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The Simultaneous Evolution of Social Roles and of Cooperation
Some Experimental Evidence

by

Y. Varoufakis & S. Hargreaves-Heap

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Section 1 Coordination, Convention and Cooperation

Game theory approaches social interaction by drawing a sharp distinction between the strategic aspects of games and the social context within which games are played. The strategic aspects are identified with the pay-off structure and the rules of the game; and an implicit objective of the game theorist is to build all the necessary elements of social context into the pay-off structure thus preserving a strategic analysis of action.

Recent experimental work has cast considerable doubt on whether the influence of social context can be diffused in this manner. Ochs and Roth (1989) summarise the evidence from the laboratory which suggests that 'fairness' is so deeply etched in the minds of agents that the notion of strategy cannot be grasped independently of a shared moral motivation and a set of normative expectations. Agents seem to bring with them notions of justice and equity which motivate them to sway from actions based purely on the strategic structure of the game. Likewise Guth and Tietz (1988), Foddy (1989) and others have explored the effect that imported social context has on actual choices. On the other side of the debate, there is the argument that the strategic considerations will displace normative beliefs over time as subjects 'learn' to play the games (see Harrison and McCabe, 1991).

In this paper we report on experimental work which reinforces the view that social context plays a significant role. Some of the experiments here refer to a different type of game: one where cooperative strategies are dominated. And not only do we not find any clear tendency for strategic considerations to displace the influence of social context, we also contribute another angle to the debate over the role of social context. Prasnikar and Roth (1992) argue sensibly that the staying power of a player's non-strategic, moral considerations depends on the type of game chosen. Our experiments show that it also depends on the role a player has within a certain game.

In particular, our experiments suggest that social context matters both because it contributes to the selection of one equilibrium when there are many (ie it helps with coordination) and because it encourages players to behave in ways which are not consistent with instrumental rationality. In the latter case, the experiments show that players obtain a surprising degree of cooperation in games where cooperative strategies are dominated. The experiments have been designed to distinguish between whether these deviations from instrumental rationality arise from 'execution errors' or from a different type of motivation. We conclude that social context, in the form of a shared moral orientation towards cooperation which is capable of overriding instrumental concerns, explains these deviations. We also find that in some games with the same structure of dominated cooperative strategies, conventions emerge with the result that the inclination towards cooperation depends on the role played in the game. Two interpretations of such conventions are possible. The conventions either reflect the nuances of the shared moral orientation, which have been triggered by the slight changes in the game; or they have been generated endogenously in the play of the games.

Section 2 The five games and a list of conventional game theoretical predictions

None of our five games feature a clearcut equilibrium solution. They have a structure which creates antagonism as well as possibilities for cooperation between the players. There were five games which we list in the order of play. Game 1 is a simple, albeit indeterminate game. For expositioal purposes player R (who chooses a row strategy) will be assumed to be female and the C player male. Naturally in our experiments the gender of R and C players was determined at random.

	C1	C2
R1	+5,0-	-1,-1
R2	-1,-1	+0,5-

Game 1

This is a game in which players have an incentive to be aggressive (ie. strategies R1 and C2 for players R and C respectively) in order to win payoff 5, but also an incentive to acquiesce (strategies R2 and C2) in order to avoid the worst outcome (-1). In the absence of a unique equilibrium, each strategy is rationalisable since no strategy is dominated, and each strategy is in *a* Nash equilibrium. (Notice the + and - signs next to payoffs. Throughout the paper, they mark the best responses of R and C players respectively and so a coincidence of a + and - marks a Nash equilibrium in pure strategies.) In addition, there exists a third equilibrium in mixed strategies: R will choose R1 (C will choose C2) with probability 6/7, leaving R2 and C1 to be chosen with probability 1/7 each.

After this game was played four times, it was augmented through the addition of a third strategy per player - see Game 2. The third strategy offers players the chance to cooperate since, if both choose it, each gets 6. Compare this with the maximum of 5 in Game 1 that they can only get at the expense of their opponent who will receive nothing.

