Individual and group behaviours in the traveller's dilemma: an experimental study

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Individual and Group Behaviours in the Traveller's Dilemma:

An Experimental Study[♣]

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Abstract: This paper provides an experimental test of the traveller's dilemma using individual and group data. Our investigation aims to address three fundamental research questions, which can be summarised as follows: (i) claims are affected by the size of the penalty/reward; (ii) individual decisions differ significantly from group decisions; (iii) individual claims are affected by the induction of a focal point *a là* Schelling. Experimental findings reported in this paper provide answers to each of these questions showing that: (i) although the size of the penalty/reward did not affect subject choices in the first-period, it played a key role in determining subjects' behaviour in the repeated game; (ii) overall, groups behave more rationally, in the sense that they were always closer to the Nash equilibrium; (iii) the reference point did not encourage coordination around the Pareto optimal choice.

Keywords: traveller's dilemma, focal point, individual and group decision

JEL codes: C91, C92, D81, D70

♣ The experiment was conducted at the ESSE laboratory at the University of Bari and financed by the same University. The paper was written up while Piergiuseppe Morone was visiting the University Jaume I of Castellón, for whose hospitality and financial support he is grateful.

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1. Introduction

There is an abundant literature relating to the traveller's dilemma (henceforth TD) (Basu, 1994). This game, together with the p-beauty contest game (Keynes, 1936; Moulin, 1986; Nagel, 1995; Morone et al., 2008; Morone and Morone, 2008; Morone and Morone, 2010) and the centipede game (Rosenthal, 1981; McKelvey, and Palfrey, 1992; Nagel, and Tang, 1998; Palacios-Huerta, and Volij, 2009), is often used to demonstrate the tension between clear-cut game-theoretic analysis based on serial inductive thinking and the vagaries of actual behaviour.

Interest in the TD is related to the fact that the optimal strategy depends on what the other player is expected to do. It is interesting since the unique game-theoretic prediction for both players' payoff is much worse than their cooperative behaviour payoff.

Basu proposed a nice and simple story:[1] two travellers spend their holiday on a tropical island, where they purchase identical and expensive items; on the return trip the airline loses their luggage containing the purchased items. In order to reimburse the two travellers for their loss, the airline representative asks each traveller separately to fill out a claim, with the understanding that claims must be at least x and no greater than X (with $x < X$). Claims will be fully reimbursed if they are equal. But if they are different both travellers will receive the lower claim. Additionally, the lower claimant will receive a small reward, and the higher claimant will incur a small penalty deducted from the reimbursement. Obviously, each person has an incentive to "undercut" the other, so no common claim above x can constitute a Nash equilibrium.

Basu proposed this game in order to demonstrate the conflict between intuition and game-theoretic reasoning in a one-shot game, where backward induction occurs at an introspective level. As it seems, game theoretic reasoning gives a clear-cut answer to what should be expected in the TD. However, "All intuition seems to militate against all formal reasoning in the traveller's dilemma. Hence the traveller's dilemma seems to be one of the purest embodiments of the paradox of rationality in game theory because it eschews all unnecessary features, like play over time or the nonstrictness of the equilibrium" (Basu, 1994: 391).

It is puzzling that a small penalty/reward can drive claims to the Nash equilibrium prediction, where the outcome minimizes the aggregate payoff. On the one hand, the Nash equilibrium in the TD is independent of the size of the penalty/reward. On the other hand, intuition suggests that behaviour conforms closely to the Nash equilibrium when the penalty/reward is high, but when the penalty/reward parameter approaches 0, subjects' behaviour should approach the Pareto optimal

[1] The story was first told by Basu at the American Economic Association annual conference in January 1994, and subsequently published in the Association Journal.

solution (where both travellers claim *X*). In this paper we present a laboratory experiment to evaluate whether average claims are affected by: (i) the size of the penalty/reward; (ii) group decisions; (iii) a reference point *a là* Schelling.[2]

The first of these research questions has been broadly investigated, consistently showing that penalty/reward size does matter. In contrast, to the best of our knowledge, the latter two research questions have never been addressed within a TD framework. However, we believe both latter questions are relevant. In fact, our second research question allows us to compare individual and group decisions within a strategic game, an area of enquiry, which has gained momentum over the last years in experimental literature. Whereas, the third research question is motivated by our firm conviction that the TD game typically conducted in the laboratory, even though the game is theoretically identical, differs from Basu's story since it omits to mention the actual value of the lost items. We believe the items' value represents a reference point *a là* Schelling, i.e. a solution that people might tend to use in the absence of communication, because it seems natural, special or relevant to them. Hence, introducing a reference point should encourage coordination around the Pareto optimal choice and help to integrate experimental results with the travellers' original story.

