on a quiz receiving the endowment of 29, second highest 27, and so forth. Ties are determined by giving the higher allocation of units to the person who finished the quiz first.

The initial endowments of *x* can also be converted into units of either offense *o*, defense *d*, or may be held as *e* once the experiment begins. Recall that, holding one unit in *e* generates \$0.00077 per second. If, for example, a subject with the average endowment of units (24 units)

were to hold her earnings in *e* for the entire session (assuming no units are taken), then she would earn a payout of $44.35.[6]

Offensive units can be used to take units of *x* from another subject, and defensive units are used to protect the subject's existing units of *x*. Units placed in defense and offense do not earn money and cannot be taken. Conceptually this is reasonable as tools used for predation and protection (firearms, security systems, walls, etc.) are not easily stolen and do not usually generate income for their owners. The opportunity cost is the productive value of holding units as *e*. To incorporate a transaction cost, converting units of *e* into either *o* or *d* takes 10 seconds. During the conversion time the unit does not earn money, and as many units as are available can be moved at one time.

Subjects can use the units of offense to take *e* from another subject. The probability that an attempt to plunder is successful is determined by the number of offensive units ($o_a$) attacker *a* has compared to the number of defensive units ($d_t$) the target *t* under attack has. Specifically, the success rate for the attacker is $\frac{o_a}{o_a + d_t}$. After any attempt to take earnings units from other subjects, offensive units are not available for use for 20 seconds. This additional transaction cost simulates the recovery costs of using force.

Individual subject holdings of *e*, *o*, and *d* are publicly observable to all participants throughout the experiment. All attempts at taking and the result of the attempts are broadcast to all participants. Individual subject identities remain anonymous at all times through the use of computers.

In what we will call the *Nozick* treatment, subjects are also able to form subgroups with other subjects. Groups are formed by one subject starting a group and then sending invitations to other subjects to join. These invitations come in the form of a prompt on the invited subject's screen. The invited subject can either accept or reject the invitation. A subject cannot be invited if she or he is currently a member of another group. All subjects can be invited to a group, but only the founding member of the group can extend invitations. Also, no member can be removed from a group once she or he joins. However, any proper subset of the group can always leave to form another group.

[6] This is calculated as follows: Maximum Median Earnings = 24 units × 40 minutes × 60 seconds × 0.00077 $/sec = $44.35.

Let $G$= {1, 2,…, 6} denote the set of all individuals and $G_i$ denote the $i$th (nonempty) subset of persons formed by a partition of $G$. Once a group is formed, members of the group automatically share all units of defense, i.e., the number of defensive units for each person in $G_i$ is $\sum_{j \in G_i} d_j$. Thus, if target $t$ is attacked with a person with $o_a$ units of offense, the probability of success for the attack against $t$ is $\frac{o_a}{o_a + \sum_{j \in G_i} d_j}$ as opposed to merely $\frac{o_a}{o_a + d_t}$.

In contrast to the defensive units which are pooled by default, group members also have the option of pooling offensive units on a voluntary basis. To pool units of offense, subjects click on a button above the group member they wish to lend their offensive units to. All units of offense are sent by the lender to the designated group member. While these units are loaned out, the lender has no ability to take units from any other subject. At any time the lender can instantly regain control of their units of offense by clicking the button above the designated group member a second time. Let $G_i^o$ denote the subset subjects that have lent a subject their $o$. Subjects who are lent $o$ are able to use these units as if they were their own, meaning the probability of success for attack against target $t$ now becomes $\frac{\sum_{j \in G_i^o} o_a}{\sum_{j \in G_i^o} o_a + d_t}$. In addition to this change in probability, subjects who are lent $o$ are also able to take more than one $e$ in any given attempt. A successful attacker takes one unit for every member that contributes to the pool of offensive units, conditional that that many units are available to be taken from a target. Otherwise the successful attacker takes all the units of the target. For instance, if the three subjects lend a person their units, then this person will now take four units rather than one any time she or he is successful. If a subject attempts to plunder another subject within their own group, however, then neither subject commands the pooled resources $d$ or $o$ of the group. It is as if they are attacking outside the apparatus of the group.

We also allow subjects to send $e$ to other subjects. This is performed by entering the desired amount of $e$ and the intended subject of these units into a text box and then clicking send. These units are not sent on a temporary basis; once these units are sent, they permanently reside with the recipient.

Subjects are able to communicate using both a public and a private chat room. Messages sent to the public chat room can be read by all subjects in the experiment. The public chat room is visible to all subjects throughout the experiment. Groups have the additional ability to communicate through a private chat room that is only visible to subjects within the particular group. We allow communication in order for groups to more easily facilitate cooperation within a mostly conflictual environment. Previous experimental research shows that communication can indeed increase the likelihood of cooperation (see Ostrom & Walker 1991). The subject is able to observe successful and unsuccessful takes by herself and others. The amount of time passed in the session, earnings per second, and total earnings are updated every second. Also, the subject can see how many defensive units and offensive units are controlled by her group at all times. Figure 1displays a sample screen shot for this treatment.

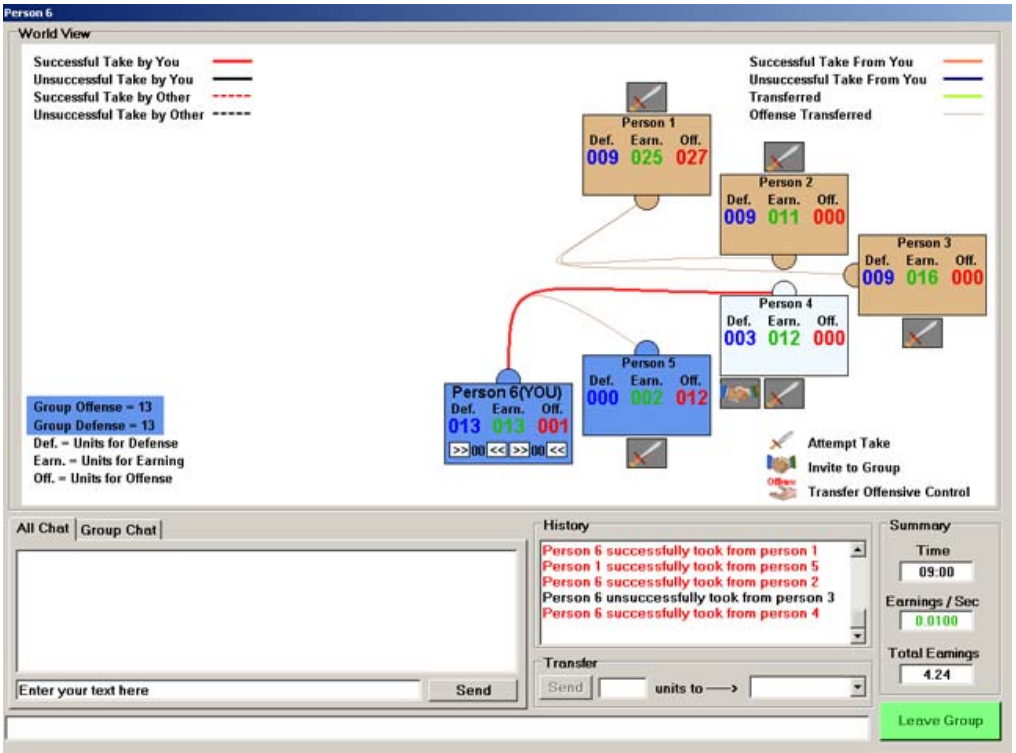



**Figure 1. Screenshot for *Nozick* Treatment**

## B. Baseline Treatment

As a baseline to the *Nozick* treatment, we also conducted a treatment that did not allow subjects to form groups, which we label the *Hobbes* treatment. Subjects in this treatment are not

