After the War: An experimental study of post-conflict behavior

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Abstract

Most models of conflict concentrate on how players allocate resources between productive and fighting efforts. After a conflict, the winner is assumed to take control of all the resources of the loser. In this paper we show experimentally that this simplification misses an important component of a conflict, namely the reaction of the defeated player. We find that, if given the choice to destroy some of their resources, many defeated players prefer to do so rather than let the winner take any of it. Given this behavior, incentives to invest in weapons as opposed to production change and in some cases lower levels of conflict are achieved. Furthermore in settings with repeated interaction, the behavior of players in post-conflict stages can serve as a form of costly communication which enables players to reach a peaceful outcome in the future.

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1 Introduction

In order to calculate the profitability of engaging in armed conflict it is necessary to know the probability of winning and the amount resources one can extract from the defeated party if one is victorious.[1] In order to calculate the latter one must have an idea of how the defeated party will react in the post-conflict stage. Hostility towards the winner or pride may motivate the loser to destroy resources that would have otherwise been appropriated by the winner, making the initial conflict less profitable. The aim of this paper is to investigate this kind of post-conflict behavior, which is essential for our understanding conflict in general.

For this purpose, we extend the models of Hirshleifer (1991, 1988) and Skaperdas (1992) in which two players allocate an initial resource between productive and appropriative efforts. The relative investments in the latter determine the winner of the conflict which keeps of the loser's production. We build on their model by introducing post-conflict stages in which the winner choses how much to take from the loser and the loser choses how much of his own resources to destroy.

We consider three different variations. The first we refer to as *Complete Surrender*. In it, we introduce one post-conflict stage where the winner decides how much to take of the loser's production as opposed to automatically receiving all of it. This second stage might be relevant if winners wish to retrain themselves out of fairness considerations or as a way to signal willingness to avoid future wars. This case also serves as a benchmark for the other two variations.

In our second variation, called *Resistance*, there is an additional third stage where the loser, once he knows the amount the winner wishes to take, decides how much of his production to destroy. This game can be considered analogous to cases in which part of the production of the loser depends on labor, thus even if defeated, the loser can reduce his effort and limit the amount of production that the winner can appropriate. Behaviors such as this has been observed in several occasions: the French resistance in the Second World War is a good example.

In the third variation, which we refer to as *Scorched Earth*, the second and third stages of the previous game are reversed. In other words, in the first post-conflict stage the loser decides how much production to destroy, and thereafter, in the second post-conflict stage, the winner decides how much to appropriate. This type of destruction has been carried out in numerous occasions. Examples include the Kuwaiti oil fires started by the Iraqi military

[1]See, e.g., Skaperdas (1992) Hirshleifer (1991, 1989, 1988); Garfinkel, 1990; Grossman (1991) among others. For an excellent survey of this line of research see Garfinkel and Skaperdas (2007).

forces in 1990 when they were driven out by the United States and Hitler's order to destroy all of Germany's productive resources once he know he had lost the war.[2] We study the three games by conducting a laboratory experiment. The experimental approach can be particularly illustrating in this case as it allows us to control type the post-conflict actions available, the probabilities of winning, and the endowments of the parties. Furthermore, given than destruction behavior is not well understood, an experiment allows us to study it without imposing assumptions concerning why people destroy their own resources. In fact, an important contribution of the paper is precisely to shed light in this type of actions.

We test our three post-conflict scenarios under *strangers* matching, where subjects are randomly paired each period, and under *partners* matching, where subjects are stay with the same partner throughout the experiment. With the latter condition we aim at studying how groups manage to avoid continuous violence, and the role post-conflict behavior has in promoting peace.

There exists a large and recent literature related to the economics of conflict. It's focus has been mainly the analysis of the trade-off between producing goods (productive activities) and weapons (appropriative activities). The aim of most of the papers in this literature is to study the optimal investment in weapons and how it is affected by altering parameters such as risk aversion Skaperdas (1991), the existence of future interaction Skaperdas and Syropoulos (1996), the optimal amount of weapons when there are both offensive and defensive types Grossman and Kim (1996), the possible equilibrium when the conflict is costly (Neary, 1996), etc. All these papers consider that the case in which the game ends after the conflict is resolved and assume the winners keeps all of the losers productive resources.

There are few experimental papers dealing with conflict. Durham et al. (1998) test the Hirshleifer's model of power. They examine how changes in the technology of conflict affects productive activities and under what conditions is the "Paradox of Power" (the poorer contender improves her position relative to the richer, Hirshleifer (1991)) is observed. Carter and Anderton (2001) test Grossman and Kim (1996) predator-prey model. They find that increases in the relative effectiveness of predation against defense leads to changes in the equilibrium amount of predation. Duffy and Kim (2005) test a model of anarchy where subjects must repeatedly choose whether they want to be predators or producers. They study whether individuals follow "career paths" or instead switch between types.

The paper is divided as follows. In section 2 we describe the games and the experimental design in detail. In section 3 we present the experimental results. Section 4 concludes.

[2]This strategy was also used by Russian army both against Napoleon in the 19^{th} century as against Hitler in the 20^{th} century.

2 The Experiment

In the experiment, three different variations of the conflict games studied by Hirshleifer (1988), Skaperdas (1992), and others were played. In this section we describe each game and at the end the experimental protocol. A convenient summary of all the games can be found in Table 1.

2.1 Complete Surrender (CS)

The Complete Surrender (CS) game is a two-player two-stage game. At the beginning of the first stage, each player $i \in 1, 2$ is endowed with y units of an exogenously given resource. The players decision in the first stage consists of allocating an amount w_i of their resource to "weapons", thus leaving $y - w_i$ to "production". The relative amount of weapons determines the probability of winning. Specifically, we use a special case of the commonly-used function in the conflict literature where the probability of winning is given by[3]

$$p_i\left(w_i, w_j\right) = \frac{w_i}{w_i + w_j} \quad \text{if } w_i + w_j > 0. \tag{1}$$

As can be seen, if both players invest equal amounts in weapons then they have an equal probability of winning the conflict. Furthermore, i's probability of winning $p_i(w_i, w_j)$ increases with her expenditures in weapons w_i and decreases with her opponent's w_j.

Unlike the majority of this literature, which considers conflict to be unavoidable, we allow players to avoid fighting by choosing $w_i = 0$. If both players invest zero resources in weapons then there is no conflict and the game ends. In this case both players receive earnings of y. If at least one of the players invests a positive amount then the game continues to the second stage.

At the beginning of the second stage a winner is determined according to (1). In this stage the winner decides how much of the loser's production to appropriate. Specifically, winner i chooses a "take rate" $t_i \in [0, 1]$ which is the fraction of $1 - w_j$ that she wishes to claim. The loser makes no decision.

Therefore, if there is conflict, the expected earnings of player i are given by

$$E\left[\pi_i\right] = \frac{w_i}{w_i + w_j^e}\left(y - w_i + t_i(y - w_j^e)\right) + \frac{w_j^e}{w_i + w_j^e}\left(1 - t_j^e\right)\left(y - w_i\right), \tag{2}$$

[3] In the more general functional form, all instances of w_i and w_j are raised to the power of $m > 0$. This so-called effectiveness parameter can be interpreted as the degree of uncertainty in the determination of the winner. Given that armed conflict is high uncertain, we consider the case where $m = 1$. See Hirshleifer (1989) and Skaperdas (1996) for an exhaustive analysis of the importance of m in conflict decisions. This functional form is also employed by Tullock (1980) and the vast literature on rent-seeking.

where w_j^e and t_j^e are i's expected value for w_j and t_j. The first element of the sum corresponds to i's expected earnings if she wins multiplied by her probability of winning, and the second element is i's expected earnings if she loses multiplied by her probability of losing.

If one assumes agents are risk neutral and rationally maximize their monetary earnings then it is relatively straightforward to calculate the optimal investment in weapons. The model is solved by backward induction. In order to maximize their earnings, winners appropriate all of the losers' production. Given this, one can maximize (2) and obtain i's best reply

$$w_i\left(w_j\right) = \sqrt{2yw_j} - w_j. \tag{3}$$

Solving for the symmetric Nash equilibrium of the game gives us the optimal amount of weapons expenditures.[4] Namely, both players spend half of their endowment in weapons, which gives both players an equal probability of winning.

2.2 Scorched Earth (SE)

The Scorched Earth (SE) game has three instead of two stages. The first stage of the game is exactly the same as the first stage of CS and hence we do not repeat it here. Unlike in CS, the loser of the conflict in SE also makes a decision.

In SE, after the winner of the conflict is determined, it is the loser who makes a decision in the second stage. It consists of choosing the fraction of his own production that he wishes to destroy. Specifically, loser j selects a "destruction rate" $d_j \in [0, 1]$ which is the fraction of $1 - w_j$ that is destroyed and thus unavailable for the winner to appropriate in the third stage.

In the third stage the winner learns how much the loser destroyed and thereafter selects a take rate as in the second stage of CS. In this case, a winner i takes a fraction t_i of the production not destroyed $(1 - d_j)(y - w_j)$.