	C1	C2	C3
R1	+5,0	-1,-1	+10,-1
R2	-1,-1	+0,5-	-1,-2
R3	-1,10-	-2,-1	6,6

Game 2

From the strategic point of view game 2 is analytically identical to Game 1. The reason is that the third (that is, the cooperative) strategy is dominated. Even though cooperation (R3,C3) is Pareto superior to any of the outcomes in Game 1, neither player has an incentive to try to cooperate (ie. to play the third strategy R3 or C3) irrespective of what he or she thinks about the thoughts of his or her opponent. And if we assume that each thinks each other is instrumentally rational, then no one will ever *expect* anyone to play the third strategy. Therefore, instrumentally rational players should neither play cooperatively nor expect that they can ever win payoff 10 since (provided they believe others to be similarly rational) they should not anticipate cooperative behviour by others. Thus Game 2 collapses to Game 1.

There is, however, one game theoretical rationale for distinguishing between the two games. If players expect a 'mistake' to be made by their opponent with positive probability, then player R might think that strategy R1 is is more enticing in Game 2 than in Game 1. For instance, suppose there is a small probability of a mistake by Player C in Game 2 which results in C3, then R1 will be reward R with 10. [Compare this with what happens when player R chooses R2 and C mistakenly plays C3.] Similarly, player C may be more sympathetic to strategy C1 in Game 2 than in Game 1 if he thinks that there is a positive probability that player R will mistakenly play R3. For if this happens when C has opted for C1, then C receives 10, whereas C2 yields -1. In standard jargon, Game 2 has a unique trembling hand equilibrium: (R1,C1). It is the only equilibrium that remains once the payoffs (or rationality) of players begin to 'tremble'.

It is worth noting that there are conceptually two rather different reasons for a 'tremble'. A player may make a mistake, an execution error (this is the standard interpretation of game theory and poses no special problems since instrumental rationality still explains what we intend to do). Alternatively the player may *decide not to follow* the dictates of instrumental rationality (and this is rather more difficult for conventional game theory to swallow because it undermines their assumption of instrumental rationality). An example of the latter is a player who feels morally bound to play cooperatively (perhaps because they apply the Kantian categorical imperative) or because they more loosely feel bound 'to play fair', in the sense of cooperating when they expect others to cooperate. In the latter case, the achievement of mutual cooperation (R3,C3) would reflect an influence of social context in the form of a shared commitment to a certain sort of moral restraint on the pursuit of instrumentally rational actions. Whereas it would be a matter of pure serendipity if trembles emanating from execution errors produced mutual cooperation. Since, we are interested in the influence of social context, our experiments have been designed to help distinguish between these two cases.

In summary, game theory, so far, hazards the following predictions:

Prediction 1: Game 1 is symmetric and therefore, on average, R1 and C2 (R2 and C1) ought to be played with the same frequency.

Notice that the absence of a unique equilibrium precludes a specific (pure) strategy prediction. There is a stronger prediction that game theory can make based on equilibrium mixed strategies (EMS). The prerequisite however, is a

strong dose of common knowledge rationality (CKR). We mark game theoretical predictions based on this assumption (and expressed in EMS terms) with an asterisk:

Prediction 2*: In Game 1 strategies R1 and C2 will be played with probability 6/7, while R2 and C1 will be played with probability 1/7.

Prediction 3: When playing Game 2, strategies R3 and C3 will only be selected by 'mistake' (that is through execution errors or because the player has <u>chosen</u> to ignore the dictates of instrumental rationality).

Prediction 4: Strategies R1 and C1 will be played more often in Game 2 than in Game 1 when, and if, players expect trembles involving R3 and C3 to occur with positive probability (in theoretical terms outcome R1,C1 is a trembling hand equilibrium, whereas R2,C2 is not - even though both are Nash equilibria).

Game 3 enables a further check on the possible influence of dominated strategies on the play of a game. It differs from game 2 because C now receives only 1, instead of 10, when the outcome is (R3,C1). In other words we have introduced a further asymmetry because player R still receives 10 under outcome (R1,C3).