able to form groups and thus do not have any of the additional abilities that go along with group formation, including the ability to lend offensive units, pool defensive units, or communicate through a private chat room. This treatment approximates Powell & Wilson's design with two additional features: subjects can communicate in a public chat room and they can voluntarily transfer *e* to other subjects. We added this feature in recognition of Buchanan's argument that "[t]o secure an initial agreement on positive claims to goods or to resource endowments, some transfer of goods or endowments may be required. That is to say, some 'redistribution' of goods or endowments may have to take place before a sufficiently acceptable base for property claims can be established" (Buchanan 1975, p. 83). We find the results of our *Hobbes* treatment closely approximate those of Powell & Wilson (2008) with a few exceptions.

### C. Procedures

We conducted six sessions in each of the two treatments, for which we recruited a total of 72 subjects from the at-large undergraduate population at George Mason University. Subjects were seated at a visually isolated computer terminal where they interacted anonymously with other participants. Sessions lasted 40 minutes after approximately 15 minutes of instructions. The subjects were recruited for an experiment that could last up to 90 minutes, but the actual experimental interaction time was left undisclosed to mitigate end-game effects of a necessarily finite experiment. Subjects received instructions about how to participate in the experiment (see Appendix 1) followed by a quiz of 10 questions. Each session had six participants who only participated in a single session of this experiment. Subjects received $7 for showing up on time in addition to what they earned in the experiment. The average earnings without the show-up payment were $14.50 and were paid privately at the conclusion of the experiment.

## IV. Hypotheses

Our experimental design is intentionally open-ended to capture the stylized features of an anarchical stage of development. While the variety of strategies in a dynamically repeated game precludes the computation of a narrow set of Nash equilibrium strategies *ex ante*, we postulate several conjectures related to several observable outcomes. First, we hypothesize that the *Nozick* treatment will be more efficient on average than the *Hobbes* treatment. Efficiency is determined by the ratio of units placed into *e* relative to the total number of units available. Following the

terminology in Skaperdas (1992), we define "full cooperation" as occurring when all available units in the economy are placed in *e*. More formally, efficiency at time $\tau$ is defined as $E_\tau = \frac{\sum_{k=1}^{6} e_{k\tau}}{\sum_{k=1}^{6} x_k}$, where $\sum_{k=1}^{6} x_k$ is always 144.[7] The "average efficiency" in a session (of 2400 periods) is $\frac{\sum_{\tau=1}^{2400} E_\tau}{2400}$. Nozick's claim that protective associations lead to a social order serves as the foundation for this hypothesis. Of course, every experimental "test" of a theory is a joint test of the theory and the applied context in which the theory is implemented (Smith 2002, 2008). If we observe that our economies in this first laboratory experiment regularly deviate from Nozick's philosophical argument, then only with more observations under a wide variety of environmental and institutional conditions will it become possible to deduce with more confidence whether these systematic deviations are due to an auxiliary hypothesis on how an experiment is implemented or due to the circumstance that the foundations of Nozick's argument do not comport with the facts of human sociality.

Second, we hypothesize that a single group will emerge in the *Nozick* treatment that will eventually include all active members. Nozick conjectures that as one group becomes relatively more powerful than the others, its members will either terminate the remaining individuals[8] or find it beneficial to provide protective services to the unaffiliated members to reduce the risk of conflict. In addition, individuals outside the powerful group will find it in their interest to join this group given their relative advantage at protection and/or predation.

Third, we hypothesize that the ability to communicate in real time allows subjects to coordinate better on cooperative strategies and settle their conflicts, resulting in higher efficiency in our *Hobbes* treatment relative to the observations in Powell & Wilson. As mentioned above, Ostrom & Walker (1991) find that allowing subjects to communicate can lead to a pronounced change in rates of cooperation.

[7] A total of 1 unit in each of two *Nozick* sessions was lost in the ether when a subject transferred multiple units. As 0.7% of the total number of units, we do not find this to be a consequential software glitch.
[8] Following Powell & Wilson (2008), we define "termination" as occurring when a subject has 3 or less units of *x*.

## V. Results

In reporting our results, we first formally test our hypotheses regarding *Nozick* and *Hobbes* treatments. To convey a deeper level of the rich interactions in these societies, we next summarize our twelve *Nozick* and *Hobbes* sessions using evidence from the chat transcripts along with general observations about development throughout each session. Each session description includes a chart that displays the allocation of units between the three uses at each second of the session. In addition, the charts for the *Nozick* contain a line plot of the Herfindahl-Hirschman Index of concentration for each moment of the session.[9] This quantifies the extent to which a single protective association emerges in the session. Finally, we offer qualitative remarks to organize the general patterns that we observe.

### A. Testing Our Hypotheses

*Efficiency*

In assessing our hypotheses, we find several surprising results. In terms of efficiency, the *Nozick* sessions displayed uniformly low levels of cooperation with only one session (*N6*) achieving efficiency greater than 50%. The *Hobbes* sessions on the other hand were either highly efficient (*H1*, *H2*) or dismally inefficient (*H3*, *H4*, *H5*, and *H6*). Table 1 reports the efficiency levels of the six *Nozick* sessions along with the *Hobbes* sessions.[10] Using a nonparametric Wilcoxon rank sum test, we fail to reject the null hypothesis that the average efficiency of the *Nozick* and *Hobbes* sessions are equally efficient ($W_{6,6} = 20$, $p$-value = 0.5909, one-sided test).

**Table 1. Average Efficiency**

| ***Session*** | ***Nozick*** | ***Hobbes*** |
|---|---|---|
| 1 | 22.7% | 60.6% |
| 2 | 34.4% | 88.2% |
| 3 | 17.6% | 11.6% |
| 4 | 26.7% | 14.7% |
| 5 | 13.3% | 13.7% |
| 6 | 51.4% | 21.8% |
| ***Average*** | 27.7% | 35.1% |

[9] We calculate the HHI as the sum of squares of the percentage share of units under the control of each group at any moment of time. Subjects who were not part of a group were counted as a group of one. Thus, the HHI at the start of each session contains six shares.

[10] The relative comparison between *Nozick* and *Hobbes* does not change significantly when average efficiency of the sessions is broken down into halves or thirds.

The two *Nozick* sessions in which full cooperation arose (*N2* and *N6*) led to moderate levels of efficiency but the remaining four were low. Subjects in both sessions *H1* and *H2* were able to attain full cooperation very early in their respective sessions. Because the life of a laboratory economy is necessarily finite, unlike the naturally occurring world in which time marches on, a frequently raised question is whether the subjects just need more time to "learn," so they can conform to the outcome predicted by our hypothesis concerning the higher efficiencies of the Nozickian societies. If so, why did sessions *N2* and *N6* not need more time to reach 100% efficiency? And why did sessions *H1* and *H2* need such little time? Apparently, our experiment is sufficiently long enough to generate a variety of outcomes, which is exactly what we need to help us to understand what factors account for better or worse performance in these economies.