If there is conflict, the expected earnings of player i in SE are

$$E\left[\pi_i\right] = \frac{w_i}{w_i + w_j^e}\left(y - w_i + t_i\left(1 - d_j^e\right)\left(y - w_j^e\right)\right) + \frac{w_j^e}{w_i + w_j^e}\left(1 - t_j^e\right)\left(1 - d_i\right)\left(y - w_i\right), \tag{4}$$

where w_j^e, t_j^e, and d_j^e are i's expected value for w_j, t_j, and d_j. The first and second elements of the sum are analogous to those of (2).

One can think of this game as a case in which players have some time between the moment they know they lost the conflict and when the winner is able to take control of the productive

[4] It is straightforward to see that $w_i = w_j = 0$ is not a Nash equilibrium. In this case both contenders have an incentive to increase their weapons expenditures, win the conflict with certainty, and take all their rival's production.

assets. As mentioned in the introduction, there are numerous examples of losers destroying their production to prevent the winner from enjoying it even though doing so might infuriate the winner and potentially leave the loser in a worse situation.

Again, assuming players are risk neutral own-earnings maximizers one can derive predictions of the optimal investment in weapons, although in this case they are somewhat ambiguous. The model is again solved by backward induction. In the third stage, a winner i maximizes her earnings by setting $t_i^* = 1$. This actually makes the loser j indifferent between the different values of d_j. If i thinks j will chose a destruction rate $d_j^* \in [0,1]$ when indifferent, then i's best reply is

$$w_i(w_j) = \sqrt{\left(2 - d_j^*\right) y w_j + d_j^* w_j^2} - w_j. \tag{5}$$

If we assume all players hold the same beliefs $d_j^* = d_i^* = d^*$, in the symmetric Nash equilibrium the optimal investment in weapons is given by $w^* = \left(\frac{1}{2} - \frac{1}{4} d^*\right) y$. Moreover, if $d^* = 1$ a second Nash equilibrium arises in which $w_i = w_j = 0$ and there is no conflict (in this case neither player has an incentive to spend money on weapons given that there is nothing to gain from winning).

Note that, if we introduce small perturbations in the actions of players we do get a unique prediction. As long as there is a small probability $\epsilon > 0$ that the take rate chosen in the third stage is not 1, losers have an incentive to not destroy. In this case, $d^* = 0$ and the optimal investment in weapons is the same as in CS. Namely, half the players' endowment.

2.3 Resistance (RE)

The Resistance (RE) game is also a three-stage game. Again, the first stage of the game is identical to the first stage of CS. Below we describe the second and third stages.

The second stage of RE is similar to the second stage of CS in the sense that the winner gets to choose a take rate. However, in this case the take rate is the fraction of the loser's production *after the third stage* that she appropriates.

In the third stage the loser is communicated the take rate chosen by the winner and then selects a destruction rate. As in SE, the destruction rate is the fraction of the loser's production that he destroys and therefore does not go to the winner. In other words, a winner i, receives only the fraction t_i of the production that loser j does not destroy $(1-d_j)(y-w_j)$.

Note that, even though in RE the second and third stages are reversed with respect to SE, the equations for expected earnings are identical and given by (4). However, there is an important difference between the two games, namely that in RE the loser can condition his destruction on the winner's chosen take rate.

Table 1: The three games

Note: In all games, the first stage is identical. The winner of the contest is determined by the players' relative expenditures in weapons, see the contest function (1).

	Complete Surrender	Scorched Earth	Resistance
first stage	players chose weapons expenditures w	players chose weapons expenditures w	players chose weapons expenditures w
second stage	winner i choses take rate t_i	loser j choses destruction rate d_j	winner i choses take rate t_i
third stage	–	winner i choses take rate t_i	loser j choses destruction rate d_j
Earnings of winner i	$y - w_i + t_i (y - w_j)$	$y - w_i + t_i (1 - d_j)(y - w_j)$	$y - w_i + t_i (1 - d_j)(y - w_j)$
Earnings of loser j	$(1 - t_i)(y - w_j)$	$(1 - t_i)(1 - d_j)(y - w_j)$	$(1 - t_i)(1 - d_j)(y - w_j)$

The RE game can be thought of as a situation in which winning the conflict gives the winner power to utilize the loser's production capacity but it does not give her complete control over it. Specifically, after learning how much the winner wants to take (e.g. through taxation) the loser can produce at less than his full capacity.

As in CS we get a clear prediction if we assume own-earnings maximization and risk neutrality. Using backward induction, one can see that a loser j does not gain by choosing a positive destruction rate, thus he chooses $d_j^* = 0$. Given this, the game becomes equivalent to CS in which the winner maximizes her earnings by choosing $t_i^* = 1$.[5] Hence, the best reply for weapons expenditures is equal to (3), and in the symmetric Nash equilibrium both players spend half their endowment in weapons.

2.4 Alternative Hypothesis

So far we have described equilibria for the games assuming players are risk-neutral and maximize only their earnings. This is a useful benchmark as it gives us clear predictions to compare the experimental results with. However, there is evidence that these assumptions might not hold. Therefore, we briefly discuss the effects of risk-aversion and other-regarding preferences.

Although it has been argued that experimental subjects should behave as if they are

[5] Note that if $t_i = 1$ then the loser is in fact indifferent between any destruction rate $d_j \in [0, 1]$. However, it is clear that the only subgame-perfect equilibrium is that in which $d_j = 0$. Alternatively one could think that the winner takes $t_i = 1 - \epsilon$ in order to make $d_j = 0$ a dominant strategy.

risk neutral due to the small stakes involved (Rabin, 2000), there is plenty of evidence from lotteries that individuals can exhibit small-stakes risk aversion (e.g., Holt and Laury, 2002). In the games we consider in this paper, risk aversion increases the equilibrium investment in weapons with the more risk-averse player investing more (Skaperdas, 1991). The basic intuition is that risk-averse players can be seen as being more fearful of losing and therefore they insure themselves against a loss by investing more in weapons. Note, however, that risk aversion does not lead to a different outcome in post-conflict stages. Thus, in this sense it predicts the same investment in all three treatments.

There is also a large amount of evidence that individuals posses other-regarding preferences and do not solely maximize their own earnings (Davis and Holt, 1993; Camerer, 2003). In particular, even in anonymous interactions, people are willing to destroy their own resources in order to avoid unfair outcomes (Güth et al., 1982; Fehr and Gächter, 2000) and they are also willing to cooperate in social dilemmas as long as others also cooperate (Keser and van Winden, 2000). Several papers have proposed different motivations as to why this is the case. The most commonly cited are inequality aversion and positive/negative reciprocity (for a recent review see Fehr and Schmidt, 2006).

In our simplest treatment, CS, models of other-regarding preferences predict two effects. On one hand, an individual with other-regarding preferences is willing to cooperate on a purely peaceful outcome if she is certain enough that the other player also possesses other-regarding preferences. On the other hand, when facing an opponent without other-regarding preferences, a heighten dislike of being in the loser position motivates individuals with other-regarding preferences to invest more in weapons in order to protect themselves from losing the conflict. Thus, whether these models predict more or less investment in weapons depends on the percentage of people with other-regarding preferences in the population. For example, if we use the inequity aversion model of Fehr and Schmidt (1999) and utilize their proposed distribution of types, the latter effect dominates resulting in an average investment in weapons of approximately $0.63y$.

For SE and RE these models make a clearer prediction vis-à-vis CS. Since they predict that some of the losers are willing to destroy their resources when they expect/face a high take rate, it follows that either because of destruction or because winners lower their take rates to avoid destruction, winning becomes less profitable. This gives players a smaller incentive to invest in weapons compared to CS. For instance, for both SE and RE, the model of Fehr and Schmidt (1999) predicts an average investment in weapons of $0.44y$.

2.5 Experimental procedures

In the experiment subjects were randomly assigned to one of three treatments. In each treatment subjects played only one of the three games. We thus refer to each treatment according to the game's name.

Subjects played the respective game for 20 periods. In 10 of those periods subjects played with the same opponent. In the other 10 periods subjects were rematched such that they played with a randomly chosen opponent in every period. In both cases subjects were informed of the matching scheme. Throughout the paper we refer to the first matching scheme as *partners* and to the second as *strangers*. To control for sequence effects, half the subjects in each treatment played the 10 first periods as partners and the second 10 periods as strangers. The other half played in the reverse order.

Subjects received 1000 tokens as their endowment y in every period. At the end of the experiment two periods were randomly selected for payment at an exchange rate of 100 tokens for €1. The experiment was conducted in the CREED laboratory at the University of Amsterdam. In total, 206 subjects participated: 76 in CS, 64 in SE, and 66 in RE. The detailed experimental procedures and the instructions are available in appendix A.

3 Results

In this section we discuss the experimental results. First, we analyze at the aggregate level the differences between treatments in earnings and weapons expenditures. Second, we study the subjects' post-conflict behavior to help explain treatment differences at the conflict stage. Lastly, we investigate why some groups attain a peaceful relationship whereas others do not.