In the following section we briefly review the literature on experimental tests of the TD as well as on group decisions. Experimental design is discussed in section 3. Section 4 presents our experimental results and section 5 concludes.

2. Literature review

Recently, a growing body of experimental literature has explored differences between individuals and groups (or between groups of different size) in various decision contexts involving strategic behaviours. Examples are the beauty-contest games (Kocher and Sutter, 2005; Kocher and Sutter, 2007; Sutter, 2005), centipede games (Bornstein et al., 2004), ultimatum games (Bornstein and Yaniv, 1998), dictator games (Cason and Mui, 1997), signalling games (Cooper and Kagel, 2005), and pair-wise choices experiments (Bone 1998; Bone et al., 1999 ; Bateman and Munro, 2005; Shupp and Williams, 2008; Masclet et al., 2009; Morone and Morone, 2012).

[2] A reference (or focal) point (also called Schelling's point) is a solution that people will tend to use in the absence of communication, because it seems natural, special or relevant to them. Schelling himself illustrated this concept with the following problem: Tomorrow you have to meet a stranger in New York City. However there is no means of communication between you. So, where and when do you meet them? This is a coordination game where any place in the city at any time tomorrow is an equilibrium solution. Schelling asked a group of students this question and found the most common answer was "noon at (the information booth at) Grand Central Station." There is nothing that makes "Grand Central Station" a location with a higher payoff (you could just as easily meet someone at a bar, or in the public library reading room), but its tradition as a meeting place raises its salience, and therefore makes it a natural "focal point" (from *Wikipedia* - mildly edited).

However, not much attention has been given to investigate the differences between individual and group decisions in the TD game. This contrasts against a relatively large body of literature experimentally dealing with the TD, which we will briefly discuss hereafter. Moreover, as already mentioned in the introduction, none of the main TD experimental tests has ever dealt with the effect of introducing a reference point in the game played in the laboratory.

Whenever the TD game has been tested in the lab, experiments confirmed the intuition that claims may be higher than the Nash equilibrium, which predicts the lowest possible claim no matter how small the penalty/reward is. Capra et al. (1999), for instance, ran a repeated TD experiment, and showed that the size of the penalty/reward matters. Specifically, the Nash equilibrium strategy solution proved to be a good predictor of people's behaviour in a TD with small penalty/reward and a rather bad predictor if the penalty/reward parameter was big.

Becker et al. (2005) proposed an experimental adjustment on the TD: testing it on participants who were experts in game theory. The fact that their results confirm the general findings, namely that the behaviour in experiments is far from the Nash equilibrium prediction, indicates that these findings should not be attributed to any lack of understanding of the game, but rather represent a robust pattern of behaviour.

Rubinstein (2006) reported on an unconventional experiment conducted during the years 2002 and 2003. He collected large amounts of data from audiences in a public lecture that he delivered at several universities. People who were invited to attend the lecture (mainly students and faculty) were asked to respond (on the website *gametheory.tau.ac.il*) to several questions before the lecture including one question that was a simplified version of the TD. As reported by the author, only 13% of respondents reported an answer in line with the game theoretical prediction. Moreover, on average, they would do poorly playing against a player chosen randomly from the respondents. As put by Rubinstein, "These players can claim to be the 'victims' of game theory" (2006: 875).

Chakravarty et al. 2010 conducted a laboratory experiment with pre-play communication, finding that pre-play communication does not help raise claims. Surprisingly, claims were highest when players could communicate using precise numerical messages even though, theoretically, such communication is not self-enforcing.