*Group Formation*

In terms of group formation, the *Nozick* sessions were marked both by cooperative and conflictual tendencies. Contra the invisible hand process proposed by Nozick, we do not observe an inevitable tendency for the subjects to form a single group. This was most strikingly evident in session *N3*. Not only did the single group break back down into several subgroups, but also as mentioned above, there was no change in the amount of plundering before or after the overarching group formed. Moreover, Sessions *N2* and *N4* developed a relatively stable equilibrium of two distinct groups for most of their respective sessions.

*Our Hobbes Treatment vs. Powell & Wilson's*

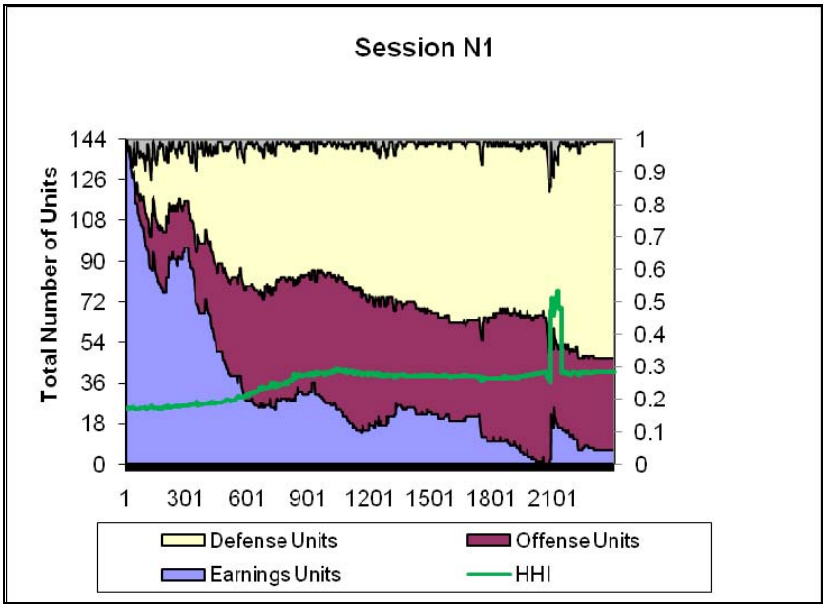
Contrary to our hypothesis, we find no evidence that the ability to communicate in real time allows our subjects to coordinate better and settle their conflicts relative to the similar, but communication-free exercise in Powell & Wilson (2008). Comparing our 6 sessions with their 8 sessions, one of our sessions is the most efficient at 88.2%, and another is the most inefficient at 11.6%. Not surprisingly then, we fail to reject using a Wilcoxon test the null hypothesis that the average efficiency of the two experiments are equally efficient ($W_{8,6}$ = 31.5, $p$-value = 0.8375, one-sided test). Succinctly put, communication is not a sufficient solution to this particular problem.

## B. Summary of *Nozick* Sessions

*Session N1*

Very few groups formed in *N1*. There were numerous attempts to start groups by a few of the subjects but almost all of these invitations were rejected. The group formation that occurred was sporadic and short-lived, and no group formed until after the experiment was past the two-thirds mark.

The average efficiency was also very low in this session (22.7%) due to constant plundering, and two subjects were terminated. An interesting development occurred towards the end of the session with at least three of the active subjects proposing a truce. One subject said, "hey guys listen i got a way to increase our earnings. lets all place our units in earn and let it increase per sec. no one attack each other." Two of the other subjects seemed receptive to this, but the session ended shortly after these comments. It was not apparent at that time that they had reached an agreement.

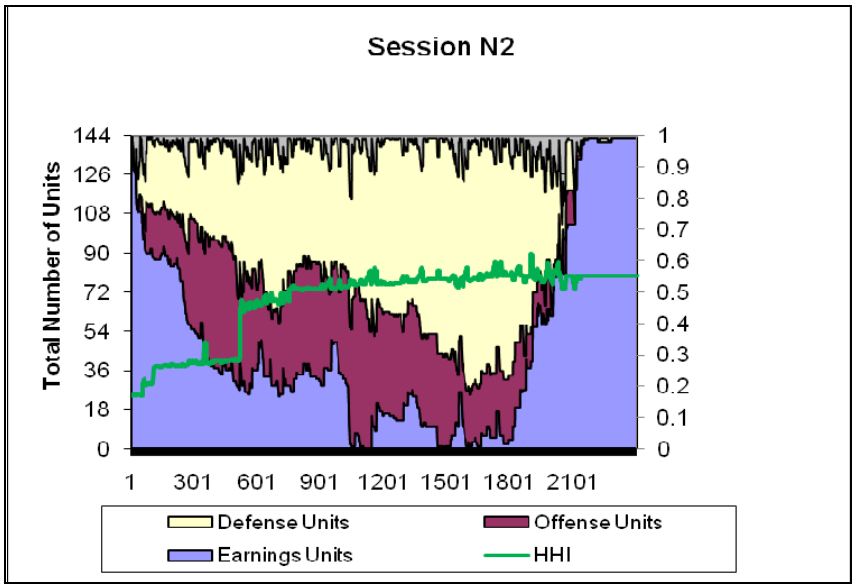



*Session N2*

Two groups emerged almost immediately in this session. Both groups pooled their offensive capabilities, and in each group, one of the subjects took the lead in offering advice on how to utilize this feature of the experimental interface. About one-third of the way into the session, two groups had emerged with three members each.

One group focused, though not exclusively, on increasing their units of defense and held the rest of their assets in earnings, while the other group put nearly all of their units into either offense or defense at any one time. Eventually, one subject had the idea of a truce by stating in the group's private chat room, "everyone SHOULD just stop attacking and earn." This led the group to further decrease their offensive units but resulted in no parallel behavior by the other group. Later the same subject wrote a message in the public chat room that said, "there needs to be an agreement between everyone. see no one is making money right now." A subject from the other group then responded in the public chat room, "should we all agree not to attack."

The two subjects who had communicated a truce in the public chat room then went back into their respective group chat rooms and prompted their group members to put all units into earnings. One of the subjects asked for a signal of trust from the other group by asking them to "take your units out of offense so i can trust you." There was still some hesitation as each subject began to pool more and more units into earnings. One of the groups even suggested a trigger strategy in case the other group defected. However, all subjects eventually put all units in earnings and abided by the agreement.