Throughout the results section when making comparisons across treatments and matching schemes, unless it is otherwise noted, we report p-values of two-sided Wilcoxon-Mann-Whitney tests. We apply individual averages across all periods as independent observations. When testing for the significance of time trends we use Spearman's rank correlation coefficients. Furthermore, since we have multiple treatments and thus we usually run more than one test we adjust the standard levels of significance $\alpha \in \{0.05, 0.10\}$ using the Benjamini-Hochberg method.[6] We refer to a test as significant if its p-value is below $\alpha = 0.05$ and as weakly significant if it is below $\alpha = 0.10$ (or the respective adjusted value). When reporting

[6]This reduces the risk of false positives due to multiple testing while controlling for the rate of false negatives (Benjamini and Hochberg, 1995). For the three hypothesis tests that we usually perform, this requires ordering the tests H_1, H_2, H_3, such that the corresponding p-values are ordered: $p_1 \leq p_2 \leq p_3$. Then reject all $H_i, i \leq k$ where k is the largest i for which $p_i \leq \alpha \frac{i}{3}$.

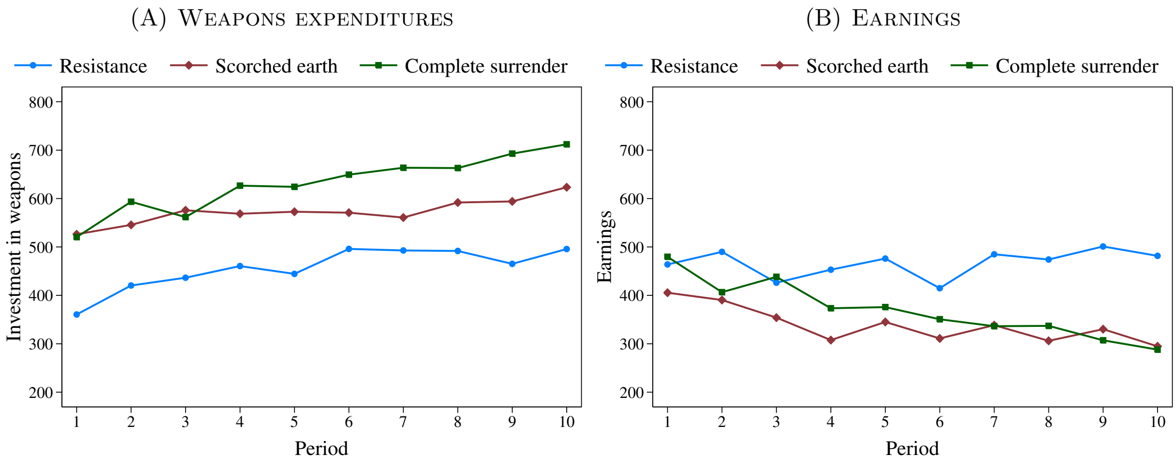

Figure 1: Strangers' weapons expenditures and earnings

Note: (A) Mean investment in weapons per period for each treatment under strangers matching. (B) Mean earnings per period for each treatment under strangers matching.

significance for multiple tests, we indicate the highest p-value when referring to significant differences and the lowest when referring to no differences (we also report the adjusted value of $\alpha = 0.10$). Given that we found no sequence effects, we report the results using the pooled data.

3.1 Conflict behavior

We start by analyzing the investments in weapons and final earning under strangers matching. Figure 1A depicts the average number of tokens invested in weapons over periods for each of the three treatments. We can see that weapons expenditures are highest in CS, second-highest in SE, and lowest in RE. Across all periods, subjects in CS invest, on average, 631 tokens in weapons. In SE they invest 573 tokens and in RE 456 tokens. We can reject equality of distributions across all treatments ($p = 0.044$, $\alpha = 0.10$). In all cases we observe that weapons expenditures increase over time. Albeit, we find a significantly increasing trend only in CS and RE ($p = 0.001$, $\alpha = 0.07$ for CS and RE and $p = 0.156$, $\alpha = 0.10$ for SE).

If we look at earnings per period, we see that they are the highest in RE with an average of 466 tokens. In CS and SE earnings are lower at 369 tokens and 338 tokens (see Figure 1B). The difference in earnings between RE and the other treatments is significant ($p = 0.001$, $\alpha = 0.07$) but that between CS and SE is not ($p = 0.202$, $\alpha = 0.10$). We find a weakly significant decreasing trend in CS and no trend in SE and RE ($p = 0.019$, $\alpha = 0.03$ and $p = 0.296$, $\alpha = 0.07$).

Next we turn to decisions under partners matching. Figure 2A shows average weapons

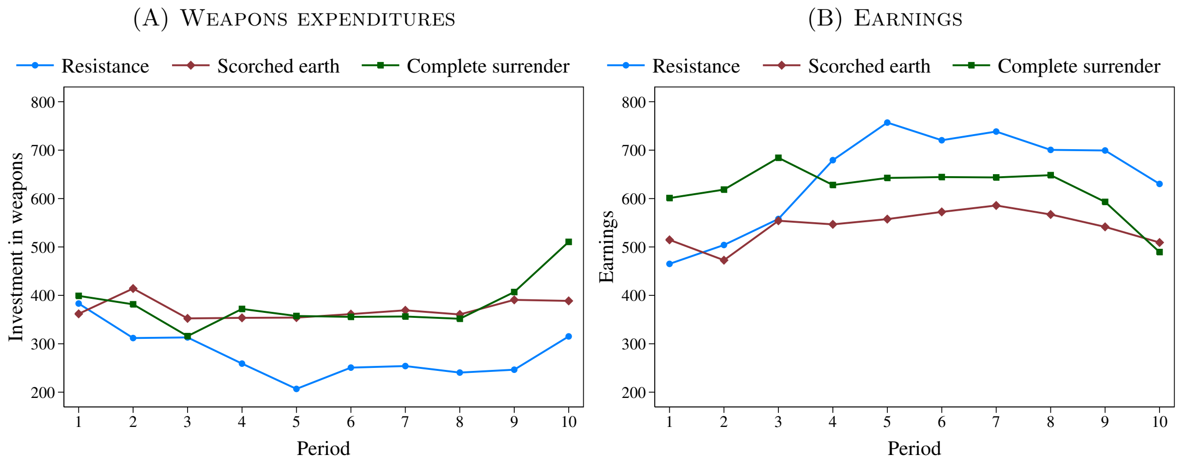

Figure 2: Partner's weapons expenditures and earnings

Note: (A) Mean investment in weapons per period for each treatment under partners matching. (B) Mean earnings per period for each treatment under partners matching.

expenditures over time in each treatment. Again, RE has the lowest mean investment in weapons with 278 tokens per period followed by SE and CS with 371 tokens and 381 tokens. Testing for statistical significance reveals that the lower investment in RE is weakly significantly different ($p = 0.029$, $\alpha = 0.03$). Unlike strangers, weapons expenditures under partners do not exhibit significant trends over time ($p = 0.058$, $\alpha = 0.03$).

Average earnings for partners display the same ordering as for strangers: 645 tokens in RE, 619 tokens in CS, and 542 tokens in SE. However, in this case, differences are not statistically significant ($p = 0.040$, $\alpha = 0.03$). As can be seen in Figure 2B, earnings increase over time in RE ($p < 0.001$, $\alpha = 0.03$), particularly in the first five periods of play. They remain more or less constant in CS and SE ($p = 0.140$, $\alpha = 0.07$). The following result summarizes these findings.

Result 1 Conflict behavior: investment in weapons and earnings
Investment in weapons and final earnings are considerably different depending on the post-conflict structure, particularly under strangers matching. The lowest weapons expenditures and highest earnings are obtained under Resistance, where losers can condition their destruction on the winners' take rate.

It is notable that in both CS and SE investment in weapons are significantly above the 500 tokens one would expect if subjects maximize solely their monetary earnings and are risk neutral (Wilcoxon signed-rank tests, $p < 0.001$, $\alpha = 0.07$). In fact, in these treatments, subjects seem to move *away* from the theoretical benchmark. Thus, unlike in many games where learning moves play closer to equilibrium (e.g. Ho et al., 2007), in this case repetition leads subjects away from it. In RE, subjects invest slightly less in weapons than the theoretical benchmark (weakly significant difference, Wilcoxon signed-rank test, $p = 0.056$, $\alpha = 0.10$), but they appear to converge to 500 tokens with time. With respect to earnings, they are significantly below the expected 500 tokens in SE and CS weakly so in RE (Wilcoxon signed-rank tests, $p < 0.001$, $\alpha = 0.07$ and $p = 0.075$, $\alpha = 0.10$).

Whereas strangers tend to invest more in fighting than theory would predict, in all three treatments under partners matching average weapons expenditures are below the 500-token benchmark (Wilcoxon signed-rank tests, $p = 0.002$, $\alpha = 0.10$). Similarly, earnings in CS and RE, but not in SE, are significantly higher than 500 tokens (Wilcoxon signed-rank tests, $p = 0.001$, $\alpha = 0.07$ and $p = 0.254$, $\alpha = 0.10$). Although, for partners, the theoretical benchmark might be less relevant as it holds only if players backward-induct from the last period (for a discussion on whether individuals do this see Holt, 2006).