Finally, Basu et al. (2011) isolated deviations from the Nash behaviour caused by differences in welfare perceptions and strategic miscalculations. Their experimental findings suggest the dominance of the change in one's own reward/penalty over the change in the other player's reward/penalty. They also found that expected claims are inconsistent with actual claims in the asymmetric treatments. Moreover, focusing on reported strategies, they documented that changes in

choices across treatments are, to a large extent, explained by risk aversion.

3. Experimental design

The experiment presented here was conducted at the ESSE laboratory of experimental economics at the University of Bari in November 2008. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007). Participants were undergraduate students from different disciplines, enrolled at the University of Bari.

Students played a repeated TD game; in total, nine experimental treatments were run, each involving 20 participants.[3] Written instructions on the experiment were distributed prior to its commencement.[4] In all treatments amounts were denoted by *ECU* (Experimental Currency Unit), where 100*ECU* = 1€. The average payoff, earned in about 15 minutes, was 9€ (including a participation fee of 3€).

As mentioned, the experiment consists of nine treatments, grouped into three sessions: *control* session (T1, T2, and T3); *group* session (T4, T5, and T6); and *reference* session (T7, T8, T9). Each treatment was carried out once. The three sessions are designed to investigate (i) the impact of the size of the penalty/reward; (ii) the impact of group decisions; (iii) the effect of a reference point *a là* Schelling.

In each control treatment (T1, T2 and T3), players were randomly paired and were allowed to interact for 10 periods in a 'stranger design'. During each period subjects were asked to report a number between 40 and 200. If both subjects in a couple reported the same number, then their payoff would have been the reported number. If they reported different numbers, then they would get different payoffs. More precisely, the subject who reported the smallest figure received the minimum reported figure plus a reward, and the subject who reported the largest figure received the minimum reported figure minus a penalty. In T1 the reward/penalty was set equal to 2*ECU*; In T2 the reward/penalty was set equal to 25*ECU*; In T3 the reward/penalty was set equal to 40*ECU*.

Groups' treatments (T4, T5 and T6) were identical to the control treatments, but this time decisions were made by randomly created groups[5] of two subjects (dyads) instead of single subjects. In fact,

[3] Treatments 4, 5 and 6 involved 40 participants, which where divided into 20 randomly created groups of two.
[4] An English translation of the Italian instructions for the experiment can be provided upon request.
[5] We are aware that there are many factors that can affect group decisions (e.g. gender, age, placement of group members). Additionally, the social interaction between a man and a woman can be quite different than between two men or two women. For instance, "beauty" and other stereotypes can have huge impact on the outcomes of group decisions (Andreoni and Petrie, 2008). To minimise the impact of such problems, we kept the pairs identity confidential so that each group member maintained anonymity with subjects communicating through the computer interface.

these treatments involved 40 players grouped into dyads, which were subsequently paired to play the TD game.

Also the reference treatments (T7, T8 and T9) were identical to the control treatments, but in this case participants were selected in a more sophisticated way. In order to induce a reference point, we initially recruited 40 subjects and let them participate in a task completely unconnected with the TD experiment. At the end of this task, half of the subjects earned 200*ECU* and the other half earned 40*ECU*. Subsequently, those players who earned 40*ECU* were paid and let go, whereas those 20 subjects that gained 200*ECU* were sent to a different laboratory where they found new experimenters who were unaware of how much money they had gained in the previous task.[6] Now, these subjects, in order to get paid, were paired and asked to claim their payoff in the usual Basu's setup, i.e. knowing that if they claimed the same amount their payoff would have been the reported number; however, if they claimed different numbers they would get different payoffs (the clamed amount minus/plus a penalty/reward).

In all treatments, decisions were referred to as "claims" and the earnings calculations were explained without reference to the context, (i.e. without mentioning the luggage travellers' scenario); hence, all treatments were designed to be contest free. A table summarizing the structure of the experiment is reported below (see Table 1).