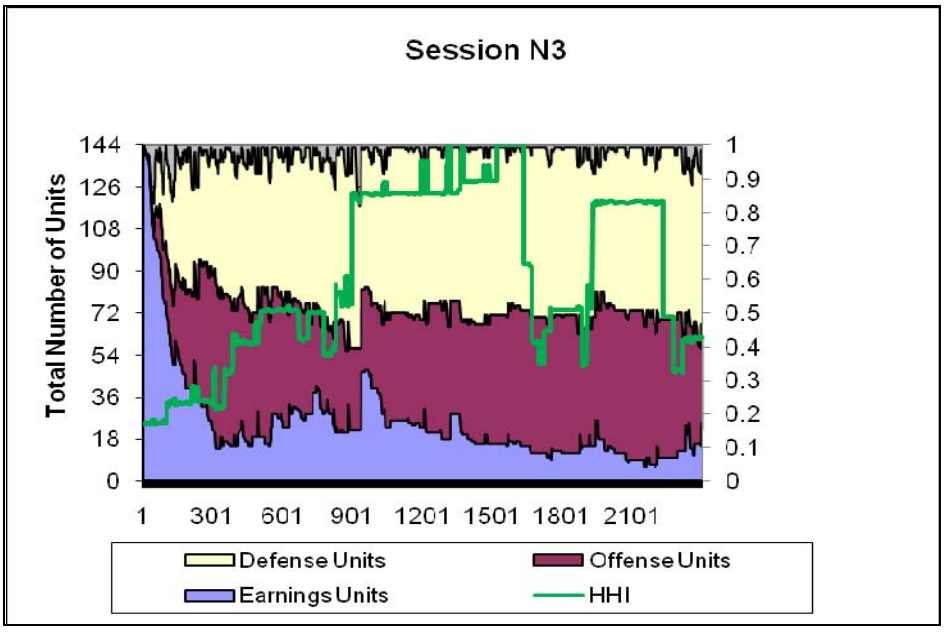



*Session N3*

Group membership in this session was erratic with members accepting invitations but then leaving the group soon after. As a result, groups were not very stable. It appeared that subjects did not develop a sufficient level of trust within groups as there was very little offensive

pooling. At the same time, the number of attacks was quite large, and the average efficiency suffered as a result (17.6%). There was no indication of any interest of a truce. No clear leaders emerged among the subjects to instigate such an outcome or even to coordinate attacks. One person was terminated.

It is interesting that the majority of the chatting took place in the public chat room versus private group chat rooms. An especially interesting development occurred when all six subjects were part of the same group just over halfway through the session. Yet this led to no observable decrease in plundering! The group eventually dissolved. There was no attempt at cooperation at this time or any other in this session.

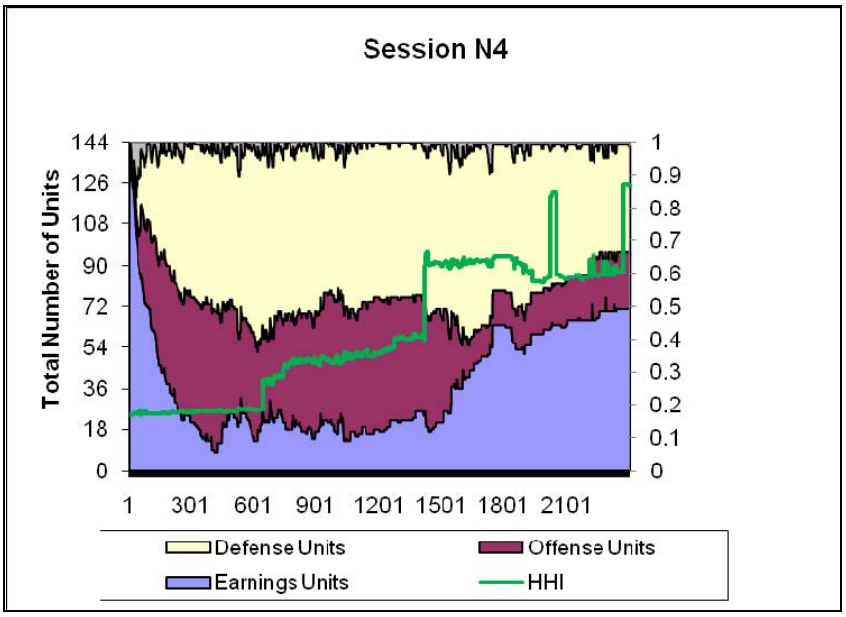



*Session N4*

Two groups formed about a third of the way through this session. These two groups contained two members each until about halfway through the session. At this time, both groups invited one of the remaining two members. The two groups did not coordinate their attacks in any systematic way. Pooling occurred occasionally but was sporadic, as the groups never came to an agreement on who would attack and how they would distribute the plundered units. Attacking was mostly uniform across the session though efficiency did improve towards the end of the experiment.

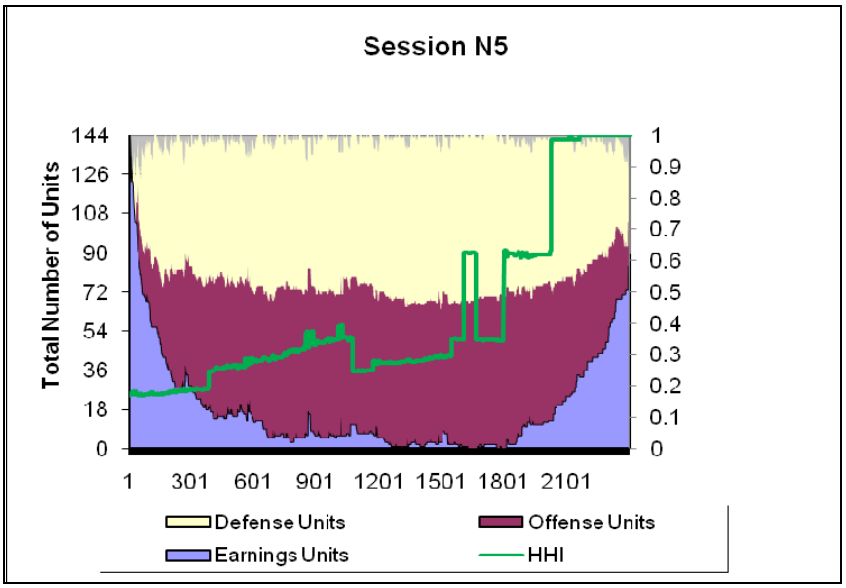
Efficiency was relatively low in this session (26.7%), and one person was terminated. By the end of the session, four of the five active subjects were in one group, which may have been

why efficiency started to rise towards the end of the session. There were no explicit attempts to cooperate, however.