Comparing partners and strangers one clearly sees that partners enjoy lower weapons expenditures and higher earnings ($p < 0.001$, $\alpha = 0.10$). Interestingly, the better performance of partners is mostly due to their ability to avoid fighting altogether. For partners, the percentage of periods in which there is no conflict because both players invest zero in weapons is 26.3% in CS, 27.5% in SE, and 31.8% in RE. In contrast, for strangers the highest percentage is 2.6% in RE. If we look at periods in which there is conflict, some of the differences between partners and strangers disappear. For instance, partners no longer have significantly higher earnings in SE and RE ($p = 0.306$, $\alpha = 0.07$) although they still do in CS ($p < 0.001$, $\alpha = 0.03$). We analyze this in more detail in section 3.3. The next result summarizes these findings.

Result 2 CONFLICT BEHAVIOR: STRANGERS AND PARTNERS
With strangers matching, investment in weapons is relatively high and increases with repetition. Also earnings are relatively low. With partners matching, investment is relatively low and does not change with repetition. Earnings are relatively high. The main difference between partners and strangers is that partners avoid conflict around 28% of the time.

The high weapons expenditures of strangers could be in part explained by risk aversion. As mentioned in section 2, risk averse players will invest more in weapons as they suffer relatively more from losing the conflict. In fact, if we assume all subjects possess the same CRRA utility function $U(x) = \frac{1}{1-r}x^{1-r}$, then in CS the equilibrium investment in weapons becomes $w^* = \frac{1}{2-r}y$. Thus, a coefficient of relative risk aversion of $r = 0.415$ could explain the observed mean investment in CS. This value for r falls well within the rage of estimates elicited in other experiments. For example, Holt and Laury (2002) estimate $r = 0.319$ with stakes of around \$2.40 and $r = 0.549$ with stakes of around \$48.50. However, although risk aversion can explain higher overall investment in weapons it provides no explanation as to why these investments differ between the three treatments.

A second explanation for the high investment in weapons is the existence of individuals with other-regarding preferences. For example, the model of Fehr and Schmidt (1999), using a distribution of types calibrated to fit behavior in ultimatum games, is remarkably accurate in predicting the average weapons expenditures in CS-strangers and RE-strangers. It predicts, respectively, 632 tokens and 438 tokens and we observe, on average, 631 tokens and 456 tokens. It does, however, underestimate the investment in weapons in SE-strangers (438 tokens vs. 576 tokens). Given that, in models of other-regarding preferences, predictions of weapons expenditures are driven by what happens in post-conflict stages, we postpone further discussion of their predictive power till after the analysis of post-conflict behavior.

3.2 Post-conflict behavior

The subjects' behavior in the post-conflict stages is summarized in Figure 3. On the top half of the figures one can see average take rates per period for each treatment. In the lower half one can see the average destruction rates of SE and RE.

Concentrating first in CS-strangers, one can see that take rates are very close to complete appropriation. Winners take on average 98.1% of the losers production. This figure is very close to the money-maximizing rate of 100%, which is in fact the modal take rate: it is chosen 88.2% of the time. This is remarkably high if we compare it to dictator games, where subjects are in an analogous position to that of winners in this treatment.[7] For example, Forsythe et al. (1994) find that on average dictators take 76% of the available money and that only 30% take everything. Thus, it appears that winning the conflict makes subjects much more willing to take. Interestingly, comparable take rates are seen if dictators have to first earn the money they latter divide. In this case, mean take rates are around 95.7% and 78.6% take all the money (Cherry et al., 2002). Thus, it is possible that winning the war has a similar effect to that of earning their own money. In other words, it makes subjects feel entitled to the loser's earnings.

At 92.9%, average take rates are almost as high in SE-strangers. Moreover, taking everything is still the modal choice occurring 78.6% of the time. If we compare take rates between

[7] In the dictator game subjects simply decide how to allocate an amount of money between themselves and a second passive player.

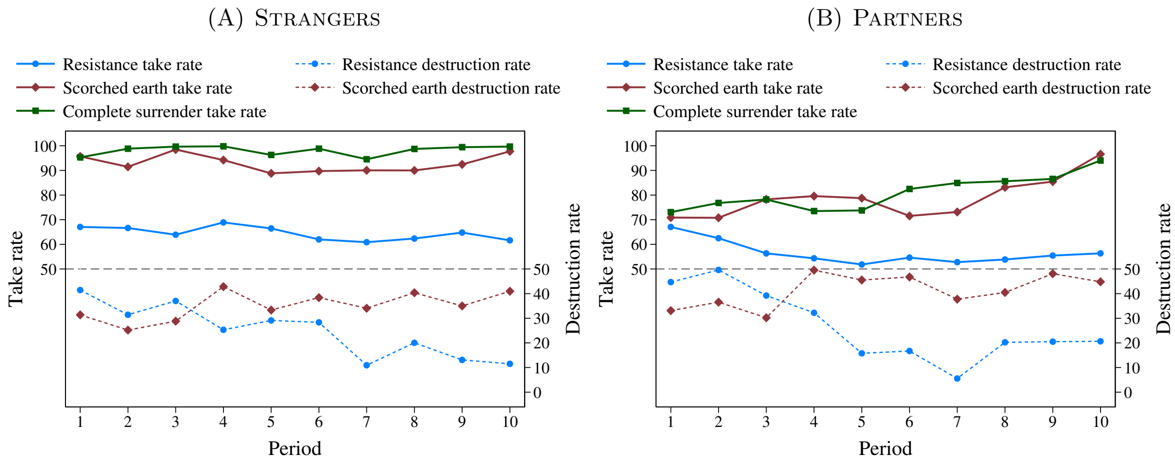

Figure 3: Take and destruction rates

Note: (A) Mean take rates and destruction rates per period for each treatment under strangers matching. (B) Mean take rates and destruction rates per period for each treatment under partners matching.

SE-strangers to CS-strangers, we find they are significantly higher in the latter ($p = 0.008$, $\alpha = 0.10$). Nevertheless, given the small difference in magnitude, one can argue that the intermediate stage in which the loser has the option to destroy has little effect on take rates.

In contrast to the other treatments, take rates are much lower in RE-strangers: they average 64.5% (differences are significant at $p < 0.001$, $\alpha = 0.10$). Furthermore, the number of subjects taking everything also drops considerably: it occurs only 4.9% of the time. Thus, giving losers the option to destroy after take rates are chosen does produce a drastic change in taking behavior. To better understand this difference we now turn to the behavior of losers.[8]

In both SE-strangers and RE-strangers, a considerable number of subjects are willing to destroy their production. Average destruction rates are 35.1% in SE and 24.9% in RE. As with take rates, the modal behavior corresponds to the money-maximizing action of not destroying: this occurs 54.2% of the time in SE and 68.2%in RE. However, for destruction the opposite action is also relatively common: losers destroy everything 29.8% of the time in SE and 20.4% in RE. Note that these two actions account for almost all of the losers' choices. In other words, the decision to destroy is quite binary. Lastly, we find a significantly decreasing trend in destruction rates in RE ($p < 0.001$, $\alpha = 0.05$) but not in SE ($p = 0.400$, $\alpha = 0.10$).

Although aggregate destruction rates are similar between SE-strangers and RE-strangers,

[8]If we check how take rates evolve over time, we find no significant trends in any of the strangers treatments ($p > 0.193$, $\alpha = 0.03$).

there is an important difference between the two. Namely, in RE-strangers, losers condition their destruction on the take rate of the winner. For example, Spearman's correlation coefficient between take rates and destruction rates in RE is 0.453 ($p < 0.001$, $\alpha = 0.10$). As a consequence of the losers' behavior, winners in RE are 'forced' to take lower amounts. In fact, in this treatment if a winner is only interested in maximizing the amount taken, she should take around 60%, which is very close to the mean take rate we observe.

The main difference in post-conflict behavior between strangers and partners is that take rates in the latter are lower in all treatments ($p = 0.025$, $\alpha = 0.10$). As in strangers, average take rates are highest in CE at 81.1%, followed closely by SE at 78.1%, and then well below by RE at 57.3% (the difference between CS and SE is not significant, $p = 0.694$, $\alpha = 0.10$, but that between RE and CS or SE is, $p < 0.001$, $\alpha = 0.03$). In addition, take rates under partners do exhibit time trends. We find significantly increasing trends in CS and SE and a significantly decreasing one in RE ($p = 0.010$, $\alpha = 0.03$). Destruction rates are very similar across matching schemes. They average 40.7% in SE-partners and 28.3% in RE-partners. Furthermore, the decision to destroy is again quite binary. Subjects destroy nothing or everything 79.8% of the time in SE and 90.6% of the time in RE. As with strangers, we do not find a significant trend in destruction rates in SE ($p = 0.151$, $\alpha = 0.10$) but do so in RE ($p < 0.001$, $\alpha = 0.05$). Lastly, in RE-partners we also find a strong positive correlation between the losers' destruction rate and the winners' take rate (Spearman's $\rho = 0.576$, $p < 0.001$, $\alpha = 0.10$). Behavior in the post-conflict stages is summarized in the next result.