Table 1. Treatments' parameterisation

Penalty/Reward	***Treatments***		
	Control Session	***Group Session***	***Reference Session***
2*ECU*	T1	T4	T7
25*ECU*	T2	T5	T8
40*ECU*	T3	T6	T9

4. Results

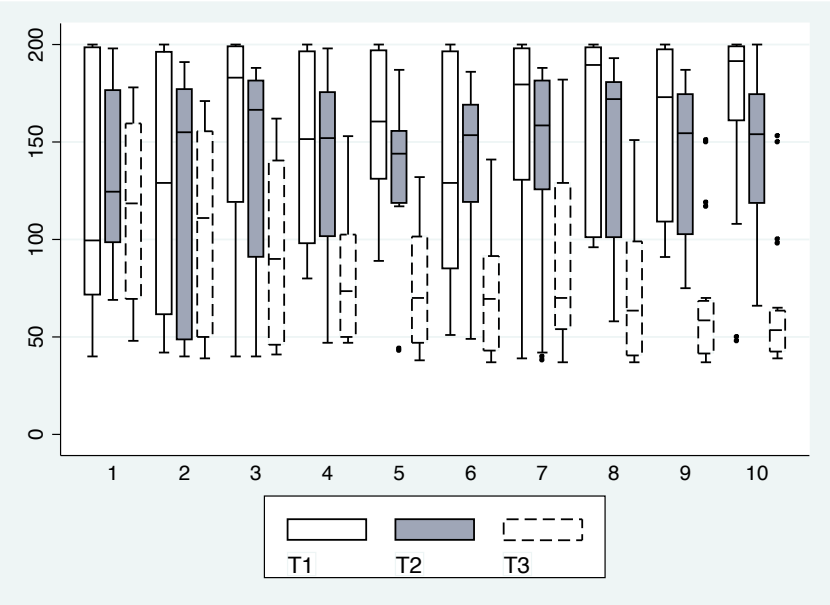
In order to address our first research question (i.e. the impact of the penalty/reward on subjects' claims) we calculated and reported, by means of a box-plot, the period-by-period claims for treatments 1, 2, and 3, as shown in Figure 1.

[6] We decided to introduce a reference point in this way since, as well-established experimental literature shows (Guth and Ortman, 2006; Bosman and van Winden, 2002; Cherry et al., 2002; Bosman, et al., 2005), people behave, *ceteris paribus*, differently if their own earnings are at stake (effort experiment) than they would if a budget was provided to them like a sort of manna from heaven (no-effort experiment).

As mentioned above, the Nash equilibrium prediction is 40*ECU* for all treatments, however, the first-period median in Figure 1 falls between 99 and 125 (more precisely, it is 99.5 in T1, 124.5 in T2, and 118.5 in T3). We tested and found that deviations from the equilibrium for the first-period claims are not statistically different at the 1% significance level across the three treatments. This finding would suggest that the size of the penalty/reward does not affect subject choices in the first-period.

Looking at the ten periods compiled in Fig.1, the picture changes. We observe that: (i) the variability of subjects claims decreases over time, and (ii) the penalty/reward parameter plays a key role in determining subjects' behaviour. In fact, when the penalty/reward is equal to 2*ECU* (i.e. T1) we can observe a clear convergence to the Pareto optimal solution; when it is equal to 40*ECU* (i.e. T3) we can observe a convergence to the Nash equilibrium; finally, when it is equal to 25*ECU* (i.e. T2) subjects' claims are somewhat below the Pareto optimal solution.

Figure 1. Period-by-period claims in treatments 1, 2 and 3



In order to statistically corroborate these results we performed, separately for each treatment, a generalized linear mixed regression with individual claims as the dependent variable and periods 1 to 10 (*Period 1-10*) as the independent variable. The model has random effects at one level, namely the individual choices. The regression results, reported in Table 2, support the hypothesis that the penalty/reward parameter plays a key role in determining subjects' behaviour: the coefficient of *Period 1-10* is positive and significant (at the 1% level) in T1, it is very small and significant (at the

5% level) in T2, and negative and significant (at the 1% level) in T3. Moreover, the constant is comparable in magnitude in the three treatments.