What extra game theoretical prediction does Game 3 generate? Nothing changes for player R. However, things are different for player C: Strategy C3 is no

	C1	C2	C3
R1	'5,0'	-1,-1	'10,-1
R2	-1,-1	'0,5'	-1,-2
R3	-1,1	-2,-1	6,6'

Game 3

dominated, for it is the best response to the expectation that R will play R3. Nevertheless it is still not rationalisable because it can be eliminated through the logic of successive elimination of dominated strategies once C realises that R has no reason to play R3 (for R3 is dominated). On the other hand, strategies C1 and C2 remain rationalisable. Therefore the *structure* of the decision problem for our players does not change significantly. Nevertheless, it is possible to argue that rational players may now have a greater tendency to coordinate on outcome (R1,C1). As before player C will play C3 if he is 'irrational'. In addition, he will choose C3 if he entertains a reasonably small probabilistic expectation that R is instrumentally irrational (that is, that R will choose R3)! So, the 'trembles' which may induce C to play C3 are perhaps more likely since they may be due to quivers in C's expectations about R, in addition to the trembles in C's own Reason. If this is so, and player R expects C3 from C with a greater probability than in Game 2, then player R may play R1 more often than in that game. In this case, the instrumentally rational player C may also play C1 more often in Game 3 because he expects a higher probability of R1 (based on the increased expectation that R will anticipate C3). In effect, outcome (R1,C1) may become a stronger trembling hand equilibrium than it was in Game 2. This thought takes the form of prediction 6.

Prediction 6 is preceded by one which is based on the fact that, outcome (R3,C3) [that is, cooperation] is as much out of equilibrium here as it was in Game 2.

Prediction 5: The frequency with which R3 and C3 (that is, the cooperative strategies) will be chosen should be the same across Games 2&3.

Prediction 6: Strategies R1 and C1 will be played with higher frequency in Game 3 than in Game 2 when players expect some trembles.

Moving on to the fourth game, its strategic structure is the same as Game 1; the only difference is that Game 4 is asymmetrical as player R receives -5 compared to C's -1 when their strategies land them in one of the two off-diagonal cells of the payoff matrix. Game theory has two predictions to make here; a weak and a strong prediction that resemble predictions 1&2* above. The weak prediction is that we cannot foretell which strategy rational agents will choose (both being rationalisable as neither dominates). The strong prediction is based on the usual EMS scenario which has it that R1 (R2) will be selected with probability 6/7 (1/7) - exactly as in Game 1 - and C1 (C2) with probability 2/3 (1/3).

	C1	C2
R1	$^{+}5,0^{-}$	-5,-1
R2	-5,-1	$^{+}0,5^{-}$

Game 4

The EMS prediction is rather strange. It suggests that player R, the one who is so obviously disadvantaged, should be equally agressive as in Game 1, whereas player C should be less aggressive than in Game 1. And all this as a result of the introduction of a payoff structure favouring player C! The predicted expected returns are (-1/7) for C-players (the same value that applied to either player in Game 1) and (-5/3) for R-players. We summarise as follows:

Prediction 7*: In Game 4, R-players will attempt to gain payoff 5 more often than C-players. More precisely, R1 will be played with

probability 6/7 and C2 with probability 2/3.

[Notice the asterisk which, as with the second prediction, indicates that this prediction too is based on an EMS scenario.]

Finally in game 5, the players were asked to play (four times, as with all games) a synthesis of Games 3 and 4.

	C1	C2	C3
R1	$^{+}5,0^{-}$	-5,-1	$^{+}10,-1$
R2	-5,-1	$^{+}0,5^{-}$	-1,-2
R3	-1,1	-2,-1	$6,6^{-}$

Game 5

There are now two types of asymmetry. The first is the same as the one that marked the difference between Games 2 and 3; namely, the fact that (R1,C3) yields 10 for R when (C1,R3) yields only 1 for C. Put baldly this provides an incentive for R to play R1 when there is a chance that C will cooperate, but C has no similar incentive. The second type of asymmetry is the same as the one that makes the difference between Games 1 and 4; namely, that when R chooses R1 while C has chosen C2, or when R chooses R2 while C chooses C1, player R gets -5 whereas player C gets -1. In other words, there is a clear advantage for player C. Is this advantage such that it can outweigh the advantage of R players which lurks in the top right hand cell of the matrix? Game Theory says, yes, unless there are trembles, because the latter is no advantage at all (since C3 is based on R3, which is dominated)!