Result 3 Post-conflict behavior: take and destruction rates
With strangers matching, in Complete Surrender and Scorched Earth take rates are very close 100%, whereas in Resistance they are considerably lower at approximately 60%. Destruction of resources is relatively common and results in a loss of around 30% of the losers' production. Losers usually destroy everything or nothing, and in Resistance they condition their destruction on the winners take rate. With partners matching results are qualitatively similar but with lower take rates.

The effect of post-conflict behavior on the profitability of war helps explain differences in weapons expenditures. In SE and RE, winning the war is less profitable than in CS. In SE this is due to preemptive destruction, whereas in RE it is due to either destruction for choosing a high take rate or to having chosen a low take rate in the first place. If we take into account that in SE losers destroy all their production around 35% of the time, and that in RE in order to maximize earnings the winner has to take around 60%, one would expect the lowest investment in weapons in RE, followed by SE, and then by CS. This is precisely the ordering we see in both matching schemes (albeit the difference between CS-partners and SE-partners is not significant). Moreover, the fact that there is destruction also explains why, in spite of lower weapons expenditures, earnings are not higher in SE compared to CS. In RE the decrease in destruction rates over time is consistent with earnings not deteriorating in spite of an increasing trend in weapons expenditures in RE-strangers, and of earnings increasing in spite of constant weapons expenditures in RE-partners. Therefore, to a large extent, the destruction behavior of losers can help explain both the differences in take rates and the corresponding differences in investments in weapons.[9]

The willingness of individuals to destroy their income when in similar situations has been documented in numerous experiments (Camerer, 2003). For instance, destruction behavior in RE-strangers is very similar to behavior in the power-to-take game, which corresponds to the two post-conflict stages of the RE game. For example, Bosman et al. (2005) report an average destruction rate of 24.7% (with an average take rate of 60.0%), and a Spearman's correlation coefficient between take and destruction rates of 0.403.

For this reason, models of other-regarding preferences that predict destruction can help explain the observed behavior. In particular, as mentioned in section 2.4, giving a negative weight to the income of the other player—for instance, due to a strong dislike of disadvantageous inequality—can in principle explain both the losers willingness to destroy and a high investment in weapons. This is well-illustrated by the model of Fehr and Schmidt (1999) which accurately predicts weapons expenditures in CS-strangers and RE-strangers.

Nonetheless, to the best of our knowledge, current models of other-regarding preferences cannot explain behavior across all *three* treatments unless one changes the models' parameters depending on the game. In particular, it is hard to reconcile the differences in destruction behavior between SE and RE. If losers correctly anticipate the take rate of the winner in SE, they should destroy at the same frequency for similar take rates in RE. However, they destroy much less. For instance, at take rates above 75% in RE, destruction rates shoot up to 55.1% in RE-strangers and 71.3% in RE-partners. Both these take rates are significantly higher than the average take rate in SE ($p < 0.013$, $\alpha = 0.10$). This same effect has also been found by Gehrig et al. (2007) using variations of ultimatum games.

Given the dissimilarities in destruction behavior between SE and RE, its informative

[9] Nevertheless, we should point out that although differences in the profitability of war explain qualitative differences between treatments in the conflict stage, they fail to explain the magnitude of these differences. For example, for risk neutral players, a reduction in the profitability of war of 35% in SE and 40% in RE ought to translate into an equivalent percental reduction in weapons expenditures. However, the reduction with respect to CS-strangers is only around 10% in SE-strangers and 30% in RE-strangers.

to look at the self-reported data that was gathered to shed light on the motivations for destruction. In the experiment, at the end of periods 1, 10, and 20, losers in SE and RE were asked to self-report their experienced emotions when making the destruction decision.[10] We find that losers who destroy everything in SE report significantly higher intensities of fear and lower intensities of hope compared to losers who do not destroy ($p < 0.001$, $\alpha = 0.02$). In RE, losers who destroy report significantly higher intensities of contempt and irritation ($p < 0.003$, $\alpha = 0.02$). Thus, whereas destruction in RE is correlated with aggressive emotions that are usually triggered by an event, in SE it is correlated with the anticipatory emotions of fear and hope, which are usually triggered by expectations (Ortony et al., 1988). This illustrates that decision-making is fundamentally different when punishing an action that already took place compared to punishing an *expected* action which has not yet occurred. Hence, a theoretical model that takes into account would help account for these results.

3.3 Achieving peace

As was mentioned in Result 2, partners in all treatments enjoy lower levels of conflict and higher earnings than strangers. Furthermore, this is due to their ability to coordinate in the peaceful outcome of no investment in weapons. In this section we analyze how partners manage to achieve peace.

The first thing one notices when looking at periods without war is that they are highly concentrated in a few groups. This can be seen in Figure 4, which shows the distribution of the number of peaceful periods achieved by each group under partners matching. It is remarkable that a majority of groups (58.3%) do not have one single peaceful period and a smaller percentage has many periods in which they remained at peace: 35.9% of the groups have five or more periods of peace and account for 93.9% of all peaceful periods. Moreover, the frequency of peacefull/warlike groups seems to be independent of the treatment. For example, if we test for differences in the frequency of groups with zero periods of peace there is no significant difference between any of the three treatments (Fisher's exact tests, $p = 0.157$, $\alpha = 0.03$).

Compared to strangers, groups that never achieve peace no longer display much of an advantage. Their average investment in weapons is 545 tokens in CS, 565 tokens in SE, and 480 tokens in RE and their average earnings are 455 tokens, 340 tokens, and 439 tokens. For these groups, investment in weapons in SE and RE is no longer significantly lower than

[10]Subjects used 7-point scales to report how intensely they felt: anger, contempt, excitement, fear, gratitude, hope, irritation, pride, regret, and shame.

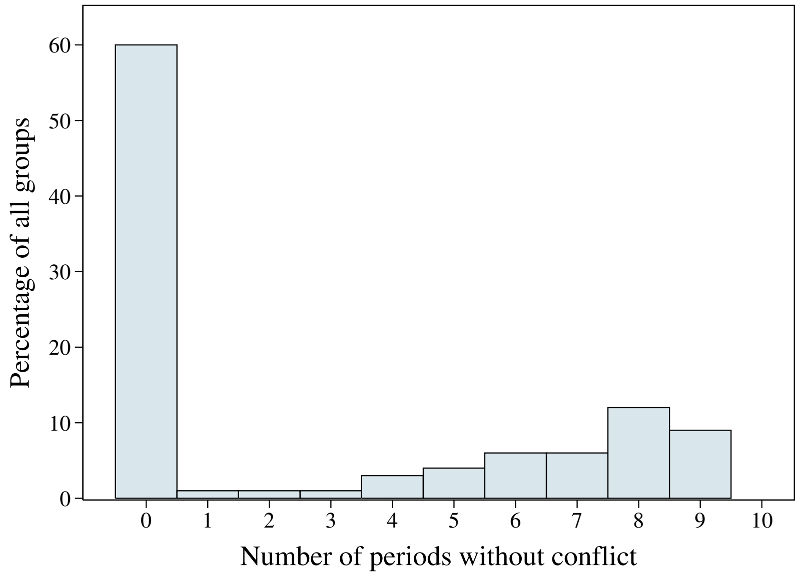

Figure 4: Frequency of peaceful periods by group

Note: Histogram showing the percentage of groups depending on the total number of periods without conflict. For all treatments under partners matching.

in strangers (p = 0.575, α = 0.07), nor are their earnings significantly higher (p = 0.310, α = 0.07). For CS this is still the case ($p < 0.006$, $\alpha = 0.03$). Hence, to understand the main difference between partners and strangers the question to answer is: why do some groups manage to reach a peaceful outcomes and others do not?

The second thing one notices is that once peace is reached, it is remarkably stable. For example, in 87.9% of the time a peaceful period was followed by another peaceful period, and if we exclude the last period to avoid end-game effects this increases to 94.5%. This can also be seen in Figures B1 through B3 in the appendix, where the investment in weapons of each group member in each group is plotted. Some of the groups are lucky enough to start a peaceful relationship already in the first period (21.4% of those who obtain at least one period of peace). However, the majority of those who reach the peaceful outcome do so after a few periods of conflict. To understand how these groups attain peace, we analyze behavior in periods preceding the first peaceful period.

In *all* cases, the first peaceful period is preceded by a period in which one of the two players did not invest in weapons. In fact, choosing not to fight in a given period leads to peace in the following period in 23.3% of the cases in CS, 27.0% in SE, and 46.2% in RE (there is a weakly significant difference between CS and RE, p = 0.030, α = 0.03). This pattern is similar to those in various coordination games where subjects who end in the payoff-dominant equilibrium usually start in the risk-dominant one. This is accomplished

Table 2: Achieving peace through post-conflict behavior

Note: Probit regressions with an dummy variable that equals 1 if subjects i and j achieve their first peaceful period in period $t+1$ and 0 otherwise as the dependent variable. We utilize observations in which $w_j = 0$ and $w_i > 0$ in period $t \in [0, 9]$, and under partners matching. All independent variables are for period t. 'Investment in war' is w_i (normalized so that 1000 tokens equal 1). 'Low take rate' equals 1 if $t_i < 60\%$ and 0 otherwise. 'High destruction rate' equals 1 if $d_j > 70\%$ and 0 otherwise. 'Period' is the period number. Marginal effects at mean values are reported. Numbers in parenthesis are z-values calculated with White's heteroscedasticity consistent covariance matrix estimator and clustering by group. Asterisks indicate significance at the 1% (***), 5% (**), and 10% (*) level.