Table 2. Generalized linear mixed effects regressions

Individual claims on periods 1 to 10 – treatments 1, 2 and 3

Control Session: T1				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	126.880	10.883	11.660	0.000
Period 1-10	3.832	0.759	5.040	0.000
Control Session: T2				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	129.430	8.928	14.500	0.000
Period 1-10	1.646	0.812	2.030	0.043
Control Session: T3				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	111.920	7.574	14.780	0.000
Period 1-10	-4.976	0.762	-6.530	0.000

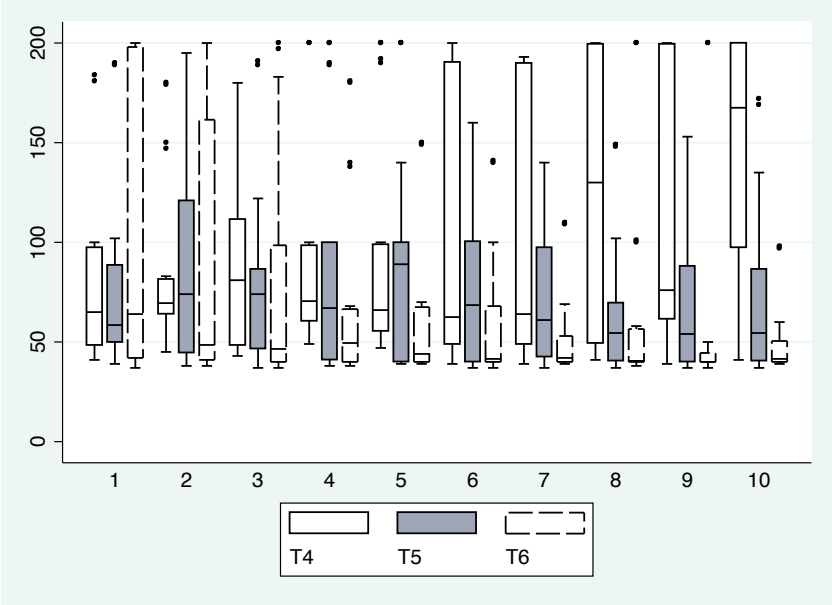
The regression results, reported in Table 2, confirm that the differences in claims among treatments are due to different time trends and not to a shift in the (initial) level of claims (i.e. a lower intercept in the regression). These, in line with earlier results, provide a further answer to our first research question, suggesting that the size of the penalty/reward influences the equilibrium in a repeated TD game. Explicitly, a small penalty/reward leads to Pareto, whereas a large penalty/reward leads to Nash.

Treatments 4, 5 and 6 allow us to address our second research question: assessing if group decisions show significant differences when compared to individual decisions. In fact, as we will show, our second session results differ significantly from earlier results.

In Figure 2 we reported the box-plot of the period-by-period claims of subjects in treatments 4, 5 and 6. As discussed in section 3 above, in these treatments each single claim is the outcome of a group decision. In the first-period the median claim falls between 58 and 65 (more precisely, it is equal to 65 in T4, 58.5 in T5, and 64 in T6).[7] Interestingly, these first-period group claims are systematically lower and statistically different (at the 1% significance level) from those observed in the first-period individual decision treatments. It appears that, in a one-shot game (i.e. the first-period), groups behave more rationally, in the sense that they are always closer to the Nash equilibrium.

[7] Also in this case we tested and found that deviations from the equilibrium in the first-period claims are not statistically different at the 1% significance level across T4, T5 and T6.