*Session N5*

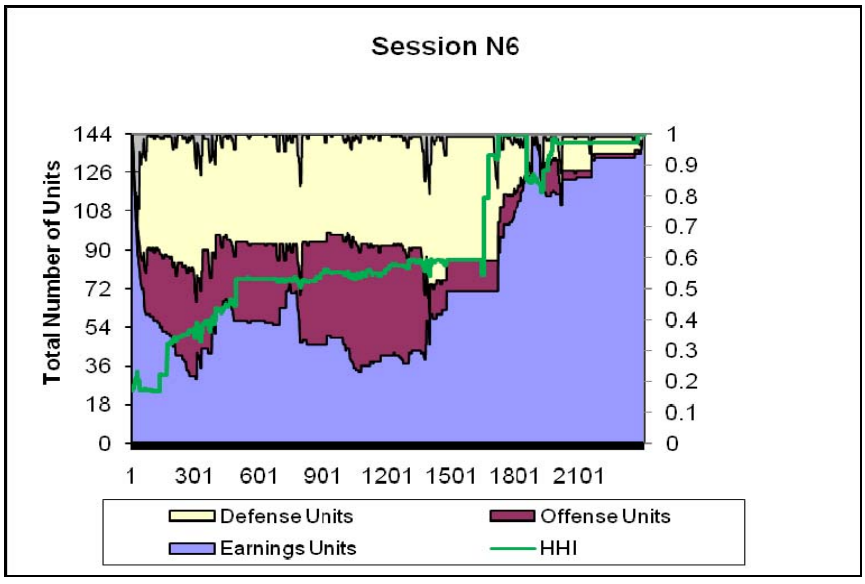
This session had a similar pattern of group development to Session *N4*. For about half of the session there were two groups with two members each. There were no explicit attempts to pool offensive resources within the groups. Eventually, one of the groups acquired another member and finally a fifth member. The remaining sixth subject never joined the group. By the end of the session, this remaining subject was attempting to plunder but was unable to get through the defenses of the five combined subjects. The large group pooled more of their units into earnings as the session reached its conclusion. However, overall efficiency was quite low (13.3%) due to the earlier plundering. Like the two previous sessions, there was no attempt to communicate a truce among the subjects.




*Session N6*

This session started like much of the others with two groups forming. One of the groups was especially well coordinated and quickly pooled their offensive capabilities. This led to a significant amount of plundering from the other group. Halfway through the session, a "leader" in this group proposed a truce by inviting the others to join their group. This led two of the remaining three members to join what one subject termed their "alliance." Eventually, the remaining subject joined as well.

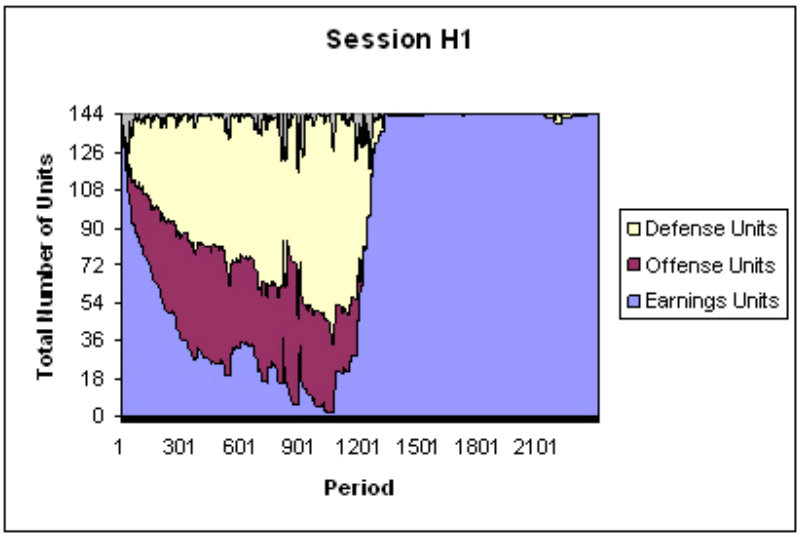
From the halfway mark on, efficiency steadily climbed. By the end of the session, all available units were in earnings. Note that this session and Session *N2* are the only *Nozick* sessions where full cooperation emerged.



**C. Summary of *Hobbes* Sessions**

*Session H1*

The first posted message in this session was "no one is earning money." Shortly thereafter, another subject proposed an agreement to stop predation by offering, "how about we all put ours in earn and not take from each other so at least we earn something," which the subjects discussed and agreed to. At one point during this discussion, a subject tried unsuccessfully to take from another subject, but this was the last attempt at predation in the session. The subjects agreed not to take from each other with one subject offering, "and if someone gets greedy everyone else will just steal from them." The subjects reached full cooperation shortly after the halfway mark in this session.




*Session H2*

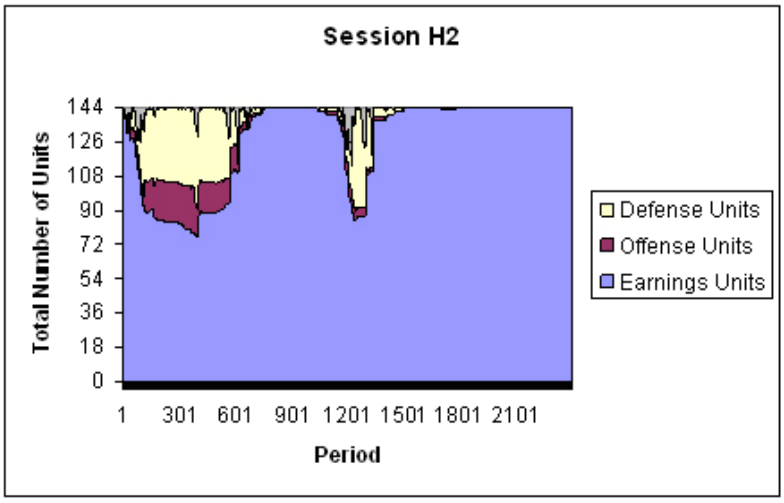
Predation was largely absent in this session relative to the others. In fact, only 23 attempts to plunder occurred in this session. This is due perhaps to one subject's proposal for an agreement to stop conflict very early in this session. The same subject also proposed the strategy of taking units away from anyone who continued to hold units in offense. The proposal did not work, however, and the subjects continued to attack each other. Several began to recognize, however, that they could do better if they all refrained. For example, one subject said, "we can allmake a lotmore if you stop [attacking]."

After testing several parameters of the experimental environment, several subjects attempted to persuade others to invest fully in earnings. One subject was concerned that the

subject who organized the agreement was making more than everyone else, saying, “this was your idea i want to know how much you are making” because “it wouldnt be fair if you have more then everybody.” The “leader” of the effort to cooperate replied, “i'm making .0216.” At this point a third subject came to the defense of the leader by saying that “if he is [making more money] its becuase he got more questions right,” in reference to the way initial earnings were allocated. They continued to discuss the fairness of the distribution of earnings and whether subjects should return units they had previously taken .

Full efficiency was reached less than a third of the way through the session. This efficiency was interrupted only once during the remainder of the session when one subject broke the agreement by successfully taking from another subject. The plundered subject immediately responded by taking a unit back. There were no more takings for the remainder of the session.