	CS	SE	SE ($d = 0$)	RE
Investment in war	−0.095	−0.081	−0.283	−0.254
	(0.53)	(0.28)	(0.49)	(1.36)
Low take rate	0.169**		0.591**	0.062
	(2.00)		(2.19)	(0.32)
High destruction rate		0.051		0.019
		(0.40)		(0.12)
Period	−0.051***	0.007	0.008	−0.068*
	(3.20)	(0.25)	(0.15)	(1.78)
Prediction at $\bar{x}$	0.08	0.25	0.19	0.27
Pseudo R^2	0.27	0.01	0.28	0.09
# Obs	47	40	16	54

if one of the players makes the costly move of playing the payoff-dominant action Camerer (2003). However, unlike in coordination games, in our experiment subjects can also use their post-conflict actions to further signal or confirm their desire to coordinate on peace.

We investigate the role of two particular post-conflict actions in facilitating peace. Given that the subject who chose not to invest in weapons loses in the conflict stage, a natural way for the winner to confirm future peaceful intentions is to chose a low take rate. Alternatively, the loser can try to avoid future conflict by choosing a high destruction rate and thus punish the winner for investing a positive amount in weapons. To test the effectiveness of these two actions, we use probit regressions in which the dependent variable takes a value of one if a pair of subjects i and j achieve peace in period $t+1$ and zero otherwise. We look at cases in which j does not invest in weapons in period t. As independent variables from period t, we use: i's weapons expenditures, a dummy variable indicating whether i's take rate is below the median (60%), and a dummy variable indicating whether j's destruction rate is above the median (70%). Lastly, since achieving peace is particularly important in earlier periods and it does not make sense to signal wiliness to act peacefully in the last period, we include the period number as another variable and exclude observations from the final period. We run a regression for CS and RE with all the applicable variables and two regressions for SE. In the first SE regression we include the dummy variable for the high destruction rate to determine whether destruction promotes peace. In the second SE regression, we use only periods in which there is no destruction, and we include the dummy for low take rates to isolate the effect of the take rate.[11] The results are presented in Table 2. Note that the reported figures are the marginal effects of the coefficients at the mean values.

The results indicate that in CS, choosing a low take rate considerably improves the probability of reaching a peaceful outcome in the next period (it increases it by 16.9%). The effect is even stronger in SE (an increase of 59.1%), although in this case, the decision to take a small amount is conditioned on the loser not destroying. In RE we do not find that choosing a low take rate facilitates future peace.[12] The reason for this can be that in CS and SE choosing a low take rate is unambiguously kind whereas in RE a low take rate can be chosen for selfish reasons (i.e. because the winner thinks the loser will destroy if she takes too much). Unlike with take rates, neither choosing a high nor a low destruction rate seems to be conductive to peace. In this sense, destruction is mostly counterproductive as it is costly and produces few benefits. In both CS and RE, the period number has a negative and significant coefficient indicating that peace is much more likely to be formed in early periods when there is more to gain from cooperating. These and the previous findings are summed up in our last result.

Result 4 Achieving peace
Peaceful relationships are achieved when one of the players signals peaceful intentions by choosing not to invest in weapons. In addition, post-conflict behavior helps achieve peace in Complete Surrender and Scorched Earth. Specifically winners can confirm a desire not to fight by choosing low take rates. The use of destruction as punishment does not facilitate future peaceful outcomes.

4 Conclusions

In this paper we study three variations of the conflict models of Hirshleifer (1991) and Skaperdas (1992). We concentrate on how different forms of post-conflict behavior affect the decision

[11]We opt for the two regressions for SE as in many occasions the loser destroys all his production leaving the winner with no choice at all. This makes impractical the simultaneous estimation of the two effects.

[12]Note that this is not due to the generally lower take rates of RE. We get the same result if we define the dummy for a low take rate as less than the median take rate in RE or as a take rate in RE's lower quartile.

to allocate resources between productive and fighting efforts.

We find that, if given the choice to destroy some of their resources, many defeated players prefer to do so rather than let the winner take any of it. Given this behavior, incentives to invest in weapons as opposed to production change and lower levels of conflict are achieved. However, due to the waste of resources in destruction this does not necessarily lead to higher earnings. The most peaceful setting occurs in the Resistance game in which losers can condition their destruction on the take rate of the winners. Since winners take this into account the winners ability to take is limited by the threat of destruction and thus less resources are wasted. A lower profitability from winning translates into less resources spent in weapons.

Furthermore, we also find that in settings with repeated interaction, the subject's choice of weapons expenditures and their post-conflict behavior can serve as a form of costly communication which enables players to avoid future conflict.

We should note that it is still a puzzle why subjects invest amounts in weapons well over what the selfish Nash equilibrium predicts. This additional aggressiveness contrasts with the usual finding from many experiments that subjects are "nicer" or "fairness-oriented" than traditional economic theory would suggest.

A Supplementary Material

A.1 Experimental procedures

The computerized experiment was conducted in 2006 in the CREED laboratory at the University of Amsterdam. Subjects were recruited through the CREED recruitment website and the experiment was programmed with z-Tree (Fischbacher, 2007). The experiment lasted around 1 hour. In total, 206 subjects participated in the experiment.

The number of subjects in each treatment and sequence of play is summarized in Table A1. As can be seen, subjects played in one of the three treatments and one of the two matching sequences. Subjects played repeatedly for 20 periods. Periods 1 to 10 under the first matching type and periods 11 to 20 under the second one. In each period, subjects received 1000 tokens as their endowment. At the end of the experiment two periods (one for each matching) were randomly selected for payment. Average earnings, including a €2.50 showup fee, were €16.69 (1000 tokens equaled €10).

After arrival in the lab's reception room, each subject drew a card to be randomly assigned to a seat in the laboratory. Once everyone was seated, subjects were given the instructions

Table A1: Experimental treatments

	Sequence	
Treatment	Partners - Strangers	Strangers - Partners
Complete surrender	38 subjects	38 subjects
Resistance	32 subjects	34 subjects
Scorched Earth	32 subjects	32 subjects

for the experiment (see below). Subjects were told that the experiment consisted of two independent parts. We emphasized the fact that their choices in the first part will not affect their earnings in the second part. Thereafter, subjects had to answer a few exercises in order to check their understanding of the game to which they had been assigned. Next, they played 10 periods of the respective game via the computer. At the end of the first part, instructions were distributed concerning the second part of the experiment. They consisted of informing subjects they would play precisely the same game for 10 more periods but with a different matching procedure. After finishing the second part, subjects answered a debriefing questionnaire after which they were paid in private and dismissed.

During the game subjects were asked to provide their expectations of the other player's actions. They were asked after subjects made their own choice but before they were informed of the choice of the other. Furthermore, at the end of periods 1, 10, and 20, subjects were asked to self-report their experienced emotions. In all treatments, winners were asked to report their feelings when making their take rate decision. Moreover, in SE and RE losers reported their feelings when making their destruction decision. We asked subjects to self-report in 7-point scales the following emotions: anger, contempt, excitement, fear, gratitude, hope, irritation, pride, regret, and shame.

Below is a sample of the instructions used in the experiment. It corresponds to the Resistance treatment in which subjects first played under the strangers matching scheme. After playing for 10 rounds, subjects where told they would play again the same game but with a different matching scheme. At that point they were given the opportunity to read the instructions once again. Instructions for other treatments and for partners matching are very similar and available upon request.

A.2 Instructions

Welcome to this experimental session on decision making. In this session, you can earn money. How much you earn depends on your decisions and the decisions of other participants. In addition and thus independent of your earnings in the experimental session - you will receive a show-up fee of 2.50 euro. The session has two different experiments. The earnings of each experiment are independent. At the end of the session you will be paid your earnings of each experiment plus the show-up fee privately (one by one) and in cash in euros.

During the experimental session you must be quiet and not communicate with other participants. If you have a question, please raise your hand. We will then come to your table to assist you.

Neither during nor after the experiment will others be informed of your actions or of you answers to any questions. Since your answers will be linked to your table number, but not to your name, anonymity is assured also with respect to the analysis of the experimental session.

Instructions for the first part of the experiment

This experiment consists of 10 rounds of decision making. In each round, you will be matched into a pair with one other participant. This other participant will be a different person for all the 10 rounds. In each round the computer will randomly determine whom you will be matched with. For convenience, we will sometimes call this other participant 'Other'.

At the beginning of each round, both you and the participant you are paired with (Other) will get 1000 tokens to earn money with. At the end of the experimental session, one of the rounds will be randomly selected for paying out. The earnings of that round, together with the show-up fee, will then be paid out.

Each round will consist of four phases. In phase 1, you and Other will have to allocate the 1000 tokens that each of you have received to two projects. In phase 2, there will be a lottery, based on the allocation of tokens. In phase 3, the winner of the lottery will have to choose a percentage. Finally, in phase 4, the loser of the lottery will have to choose a percentage. We will now discuss these phases in detail.