Figure 2. Period-by-period claims in treatments 4, 5 and 6

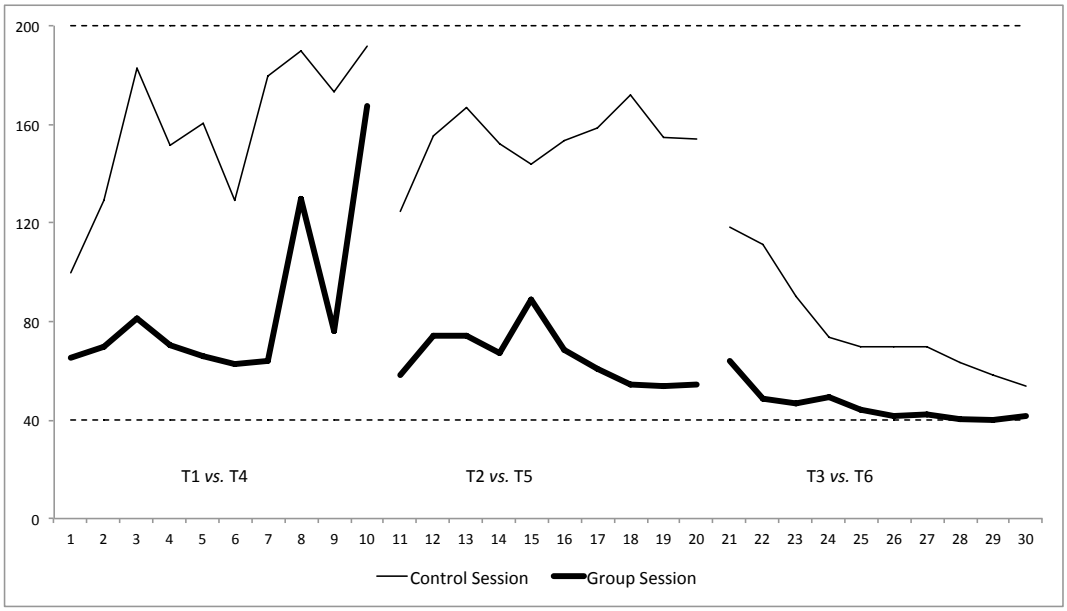


When looking at the repeated game, other interesting results arise. In the treatment with a penalty/reward parameter equal to 40*ECU* the median of claims rapidly converges to the Nash equilibrium and the variability of subjects' claims narrows (from the third period onward). Also with a smaller penalty/reward (set equal to 25*ECU*) the median claim decreases over time, although at a slower pace. In contrast, with the smallest penalty/reward (set equal to 2*ECU*), the trend reverts. Moreover, even though the T4 median converges to the Pareto optimum, the variance of the claims is stubbornly high. This is due to the fact that 40% of the groups claimed systematically close to the Nash equilibrium, whereas the remaining 60% claimed haphazardly – in one period playing (close to) Nash and in the subsequent period playing (close to) Pareto.

In order to better appreciate differences, we report a direct comparison of the two sessions in Figure 3. Specifically, each thin line connects the period-by-period median claim for treatments 1, 2 and 3; and each thick line connects the period-by-period median claim for treatments 4, 5 and 6. The data plots are bounded by two horizontal dashed lines that show the maximum and minimum claims of 200*ECU* and 40*ECU*, respectively.

It appears that the group session is steadily closer to the Nash equilibrium when compared to the control session; confirming that groups are more rational than individuals. However, this 'rationality gap' reduces significantly when the value of the penalty/reward is set equal to 40*ECU* and picks up when the penalty/reward is set equal to 25*ECU*.

Figure 3. Median Claims for Control Session and Group Session



Another interesting feature emerging from this comparison refers the slope of the ten periods trend. In fact, when looking at the treatments with a small penalty/reward (T1 and T4) the two sessions show a common upward trend. Similarly, when looking at the treatments with a large penalty/reward (T3 and T6) the two sessions show a common downward trend. A diverging picture emerges when comparing the two sessions when the penalty/reward is set equal to 25*ECU* (T2 and T5). In this case, the trend is upward in the reference session and downward in the group session. This finding might suggest that strategic and rational behaviours emerge earlier (i.e. with a smaller penalty/reward) when decisions are undertaken in groups rather than individually.

These findings are statistically robust; in Table 3 we report the results of the generalized linear mixed regression concerning T4, T5, and T6. First, as in the previous session, we can accept the hypothesis that the penalty/reward parameter plays a key role in determining subjects' behaviour. Moreover, comparing the estimated coefficient in T1 with T4, in T2 with T5, and in T3 with T6 we can test if groups affect decision in a TD game. As it seems, the intercept is always higher in T1, T2, and T3 with respect to T4, T5, and T6, thus suggesting that groups claim significantly less than individuals. Additionally, comparing T3 with T6, we can state that groups converge faster to the Nash equilibrium (when the penalty/reward parameter is big) and comparing T2 with T5 we can conclude that groups converge to the Nash equilibrium, but individuals converge to the Pareto equilibrium (when the penalty/reward is not set equal to 25*ECU*).