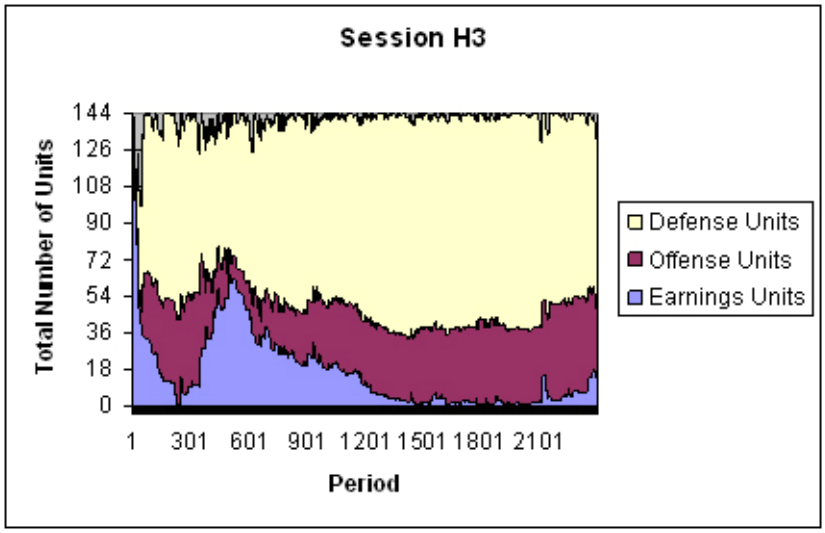
The subjects in this session were very concerned about distributive issues. There were several proposals for ways to improve the distribution, but some noted the difficulty in determining who owed compensation to whom, because everyone had stolen from everyone. One subject suggested that everyone should have an equal amount. Another subject told everyone to “give back whatever you stole.” The subjects agreed to this last strategy and began transferring units to compensate for previous takings for the remainder of the session.




*Session H3*

The most notable feature of this session was the lack of chat. The first message did not appear until the second half of the session, when one subject asked, “Subject 2 can you send some units to 6.” Following this request, subjects posted several similar messages prompting

subjects to redistribute units voluntarily. For example, one subject told another to "give some to Subject 4 dont be greed…he or she needs it." Towards the end of the session, a subject proposed that they all "put everythng in earnings." Nevertheless, plunder continued until the end of the session. Efficiency was persistently low and never went past the 50% mark once the session began.

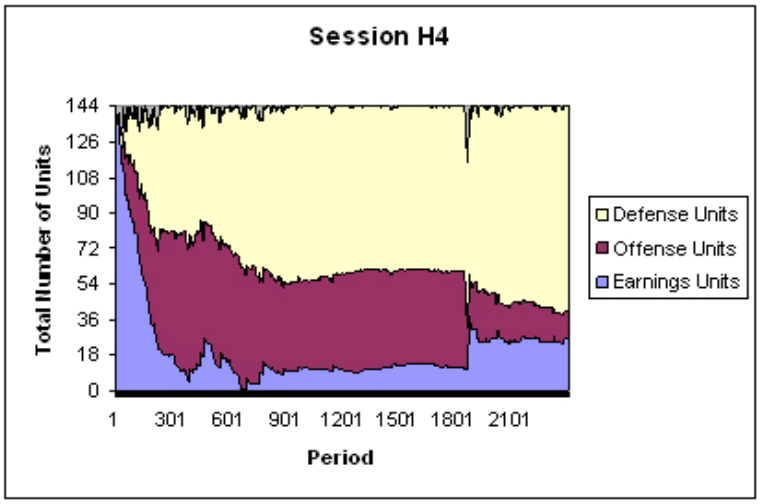



*Session H4*

After several minutes, the participants began chatting, and one subject was terminated early. One subject proposed, "want to make a pact whereever ones puts there stuff in earnings and doesnt take from anyone and just collect mmoney?" There was some discussion about a possible agreement, and several subjects said they would comply. However, one subject held out and did not respond even when directly addressed by the other subjects. The subject rarely engaged in conversation. When he did, it was unclear what he meant. For example, he interjected "game over" in the midst of a discussion regarding cooperating. Perhaps the holdout thought that if all subjects begin to cooperate, the experimenter would end the session arbitrarily or perhaps that refraining from dialogue would increase his bargaining power (See, for instance, Schelling 1960).

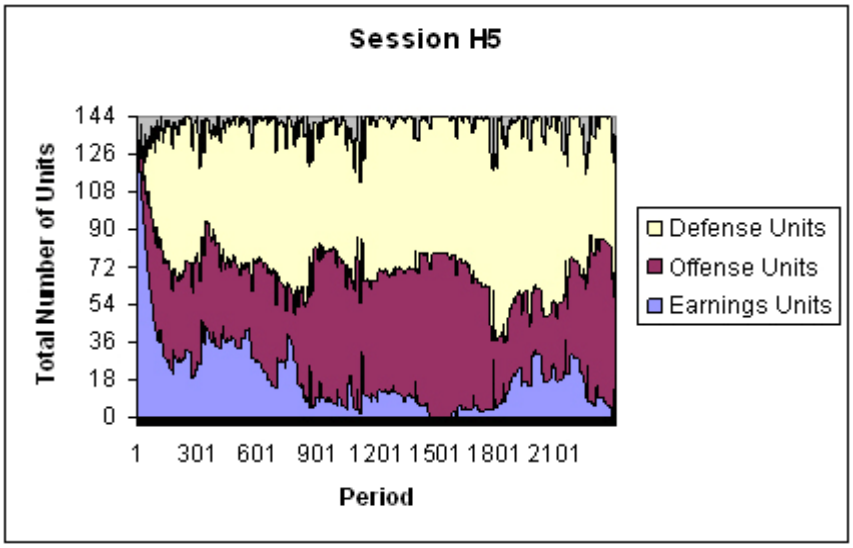
After the halfway mark, the subjects discussed making an agreement without the holdout. They come close to agreeing on a contract, but it is unclear if they ever really made one. For instance, one subject complained that they could not make money if the holdout continued to take from them. In the remainder of the experiment, the subjects pleaded with the holdout, who remained silent. This session was particularly interesting because all subjects clearly desired

agreement except for one, yet this one subject's refusal to commit to an agreement was an effective obstacle to implementing it.



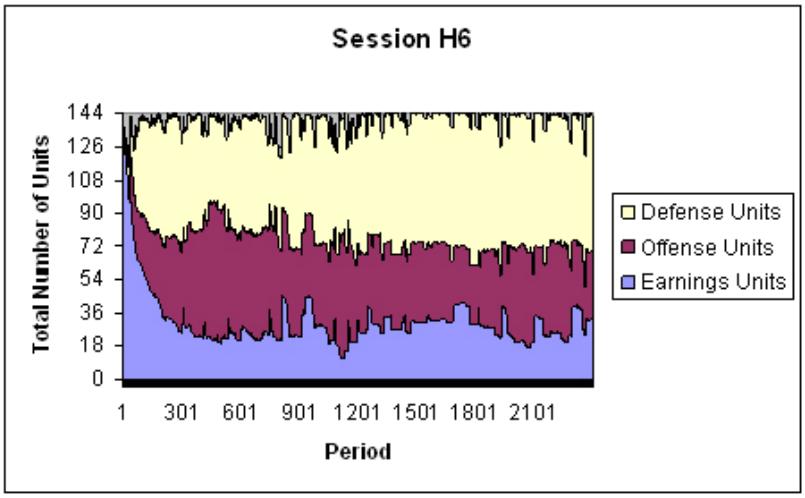

*Session H5*

Communication began early in this session, as a subject proposed cooperation by asking, "What would happen if we all just put everything in earnings." Later another subject explicitly proposed a cooperative agreement by asking, "does everyone want to try setting a defense for all of us and depositing all our offense in earning and not attacking." The others did not agree and continued to take from each other. The initial instigator for cooperation raised the idea again saying, "I vote we put it 100% in earnings" and "Can we agree on dumping all our points into earnings?" Four of the subjects agreed but attempts at plundering continued throughout the session. One of the two subjects who did not agree to the cooperative agreement did not send any messages during the entire session.