More formally, when we compare Game 3 to Game 5. The structure of expectations and of the strategies they support has not changed. You can see this by comparing the + and - markings (which indicate optimal responses for each row and column strategy respectively) between the two figures: their location is identical. Thus, the dominated outcomes of Game 3 remain dominated here. Similarly with the rationalisable strategies (R1,R2,C1 and C2), the Nash equilibrium outcomes (R1,C1) and (R2,C2), and the unique trembling hand equilibrium (R1,C1). The only difference appears in terms of the equilibrium mixed strategy (EMS) scenario according to which strategy C2 will be played more frequently than in Games 1 2, or 3. However, this prediction hinges on EMS assumptions and therefore, due to their weakness, it may be considered a weak prediction. Thus, the asterisk.

Prediction 8* Strategy C2 will be played more frequently in Game 5 than in Game 3. Strategy R1 will remain equally popular as in Game 3.

It is worth noting that this EMS-based prediction conflicts with the trembling-hand logic as the latter may be utilised to argue that (R1,C1) becomes even more of an attractor here as strategy C3 may be chosen on the basis of an expectation that R3 will be chosen (irrationally). Finally, given the equivalence in the strategic structure of Games 3 and 5, game theory is obliged to predict that the cooperative strategies in these games face the same fate.

Prediction 9: Strategies R3 and C3 will be played in Game 5 with the same frequency as in Games 2 and 3 (that is when players tremble away from instrumentally rational action).

Section 3 The experimental framework

These games were played by a set of 138 volunteers (75 men and 63 women), divided into 13 groups ranging from 8-14 people (see Appendix A for a breakdown). Each person played every game four times, resulting in each game being played 276 times. Most of them, although not all, were University students (mainly undergraduates) from different faculties of Australian, Austrian, Greek and Hong Kong Univerities. None had taken courses on game theory. A small proportion of the participants were professional people, most of whom had a University degree; and as might be expected from this, the ethnic mix of the sample was diverse as was their career orientation, social class, ideology and general outlook.

The subjects in each group played the games without knowing who they were playing against. They knew that they were playing against *someone* in their group but could not pinpoint that person. Moreover, in each round they played against another random draw from the group, so the games were not of a repeated nature (as defined in formal game theoretical terms). Although each game (of the five we described above) was repeated four times, the fact that players did not know their opponent before or after a play of the game ensured that no player-specific reputation or signalling was possible. One can, however, argue that because the games were played by members of a group over and over again, social conventions could emerge specific to that group. If this were so (and we believe it was), then there are evolutionary elements that should be studied carefully.

The experiments were conducted as follows: Each player was assigned (at random) the role of player R or of player C. Then an R player was randomly paired with a C player. They were not told who they were paired with. We asked them to record two bits of information: (a) their prediction as to what strategy their opponent would choose, and (b) their own strategy choice. The purpose of (a) was to gain an insight into their thinking [that is, their 'beliefs' or expectations] which led to (b); the choices. Their payoffs were as in the payoff matrix and were translated into Australian dollars. For instance, if during a round of Game 2 outcome (R1,C3) occurred, then in that round player R won A$10 and C lost A$1. We started with Game 1 and then proceeded with the remaining four games. Each game was played four times before proceeding to the next. After the first rounds

of each game, roles were re-drawn and pairs re-constituted at random. The only constraint to the randomisation was that, in the four rounds of each game, each player had to play the role of R half of the time (that is, each player was R twice and C twice).

At the conclusion of each round, we announced to the group how the game was played without specifying *who* did what. For example, we would tell them that: 'In the last round 2 pairs reached outcome (R1,C2), 3 pairs reached (R3,C3) etc.' In this way, players were informed anonymously about how the game had been played by the group. In the end, each player received in cash the sum of his or her payoffs from all twenty rounds. At the outset we guaranteed a floor payoff of A$10 to ensure that the subjects would not drop out of the sample fearing a negative (or insignificant) final payout. Nevertheless, the minimum payment was A$11 (that is, the floor never became binding) and the maximum A$99. The average was A$47. Notice that this is quite a lot of money for students to make in less than an hour. We hoped that handsome rewards would engineer a high degree of concentration.

Section 4 The results

In this section we report on the results as they relate to the 9 predictions and we draw 3 interpretations from those results regarding the influence of social context. Table 1 offers a brief summary with regard to the frequency of the diagonal elements of our payoff matrices. The first two (R1,C1) and (R2,C2) are, in every game, Nash equilibria [recall of course that any outcome involving R1,R2,C1,C2 is rationalisable]. The third (R3,C3) is the cooperative outcome which, from a strategic viewpoint, is *not* rationalisable. Each row gives the aggregate frequencies of four rounds.