Phase 1: Allocation of tokens to two projects

In this phase, you as well as Other will have to allocate the 1000 tokens that each of you received to two projects: project P1 and project P2. Any distribution of tokens is allowed, including putting all tokens in only one project. Tokens put into P1 (P1-tokens) directly lead to earnings, whereas tokens put into P2 (P2-tokens) will give a chance to get earnings, as will be explained next.

Project P1:

For tokens put into P1 it holds that: 100 tokens = 1 euro in earnings. Thus, each token allocated to P1 generates earnings of 1 eurocent.

Project P2:

This project concerns a lottery. The tokens that you and Other put into P2 will determine your and Others chances of winning this lottery. Whoever is the winner of this lottery will have to choose a percentage in phase 3. This percentage determines the share of the P1-tokens of the loser of the lottery that will go to the winner. This is further explained below. Whoever is the loser of this lottery will have to choose a percentage in phase 4. This percentage determines the share of the P1-tokens of the loser of the lottery that will be destroyed. This is also further explained below. We will now show how the chance of winning the lottery is determined. Your chance of winning is determined by your share in the total number of tokens in P2:

$$\text{Your chance of winning} = \text{Your P2-tokens} \;/\; (\text{Your P2-tokens} + \text{Others P2-tokens})$$

Similarly, Others chance of winning is determined by Others share of the tokens in P2. Thus, the chances for you and Other together always sum up to 100%. For example, suppose that you put 200 tokens in P2 and Other puts 800 tokens in P2. Your chance of winning the lottery then equals: $200/(200 + 800) = 200/1000 = \frac{1}{5}$ (20%), whereas Others chance of winning equals: $800/1000 = \frac{4}{5}$ (80%).

For any given number of tokens that Other will put into P2, your chance of winning increases the more tokens you put into P2 yourself. In our example, if you would have put 800 in P2, instead of 200, your chance of winning would have become: $800/(800 + 800) = 800/1600 = \frac{1}{2}$ (50%).

Clearly, the chance of winning will always be 50% if both you and Other put the same number of tokens in P2. However, you will not know Others decision when you make your own decision. Once you and Other have decided you will be informed about each others decision regarding the allocation of tokens to P1 and P2.

Note that there will be no lottery if neither you nor Other puts any tokens in P2. In that case phases 2, 3 and 4 will not take place, the round ends here and your earnings at the end of this round amount to 1000 tokens from your P1-tokens (10 euros).

Phase 2: Lottery, based on tokens in P2

In this phase, the computer will perform the lottery, based on the tokens put into P2, to select and announce the winner.

Phase 3: Winner of lottery chooses a percentage

In this phase, only the winner of the lottery must make a decision, which consists of choosing a percentage. This percentage determines the share of the P1-tokens of the loser of the lottery that will be transferred to the winner. The percentage must be an integer between 0 and 100. Also the values 0 and 100 are allowed. After the winner of the lottery has chosen the percentage, this decision will be known by the loser of the lottery. Also for the tokens obtained by the winner in this way it holds that: 100 tokens = 1 euro.

Phase 4: Loser of lottery chooses a percentage

In this phase, only the loser of the lottery must make a decision, which consists of choosing a percentage. This percentage determines the share of the P1-tokens of the loser of the lottery that will be destroyed. The percentage must be an integer between 0 and 100. Also the values 0 and 100 are allowed. Also for the tokens destroyed by the loser in this way it holds that: 100 tokens = 1 euro.

Example of determination of earnings in a round

We illustrate with an example how earnings in a round are determined. Suppose that, in phase 1, you put 400 tokens in project P1 and 600 tokens in project P2, while Other (the participant you are paired with) puts 800 tokens in P1 and 200 in P2. This means that your chance of winning the lottery equals $600/(600 + 200) = \frac{3}{4}$ (75%), while Others chance equals $\frac{1}{4}$ (25%). Furthermore, assume that the outcome of the lottery, in phase 2, shows that you are the winner. Assume next that, in phase 3, you decide that 60% of the P1-tokens of Other are to be transferred to you. Assume next that, in phase 4, Other decides that 50% of her or his P1-tokens are to be destroyed. The transfer from Other to you is then equal to 240 tokens (60% of 400 tokens).

Since 100 tokens are worth 1 euro, your earnings at the end of this round then amount to: $400/100 = 4$ euro (from your P1-tokens) plus $240/100 = 2.40$ euro (via the transfer from Other), which amounts to $4 + 2.40 = 6.40$ euro earnings in total.

Others earnings in this example amount to: $800/100 = 8$ euro (from Others P1-tokens) minus $400/100 = 4$ euro (due to the destruction) minus $240/100 = 2.40$ euro (due to the transfer to you), which amounts to $8 - 4 - 2.40 = 1.60$ euro earnings in total.

Summary

There will be 10 rounds of decision making. In each round you will be randomly and anonymously paired with one other participant who will be a different person for all the 10 rounds. Furthermore, each round consists of four phases.

In phase 1, both you and the participant you are paired with will get 1000 tokens to allocate to two projects, P1 and P2. Each token put in P1 earns 1 eurocent (1 euro per 100 tokens). Tokens put in project P2 determine the chance of winning the lottery in phase 2.

The winner of this lottery decides in phase 3 which percentage of the P1-tokens of the loser (of the lottery) is transferred to her or him (the winner). This decision will be known by the loser of this lottery. Next the loser of this lottery decides in phase 4 which percentage of her or his P1-tokens is destroyed. There will be no lottery if you as well as the participant you are paired with allocate 0 tokens to P2. In that case the round ends after phase 1.

At the end of the experimental session one of the rounds will be randomly selected to be paid out. The earnings from that round will be paid out in private and in cash.

To make you fully familiar with the determination of your earnings, we will shortly ask you to answer some questions. If you want, you can now look again into these Instructions. When you are ready, please click on [ready].

B Additional Figures

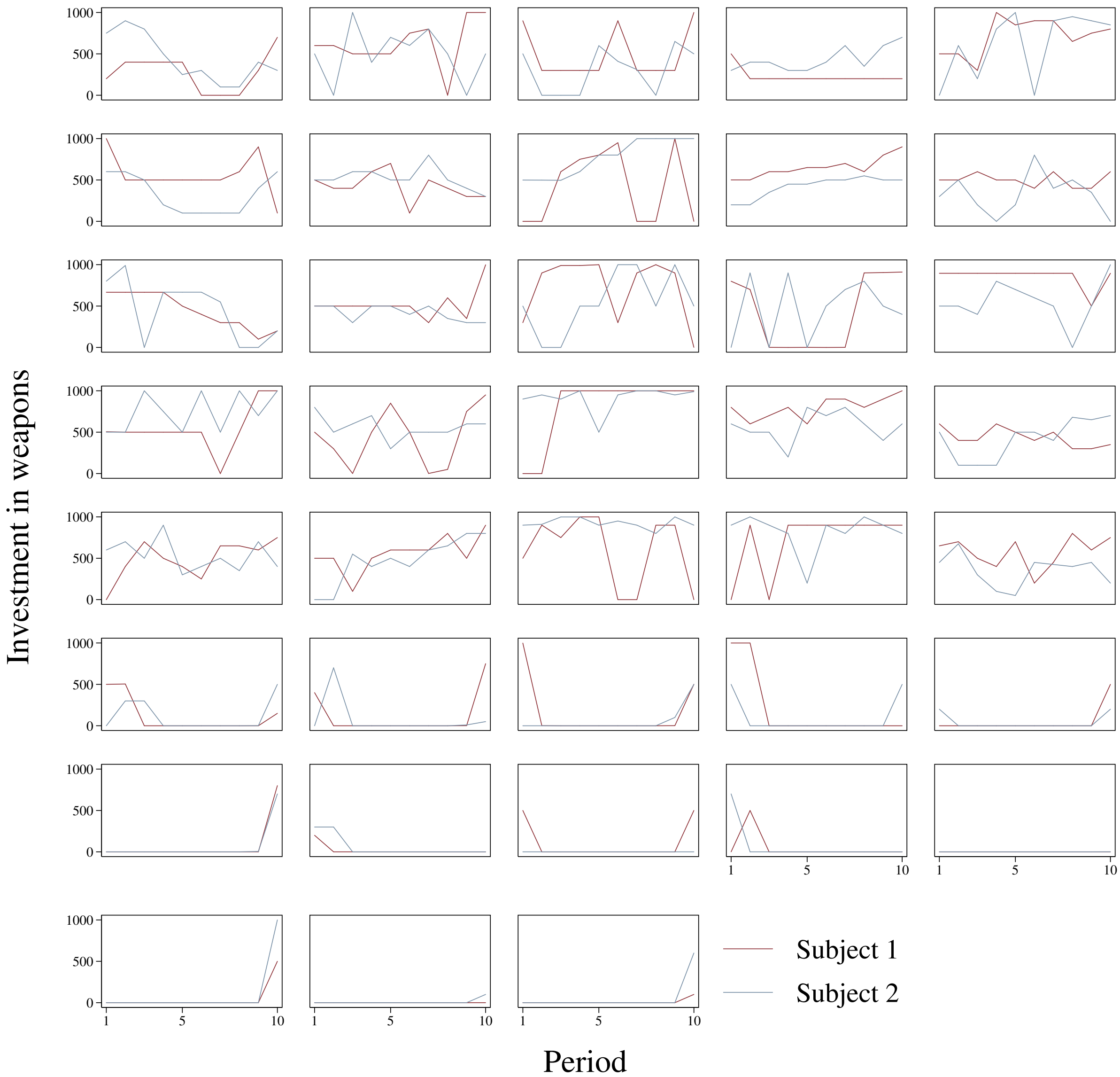

Figure B1: Weapons expenditures per group in CS

Note: Each graph shows, for the Complete Surrender treatment, the amount spent on weapons by each subject in the group. For groups that remain the same across periods. Groups classified as successful correspond to the last thirteen groups.