*Session H6*

The subjects did not communicate in this session until after the halfway mark. Soon after they did, they began to discuss a cooperative agreement. The establishment of such an agreement never took place, however, and the session was particularly nasty, brutish and short. Three subjects were terminated. Two of these subjects were "resurrected" later in the session by transferred units from one of the remaining subjects, for which he received the praise, "bravo person 5."



*Discussion*

In interpreting our results, we draw upon Miller (1992), who addresses social dilemmas within the context of hierarchy. The similarity between Miller's work and our own is the common attempt to address issues of conflict within an environment where incentives may lead individuals to act against the interests of the collective unit. Miller posits three general features that may solve coordination failures in the context of a social dilemma: leadership, the creation of cooperative social norms, and binding institutional provisions to maintain cooperation (p. 233).

These general insights are helpful in determining why some sessions led to such dismal levels of efficiency while others were able to achieve full cooperation. Each session that achieved full cooperation had particular subjects who constantly appealed to their fellow subjects to cease plundering. Most of the sessions that did not reach full cooperation had no such leadership in guiding the group to the cooperative outcome. In session *N1*, for example, subject 3 emerged as a leader in focusing the group on a more cooperative outcome. Unfortunately, his comments came at the end of the session and the group did not act on them in time to increase overall efficiency. In session *N2*, subject 6 was the most vocal in coaxing both members of his own group and the other group to cease attacking and to put all of their units into earnings, and he was eventually successful in this endeavor. Subject 1 in session *N6* impelled his fellow subjects to cease attacking, and hence the session was able to reach full cooperation more quickly than any other *Nozick* session. The result was that this was the most efficient session in the treatment.

Sessions *N3*, *N4*, and *N5* were notable for their lack of leadership to achieve cooperation. There was no message that mentioned either the nature of the dilemma that the subjects faced or what actions would be necessary to attain full cooperation. This result is especially surprising when the *Hobbes* sessions are taken into account. All six *Hobbes* sessions had at least one subject mention the dilemma and the cooperative strategy of putting all units into earnings. Only half of the *Nozick* sessions, however, explicitly expressed this mind-set. This leads us to the conjecture that *group formation mechanisms in our experimental environment obfuscates the social problem to be solved by activating the evolutionarily deep "us-versus-them" mentality of tribes.*

In another paper with free-form communication among its participants, Kimbrough, Smith, and Wilson (2008) investigate how impersonal distal exchange may grow out of local

personal exchange in an economy with three geographically separated communities each connected to a local meeting area. To quantify how personal or impersonal their participants' exchanges are, they conduct a word count on the first-person plural pronoun "we" in the local and distal chat rooms. They argue that the word "we" reveals a personal connection between its user to another person or persons, and indeed find overwhelmingly that subjects use "we" more often in the local personal community.

In conducting a word count on our own transcripts, we find two results of interest. Because our participants all reside in the same visible area, "we" and "us" in the *Nozick* treatment could be inclusive of the small subgroup or the whole group of 6 participants in a way that the context of the discussion could not discriminate. However, the third personal plural pronouns "they" and "them" connote "others" or rival outsiders. These outsiders can be easily demarcated by color and private conversation in the *Nozick* treatment but not so in the *Hobbes* treatment. To test the conjecture that the *Nozick* treatment actuates an "us-versus-them" mindset in a way that the *Hobbes* treatment does not, we count the number of times "they" and "them" appear in the transcripts as well as how many times "we" and "us" appear. We conjecture that "they" and "them" will appear more often in the transcripts of the *Nozick* treatment than in the *Hobbes* treatment, but that there would be no difference in the use of "we" and "us." Table 2 reports the raw counts of these words.

**Table 2. Word Counts by Session**

| ***Session*** | **We/Us** | **They/Them** |
|---|---|---|
| *N1* | 2 | 1 |
| *N2* | 40 | 16 |
| *N3* | 7 | 1 |
| *N4* | 17 | 21 |
| *N5* | 18 | 5 |
| *N6* | 74 | 17 |
| *Average* | *26.3* | *10.2* |
| | | |
| *H1* | 13 | 4 |
| *H2* | 39 | 4 |
| *H3* | 1 | 0 |
| *H4* | 26 | 2 |
| *H5* | 12 | 1 |
| *H6* | 3 | 0 |
| *Average* | *15.7* | *1.8* |

As conjectured, we find that the subjects use “they” and “them” statistically more often in the *Nozick* treatment than in the *Hobbes* treatment ($U_{6,6}$ = 29, *p*-value = 0.0465, one-sided test), and we cannot reject the null hypothesis of equal usage of “we” and “us” across treatments ($U_{6,6}$ = 23, *p*-value = 0.4848, two-sided test).

The third feature, binding institutions, has less relevance within the parameters of our experiment, as subjects were unable to commit to any sort of binding agreement given the lack of external enforcement. However, in several sessions, subjects communicated “rules” that would govern subsequent behavior once full cooperation had been achieved. For example, in Session *H2* a subject was reluctant in putting all of their units into earnings so they retained some units in defense. This led another subject, who was the leader in focusing the subjects on the cooperative outcome, to proclaim “person 1, please take down your defense” followed by another subject to remark “you dont wanna be against everyone else.” The offending subject eventually acquiesced and put all of their units into earnings. In this case and in other sessions, it was apparent that the explicit threat of punishment created a provision militating against conflict. This was easier to accomplish once subjects placed the vast majority of units in earnings. To illustrate the significance of this point, neither session that achieved higher than 90% efficiency after the first 100 periods never subsequently fell below this mark.

## VI. Conclusion

Contrary to the Nozick hypothesis, we find that allowing subjects to form groups does not ameliorate conflict. If anything, it hinders the development of a collective regard for solving the dilemma by encouraging in- and out-group attitudes. The implication of these observations is that the ability to form private protective associations does not alone foster the necessary social cohesion to blunt plunder and eliminate costly expenditures on the defense against plunder. Sociality appears to be the key for a group to recognize the dilemma, and the emergence of a leader from within the group serves the vital role of encouraging participants to establish their own rules of order. As Hume (1740) appositely notes, “It is only a general sense of common interest; which sense all the members of the society express to one another, and which induces them to regulate their conduct by certain rules” (pp. 314-5).

It is deeply embedded in human nature for individuals to form tribal groups, yet such social formations may lead to both cooperation and conflict (Ridley 1997). To ameliorate the

threat of conflict, it may be prudent to move individuals beyond factions by focusing attention on the consequences of conflict and the rewards of cooperation. Our experiments demonstrates that such endeavors appear to succeed where a general sense of common interest, leadership, and provisions against backslide are present.

## References

Becker, G., Stigler, G., 1974. Law Enforcement, Malfeasance, and Compensation of Enforcers. Journal of Legal Studies 3, 1-18.

Buchanan, J., 1975. The Limits of Liberty. Liberty Fund, Indianapolis, IN.

Caplan, B., Stringham, E., 2002. Networks, Law, and the Paradox of Cooperation. Review of Austrian Economics 16, 309-326.