	Outcome (R1,C1)	Outcome (R2,C2)	Outcome (R3,C3)
Game 1	50 (34)	38 (34)	N/A
Game 2	77 (34)	0 (34)	67 (0)
Game 3	51 (34)	0 (34)	69 (0)
Game 4	39 (78)	98 (26)	N/A
Game 5	58 (78)	0 (26)	54 (0)

A summary of the incidents of Nash Equilibria (R1,C1) and of (dominated) cooperation (R3,C3). Each row of the table is the sum of the observations from the four rounds of each game. The numbers in brackets are the predictions based on the EMS scenario (as contained in 2' and 7'). Note that these predictions are relevant only to the extent that each round can be construed as a one-shot game. Although each game in isolation is played as a one-shot incident, group learning could lead to deviations. Nonetheless, the comparison of expected and actual frequencies remains indicative. More information can be found in the first rows of Tables 3&4 which contain the data on a round by round basis.

Table 1

The first inference is that **Predictions 1&2*** seem to fail. Although the first game is utterly symmetrical, there seem to be a significant bias in favour of R players in the sense that they get A$5 50 times compared to C players who get the same amount only 38 times. Furthermore, the observed frequency of R1 and C1 lends no comfort to Harsanyi's view that agents, on average, behave *as if* according to equilibrium mixed strategies (EMS) in a manner that reflects their uncertainty about their opponents, even when they may not follow consciously the EMS pattern. We offer the following interpretation of the result from game 1.

Interpretation 1: Agents seem able to draw on a social context which prioritises R and so they achieve a surprising degree of coordination around (R1,C2) in game 1.

To support this interpretation of the data, notice that the surprising degree of asymmetric coordination around (R1,C1) cannot be explained by the presence of some hidden, but shared personal characteristics of R players which differ from those which are also hidden and shared by C players. In other words the personal characteristics of R and C players cannot explain the asymmetry because, it will be recalled, that all the players took on the R and C roles with the same, equal frequency. Hence, if the coordination is not a statistical fluke, then it must arise because individuals have a social context which they draw upon in a similar way with the result that they prioritise the R role when playing R and concede to R when playing C. But what part of the social context might be responsible for this? It is difficult to find anything in the neutral descriptions of 'row' and 'column' which might connect with some shared moral orientation, so it hardly seems likely that the social context is supplying some shared moral framework which in turn explains the coordination. Rather we conjecture that influence of social context comes from the shared practice of reading from left to right. This practice automatically prioritises rows over columns (since it means we read rows first and only then look at the columns) and so role R plausibly gains a salience that C-players also recognise. There is no hard evidence on this. But, the sample included a number of subjects (13) whose first language was Chinese or Korean and who are used to reading matrices columns-first. Unlike the rest of the population, they were not attracted to (R1,C1) as often as the others. [Overall, in Game 1 Rs went for the $A5 203 times as opposed to the Cs who were similarly ambitious 187 times. Our sample of 13 Chinese and Korean displayed an opposite tendency: 29 choices of C2 and only 23 of R1.]

Turning to **Prediction 3**, game theory predicts no cooperative play in the absence of trembles. Table 1 shows significant mutual cooperation (and cooperative play is even more widespread, see tables 3 and 4). While this is not a test of the prediction, if we accept the premise then we would conclude from the evidence that there were significant trembles and this conclusion is supported by the evidence regarding **Prediction 4**. Outcome (R2,C2) disappears entirely from Table 1 as we move to the second game and this is predicted as trembling hand equilibrium.

We offer the following interpretation of these trembles.

Interpretation 2: People play cooperatively, in part, because they are morally motivated and thus a social context which provides a shared moral orientation explains, in part, the achievement of mutual cooperation.

Several arguments, based on the experimental evidence, can be made in support of this interpretation. Firstly, the degree of mutual cooperation simply seems too high to be explained by individual acts of cooperation which come from execution errors. Remember that when an R player expects cooperation (that is, C3) because C trembles then she can play R1, collect A$10, and condemn the C player to losing one dollar. Thus a simulataneous tremble in this direction is required to achieve mutual cooperation. And yet, we have 67 instances of successful cooperation in the second game, 69 in the third and 54 in the fifth. In short, either our subjects were so prone to trembling that they often trembled together (and so avoided the trap of being too clever for their own good) or they were motivated to behave differently.