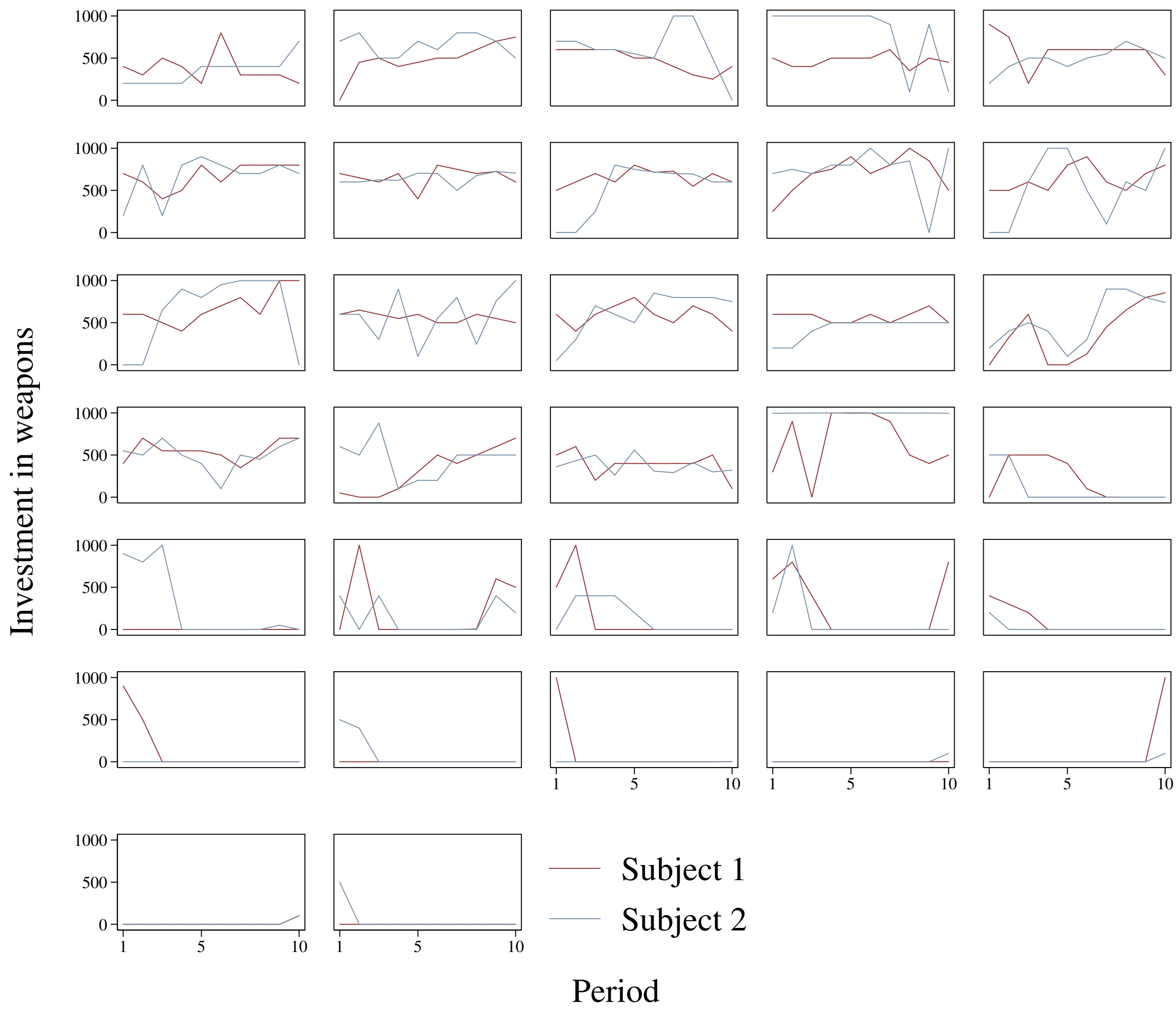

Figure B2: Weapons expenditures per group in SE

Note: Each graph shows, for the Scorched Earth treatment, the amount spent on weapons by each subject in the group. For groups that remain the same across periods. Groups classified as successful correspond to the last ten groups.

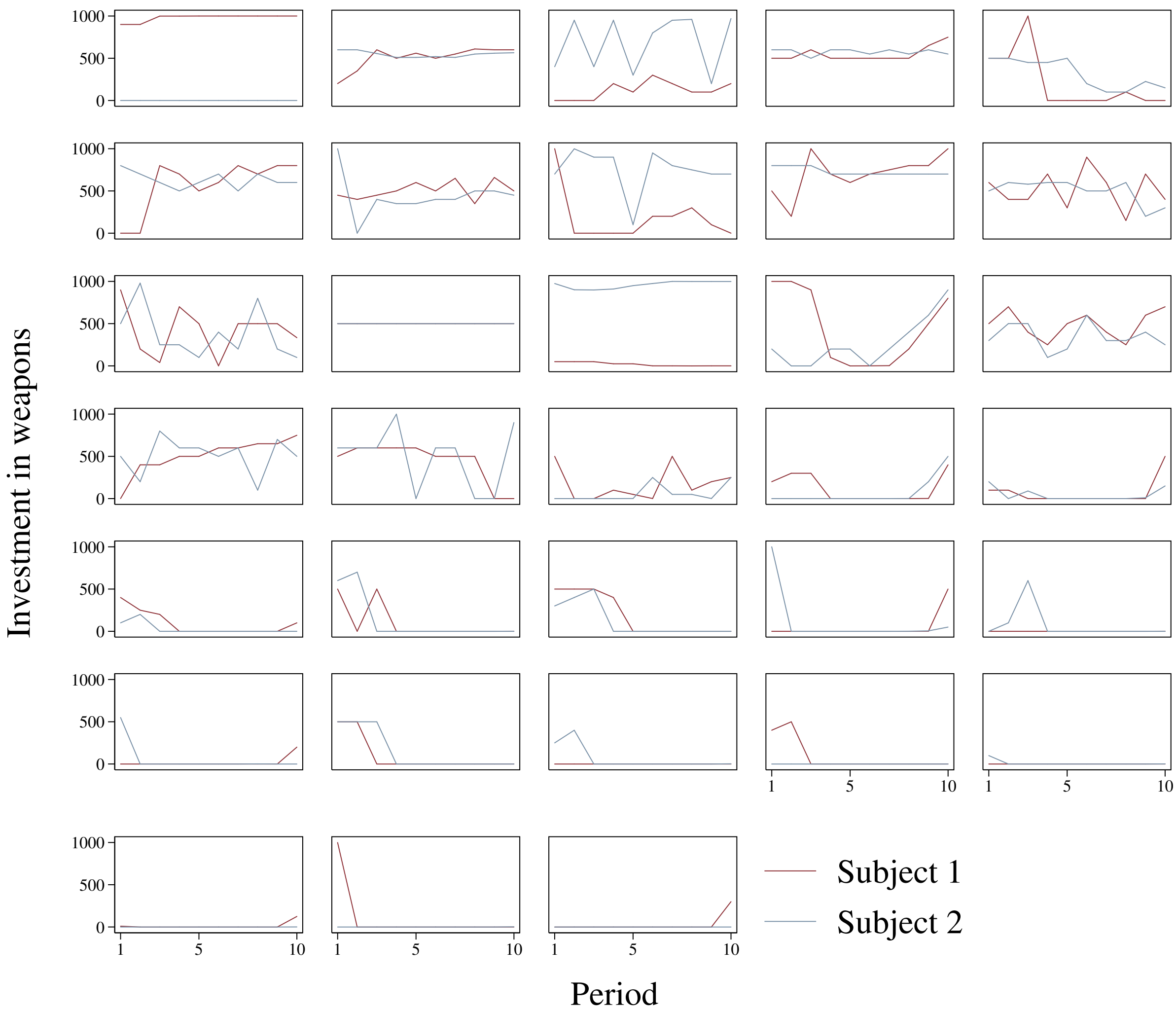

Figure B3: Weapons expenditures per group in RE

Note: Each graph shows, for the Resistance treatment, the amount spent on weapons by each subject in the group. For groups that remain the same across periods. Groups classified as successful correspond to the last fourteen groups.

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