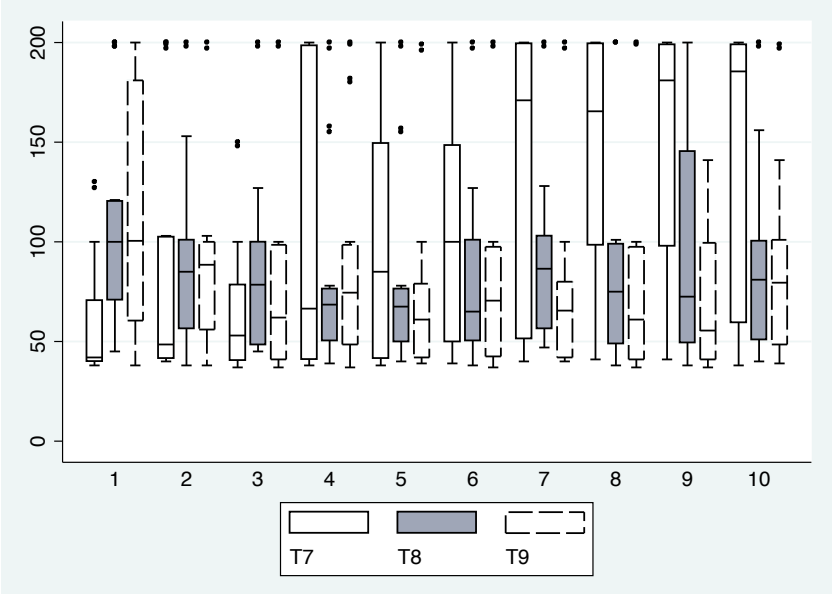
Table 3. Generalized linear mixed effects regressions

Individual claims on periods 1 to 10 – treatments 4, 5 and 6

Group Session: T4				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	63.863	10.663	6.360	0.000
Period 1-10	6.238	1.101	5.670	0.000
Group Session: T5				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	88.58	8.471	10.460	0.000
Period 1-10	-1.981	0.819	-2.420	0.016
Group Session: T6				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	97.613	8.050	12.120	0.000
Period 1-10	-5.259	1.089	-4.830	0.000

We conclude our investigation considering the effect of a reference point *a là* Schelling in the TD game. In Figure 4 we report the period-by-period average claim for treatments 7, 8 and 9. As explained earlier, in these treatments subjects earned a payoff of 200*ECU* in a previous task; as we believe, this provided them with a clear reference point. The first-period median in T7 is 42, in T8 it is 100, and it is equal to 100.5 in T9.[8] Also in this case, these first-period group claims are systematically lower and statistically different (at the 1% significance level) from those observed in the first-period of the control treatments.

Figure 4: Period-by-period claims in treatments 7, 8 and 9



[8] Also in this case we tested and found that deviations from the equilibrium in the first-period claims are not statistically different at the 1% significance level across T7, T8 and T9.

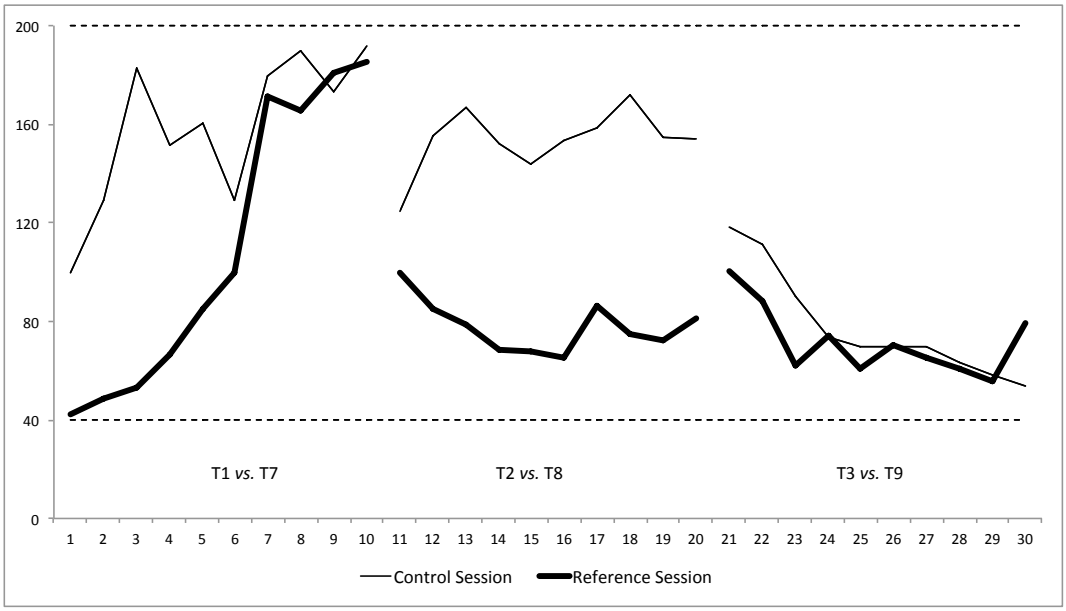
For the sake of clarity, we report a summary of the first-period claims across all nine treatments in Table 4. Hence, contrary to our expectations, providing subjects with a reference point equal to the upper bound does not increase the number of subjects playing at (close to) the Pareto end of the spectrum. Apparently, in a one-shot game the reference point does not encourage coordination around the Pareto optimal choice, but rather it stimulates strategic behaviours, pushing individual choices towards the Nash equilibrium.