Secondly the experiment generated data on the expectations which players entertained regarding the play of their opponent and again this points to a motivated departure from the dictates of instrumental rationality. Tables 2, 3 and 4 summarise this evidence. Table 2 breaks down the data on the basis of the R and C dichotomy. The first two columns summarise for each game the incidence of consistent choices of the first and second strategies. By *consistent choice* (labelled CON) we mean a choice of strategy i (i=R1,R2,C1,C2) underpinned by an expectation that one's opponent will play strategy j (j=C1,C2,R1,R2) respectively. That is, the CON variables tells us the number of times the first and second strategies were chosen in a manner consistent with the choosers' expectations (or, using the term advisedly, rationally). For example, if you are a C player in any of the games and you have chosen C1, then your choice is listed as consistent only if your expectation concerning your opponent's choice was R1. We compute these variables only for the two 2X2 games (the first and the fourth) because the intrusion of the third strategy makes it more difficult to make sense of such 'consistent' choices.

For games 2,3 and 5 we compile two other variables which we think are more informative in the presence of the third strategies. The third column (labelled P3P3; standing for 'predicted strategy 3 and chose strategy 3') tells us how many times a cooperative strategy was played *when the person who played it was anticipating cooperation*. We call this reciprocal cooperation. The 'Cheat' column relates the cases in which a player expected cooperation (that is, expected the third strategy) and chose to take advantage of this by playing strategy 1. Henceforth we refer to this as *cheating* (or 'zapping' in postmodern dialect). Tables 3 and 4 give a more detailed breakdown of these same statistics for each round of each game.

These tables suggest a very high incidence of people who choose cooperation when they expect their opponent to cooperate. Indeed, the overwhelming majority of people who play cooperatively have predicted that their opponent will play cooperatively (for instance, in the first round of game 2, 37 row players played cooperatively and 30 of them predicted that their opponent would play cooperatively). Thus a prediction of cooperation is closely associated with playing cooperatively, yet there seems no strong reason for supposing that execution errors should be related in this way to individual predictions. When execution errors are random (which seems to be the standard view of game theory) then a prediction that your opponent will make an error towards cooperating would not make it any more likely that you make a similar error. On this account your errors are independent of your predictions. Alternatively, if errors are more likely when the perceived cost of such errors is low, then we should expect fewer execution errors when the individual predicts cooperation.

Thirdly, the evidence on consistency and cheating also supports this interpretation because our sample in other respects seems to demonstrate and act upon an instrumental understanding of the game. This may not be obvious in the consistency data because at first sight players neither demonstrate high levels of consistency in game 1 nor in game 3. In other words, execution errors would appear to be present in these experiments because trembles from instrumental rationality occur when moral motivation has no obvious contribution to make. Nevertheless, in a result which we report fully later (in table 7), there is a positive correlation between those who choose consistently and those who play cooperatively after a prediction of cooperation. The evidence on cheating also indicates that while our sample does make mistakes, it is sensitive to the changes which are suggested by instrumental reason. To see this, for instance, notice that it is purposeless for Cs in games 3 and 5 since it is strategically dominated by cooperation (ie. C3). The data bears this point out as the occasions of *cheating* by Cs drops from 60 in Game 2 to 12 and 11 in Games 3 and 5.

Finally Table 5, which gives the actual ex-post average pay-offs from each strategy, demonstrates that there were significant gains to be made by switching from the cooperative strategies to R1 or C1. In other words, if cooperation came from 'execution errors', then these 'errors' were costly and one might expect agents to learn from their mistakes quite quickly in these circumstances. Instead, there is only a gradual growth of cheating by R players and no change by C players.