Cherry, T., Frykblom, P., Shogren, J., 2002. Hardnose the dictator. American Economic Review 92, 1218–1221.

Cowen, T., 1992. Law as a public good: the economics of anarchy. Economics and Philosophy 8, 249–267.

Duffy, J., Kim, M., 2005. Anarchy in the laboratory (and the role of the state). Journal of Economic Behavior and Organization 56, 297-329.

Esteban, J., Sakovics, J., 2003. Olson vs. Coase: Coalitional Worth in Conflict. Theory and Decision 55, 339-357.

Friedman, D., 1989. The Machinery of Freedom. Open Court Publishing Company, La Salle, IL.

Friedman, D., 1994. Law as a private good: a response to Tyler Cowen on the economics of Anarchy. Economics and Philosophy 10, 319–327.

Hirshleifer, J., 2001. The Dark Side of the Force. Cambridge University Press, New York, NY.

Hume, D., 1740/2000. A Treatise of Human Nature. D. Norton and M. Norton, Eds. Oxford University Press, New York, NY.

Kimbrough, E., Smith, V.L., and Wilson, B.J., 2008. Historical property rights, sociality, and the emergence of impersonal exchange in long-distance trade. American Economic Review, 98(3), 1009-1039.

Landes, W., Posner, R., 1979. Adjudication as a Private Good. Journal of Legal Studies 8, 235-284.

Miller, G., 1992. Managerial Dilemmas. Cambridge University Press, New York, NY.

Mokyr, J. 1990. The Lever of Riches. Oxford University Press, New York, NY.

Noh, S.J., 2002. Resource distribution and stable alliances with endogenous sharing rules. European Journal of Political Economy 18, 129-151.

Nozick, R., 1974. Anarchy, State and Utopia. Basic Books, New York, NY.

Ostrom, E., Walker, J., 1991. Communication in a Commons: Cooperation without External Enforcement. Laboratory Research in Political Economy, University of Michigan Press.

Powell, B., Wilson B.J., 2008. An experimental investigation of Hobbesian jungles. Journal of Behavioral and Economic Organization 66(3-4), 669-686.

Ridley, M., 1997. The Origins of Virtue. Viking Penguin, New York, NY.

Skaperdas, S., 1992. Cooperation, Conflict, and Power in the Absence of Property Rights. American Economic Review 80, 720-739.

Skaperdas, S., 1998. On the formation of alliances in conflict and contests. Public Choice 96, 25-42.

Smith, V.L., 1982. Microeconomic systems as an experimental science. American Economic Review 72, 923–955.

Smith, V.L., 2002. Method in experiment: Rhetoric and reality. Experimental Economics 5, 91-110.

Smith, V.L. 2008. Rationality in Economics: Constructivist and Ecological Forms. Cambridge University Press, New York, NY.

Sutter, D., 1995. Asymmetric power relations and cooperation in anarchy. Southern Economic Journal 61, 602–613.

## Appendix: Experiment Instructions

**Welcome**

This is an experiment in the economics of decision-making. Your earnings, which will be paid to you in CASH at the end of the experiment, will be determined partly by your decisions and partly by the decisions of others. If you have questions at any time while reading the instructions, please raise your hand and a lab monitor will assist you.

Each person is endowed with units of a fictitious good. The number of units of this fictitious good you will start this experiment with will be determined by your answers to a set of 10 questions. You will then be ranked depending on how many questions you answered correctly. Ties will be decided by giving a higher ranking to the person who finishes the quiz in the shortest amount of time. The higher your ranking, the more units you will start with.

Your initial endowment will be placed in your earnings. The number of units designated for earning is displayed in green under "Earn." in your box (the one labeled "YOU"). You will earn **$0.00077** per second for EACH unit you designate for this purpose. This is equivalent to **$0.0462** per minute per unit.

Earnings units can also be used to take Earnings units from other people, which we will call Offensive units ("Off."). Alternatively, Earnings units can serve as units for defense ("Def."). To move units to either Offense or Defense, click << or >> buttons in your box (you will not be able to do this until the experiment starts). It will take 10 seconds for the units to transfer. You may also transfer units back to Earnings in the same manner.

Notice that the other players in the game have a  (take) button next to their box. If you have designated some number of units for offense, then you can attempt to take a unit from another player. If you take a unit from someone else, it will be added to your Earnings units and taken away from their Earnings units. Once you attempt to take a unit, you will not be able to attempt again for a period of 20 seconds. Also, when you attempt to take a unit, a line will appear between your house and your targets. The line will slowly fade as time passes. Note that there are several other colored lines that will indicate certain functions throughout the experiment. A key for these can be found in the top right- and left-hand corners of the screen.

An attempt to take units from another person will be successful depending on how many units the taker has designated for Offense relative to how many units the target has designated for Defense.

Specifically, the probability that the taker is successful is:
Success rate of taker = (Units of Offense) ÷ (Units of Offense + Units of Defense)

For example, if you have 1 unit of Offense and the target has 1 unit of Defense, the probability that the attempt will be successful is 1 ÷ (1 + 1) or 50%.
If the target has 2 units of Defense, then the probability that the attempt will be successful is 1 ÷ (1 + 2) or 33%.
If the target has no units of Defense, then the attempt will be successful 100% of the time.

You may communicate with others in the chat frame once the experiment starts. To send messages, type in the small box next to the send button and press the enter key or the send button. Your text will appear in the textbox above. You are free to discuss all aspects of the experiment, with the following exceptions: you may not reveal your name, discuss side payments, make threats, or engage in inappropriate language (including such shorthand as 'WTF'). If you do, you will be excused and you will forfeit your earnings.

[Begin *Nozick* treatment only instructions]
Individuals can pool together units in a group. To start a group, use the Start Group button at the bottom right corner of your screen. The background color of your box will change to denote your group. To invite people to join your group, use the  (invite) button next to their box.

Everyone in your group will pool their defense. This means that if there are 3 people in your group and each person has 5 units put towards defense, each person in your group will have a defense of 15.

Everyone in your group will also have the option to pool offense. To pool your offense with another person click the 

(transfer control) button above their box. This will transfer control of the units you have designated for offense to that person. That means that if you have 5 units for offense and the person you have transferred control to has 6 units then the combined offense will be 11 and that person may then attempt to take from another person. If they are successful the person you have transferred control will receive *one unit for each person (including themselves)* that has transferred control to them. You may retract your offensive units at anytime by clicking transfer control button again.

You may chat with anyone in your group using the "Group chat" frame at the bottom of your screen. Only people currently in your group will be able to view and send messages in it.
[End *Nozick* treatment only instructions]

A summary of your earnings along with your current rate of earnings per second and the time elapsed in the experiment can be found in the "Summary" frame at the bottom right corner of your screen.

The sum of your earnings will be paid to you privately at the end of the experiment. You will not be told how long the experiment will last.

This is the end of the instructions. If you have any questions please raise your hand and a monitor will come by to answer them. If you are finished with the instructions please press Start. The instructions will remain on your screen until the experiment starts.

A summary of the information is displayed at the bottom of your screen. You will not be told how long the experiment will last. This is the end of the instructions. If you have any questions, please raise your hand and a monitor will come by to answer them. The experiment will begin when everyone has finished reading the instructions.