Table 4. First-period median claims

Penalty/Reward	***Treatments***		
	Control Session	***Group Session***	***Reference Session***
2*ECU* (T1, T4 and T7)	99.5	65.0	42.0
25*ECU* (T2, T5 and T8)	124.5	58.0	100.0
40*ECU* (T3, T6 and T9)	118.5	63.0	100.5

An overall look at the repeated game basically confirms our earlier findings. Figure 5 reports a direct comparison of the two sessions. Specifically, each thin line connects the period-by-period median claim for treatments 1, 2 and 3; each thick line connects the period-by-period median claim for treatments 7, 8 and 9. Again, data are bounded by two horizontal dashed lines showing maximum and minimum claims. It can be seen that the reference session is (almost) always below the control session; suggesting that providing a reference point improved subject rationality rather then pushing them to play (closer to) the Pareto end of the spectrum.

Figure 5. Median Claims for Control Session and Reference Session



To statistically corroborate this graphical analysis we report in Table 5 the results of the generalized linear mixed regression concerning T7, T8 and T9. Now, by comparing these results with earlier findings (T1, T2 and T3), we can confirm that the reference session is closer to the Nash equilibrium when compared to the control session, but this gap closes when the value of the penalty/reward is set equal to 40*ECU*. Consistent with earlier findings, the outcome of this test also suggests that the presence of a reference point does not improve subjects' coordination towards Pareto.

Table 5. Generalized linear mixed-effects regressions
Individual contributions on periods 1 to 10 – treatments 7, 8 and 9

Reference Session: T7				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	53.683	11.305	4.750	0.000
Period 1-10	9.896	1.086	9.100	0.000
Reference Session: T8				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	94.676	9.491	9.970	0.000
Period 1-10	-0.766	0.848	-0.900	0.366
Reference Session: T9				
Independent variable	Coefficient	Std. Error	*z*	*P*>|*z*|
Constant	95.776	9.615	9.960	0.000
Period 1-10	-2.322	0.742	-3.130	0.002

5. Conclusion

In this paper we reported on a laboratory experiment on the traveller's dilemma conducted at the ESSE laboratory (Bari University, Italy) at the end of 2008. The aim of this experiment was to address three fundamental research questions, which can be summarised as follows: (i) claims are affected by the size of the penalty/reward; (ii) individual decisions differ significantly from group decisions; (iii) individual claims are affected by the induction of a focal point *a là* Schelling. Experimental findings reported in this paper provide answers to each of these questions. With reference to the first question, although the size of the penalty/reward did not affect subject choices in the first-period, it played a key role in determining subjects' behaviour in a repeated game. In line with earlier literature, we found that a small penalty/reward leads to Pareto, whereas a large penalty/reward leads to Nash.

As for the second research question, we found that, in a one-shot game (i.e. the first-period of our experiment), groups behave more rationally in the sense that they were always closer to the Nash equilibrium. This finding was confirmed in the repeated game where we found that the group session was steadily closer to the Nash equilibrium than the control session; however, this 'rationality gap' reduced significantly when the value of the penalty/reward was set higher.

Finally, we tested the effect of a reference point on individual claims. Contrary to our expectations, we found that the reference point did not encourage coordination around the Pareto optimal choice, but rather it stimulated strategic behaviours, pushing individual choices towards the Nash equilibrium.

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