Predictions 5&6 are more difficult to assess. This is not obvious at first glance since with regard to the latter, table 1 shows that the trembling hand equilibrium outcome (R1,C1) not only does not become more prevalent, but that its frequency declines significantly. Thus it seems **Prediction** 6 fails and this tells against the earlier interpretation which favoured a trembling hand interpretation of the results. The assessment of **Prediction** 5 also seems straightforward: it appears to receive support since the number of successful cases of cooperation is remarkably similar in Games 2 and 3 - see Table 1. But, when we look at Tables 2,3 and 4, we notice the following:

(a) From Table 2, it transpires that **R players act cooperatively** when they anticipate cooperation from their opponents (P3P3, to use our earlier label) with a

diminishing frequency as we move from Game 2 to Games 3 and 5 (thus supporting those who claim strategic considerations gradually displace social context). The last column in Table 2 provides a clue: R-players take the opportunity to 'cheat' a lot more. But on the other hand, **C players display the opposite trend:** P3P3 instances grow from 77 in Game 2 to 107 in Game 3 and 127 in Game 5 (thus confounding any simple assertion that strategic considerations gradually dominate).

(b) Tables 3 and 4 offer more detail. P3P3 in Games 3 and 5 occur more often in the case of Cs *in every round*. The difference is far less pronounced in the case of Game 2. Indeed, while R and C players are as likely to be P3P3ers in Game 2, by Game 5 R players are half as likely as C players to be P3P3ers.

Row Players

ROW PLAYERS	CON-R1 - ie. Consistent Choice of Strategy R1 (ie. predict C1 and play R1)	CON-R2, ie. Consistent Choice of Strategy R2 (ie. predict C2 and choose R2)	P3P3 - ie. predicting C3 and playing R3	Cheat - ie. predicting C3 and playing R1
Game 1	84	49	-	-
Game 2	-	-	80	89
Game 3	-	-	76	130
Game 4	75	110	-	-
Game 5	-	-	60	148

COLUMN PLAYERS	CON - C1 Choice of Strategy C1	CON-C2 Consistent Choice of Strategy C2	P3P3 - ie. predicting R3 and playing C3	Cheat - ie. predicting R3 and playing C1
Game 1	58	66	-	-
Game 2	-	-	77	60
Game 3	-	-	107	12
Game 4	51	110	-	-
Game 5	-	-	127	11

Total number of choices in games 2,3 and 5 = 138x4x3 = 1656; Total number of P3P3 choices = 527; Average of P3P3 incidence = 32%; Average for Rs = 26%; Average for Cs = 38%; Number of P3P3 for Rs minus the number of P3P3 for Cs:

Game	Mean	Standard Deviation
2	-1.75	6
3	-7.75	5.12
5	-14.25	9.17

Comparing Consistent Choices in games 1&4 with P3P3 in games 2,3 and 5

Table 2

The Observed Behaviour of Subjects when Playing the Role of Player R

	C1	C2	C3	R1	R2	R3	CON-R1	CON-R2	P3P3	Cheat
	18	51	-	49	20	-	12	14	-	-
Game 1	29	40	-	47	22	-	22	15	-	-
	29	40	-	53	16	-	26	13	-	-
	29	40	-	54	15	-	24	10	-	-
	20	5	44	31	1	37	13	1	30	14
Game 2	26	2	41	36	2	31	18	0	23	17
	27	3	39	38	1	30	17	0	18	20
	23	3	43	44	1	24	17	0	18	24
	9	2	58	42	0	27	7	0	25	33
Game 3	15	10	44	47	2	20	11	1	16	28
	12	3	54	45	1	23	9	0	20	33
	17	3	49	50	0	19	13	0	13	36
	21	48	-	44	25	-	19	23	-	-
Game 4	24	45	-	38	31	-	21	28	-	-
	28	41	-	27	42	-	18	32	-	-
	22	47	-	38	31	-	19	28	-	-
	11	4	54	41	1	27	8	1	24	30
Game 5	15	4	50	50	2	17	10	0	11	38
	12	3	55	58	0	12	11	0	10	45
	19	2	47	50	1	17	16	1	13	34

The above table relates the observed behaviour, as well as the predictions, of our participants while playing the role of player R. The first three columns tell us how many times C1, C2 and C3 were *predicted*. The next three columns tell how many times R1, R2 and R3 were *chosen*. Columns labelled Rat. R1 and Rat. R2 indicate how many times R1 and R2 were chosen in a rationalisable manner; that is, how many times player R played R1 (R2) because of an expectation that C would play C1 (C2). Column labelled 'Pred C3 Play R3' tells us how many times a row player predicted C3 and responded by R3 (that is, the number of cooperative moves supported by a belief that the C player would also cooperate). Finally, 'Cheat' gives us the number of incidents when an R player anticipated C3 (ie. cooperative behaviour by C) and chose to 'defect' and go for the A$10 payoff instead.

Table 3

The Observed Behaviour of Subjects when Playing the Role of Player C

	R1	R2	R3	C1	C2	C3	CON-C1	CON-C2	P3P3	Cheat
	56	13	-	22	47	-	17	8	-	-
Game 1	47	22	-	27	42	-	18	13	-	-
	40	29	-	25	44	-	15	19	-	-
	37	32	-	15	54	-	9	26	-	-
	24	2	43	30	4	35	13	1	26	17
Game 2	26	2	41	32	5	32	16	1	25	16
	28	3	38	25	4	40	15	2	28	10
	33	0	36	41	1	27	22	0	17	19
	35	3	31	19	2	48	14	0	26	5
Game 3	33	1	35	16	3	50	11	1	29	5
	37	3	29	15	5	49	15	2	27	0
	42	0	27	20	2	47	17	0	23	3
	44	25	-	21	48	-	18	22	-	-
Game 4	39	30	-	21	48	-	16	25	-	-
	31	38	-	14	55	-	10	34	-	-
	36	33	-	12	57	-	8	29	-	-
	36	3	30	17	4	48	13	2	25	4
Game 5	38	0	31	19	4	46	18	0	29	1
	29	2	37	16	4	48	12	1	32	4
	38	0	32	18	4	48	16	0	29	2

The above table relates the observed behaviour, as well as the predictions, of our participants while playing the role of player C. The first three columns tell us how many times R1, R2 and R3 were *predicted*. The next three columns tell how many times C1, C2 and C3 were *chosen*. Columns labelled Rat. C1 and Rat. C2 indicate how many times C1 and C2 were chosen in a rationalisable manner; that is, how many times player C played C1 (C2) because of an expectation that R would play R1 (R2). Column labelled 'Pred R3 Play C3' tells us how many times a row player predicted R3 and responded by C3 (that is, the number of cooperative moves supported by a belief that the R player would also cooperate). Finally, 'Cheat' gives us the number of incidents when a C player anticipated R3 (ie. cooperative behaviour by R) and chose C1 instead.

Table 4

Average Payoffs per Strategy per Player	Row Players			Column players		
	R1	R2	R3	C1	C2	C3
	0.59	-0.45	N/A	-0.41	.45	N/A
Game 1	0.96	-0.5	N/A	-0.22	.43	N/A
	1.30	-0.31	N/A	-0.2	0.5	N/A
	0.11	-0.27	N/A	-0.27	0.26	N/A
	6.68	-1	2.97	5.3	-1	3.2
Game 2	6.61	-1.5	2.9	3.4	-1.6	3.06
	7.45	-2	3.27	4	-1.5	2.15
	6.57	-2	2.2	3.17	-1	1.85
	8.33	N/O	4.18	0.26	-2	1.95
Game 3	8.13	-2	4.25	0.19	-1	1.24
	7.89	0	3.86	0.46	-1	1.4
	8.08	N/O	4.53	0.15	-1.5	1.28
	-1.81	-2	N/A	-0.24	0.84	N/A
Game 4	-1.84	-1.13	N/A	-0.43	1.54	N/A
	-2.78	-1.07	N/A	-0.64	2.6	N/A
	-2.63	-0.48	N/A	-0.25	1.98	N/A
	8.29	-0.5	3.63	0.47	-1.5	1.95
Game 5	7.36	-0.5	4.77	0.16	-1.25	1.13
	8	N/O	4.25	0.06	-1.5	0.31
	7.56	-2	4.35	1.28	-2.25	0.81

where N/O indicates 'no observations' and N/A 'not applicable' Payoffs per strategy for each player (on average)

Table 5

Thus the overall unchanged level of mutual cooperation between games 2 and 3 (and 5) masks an important set of changes in behaviour which are role specific. R players cooperate less while C players cooperate more. This same fact explains why the incidence of (R1,C1) does not rise because although R plays R1 more frequently, C is increasingly playing C3. (Notice also this evidence affords further support for **Interpretation 2** because a execution error interpretation of trembles would now have to improbably argue that the tendency to error evolves over time in this way and differently depending on role!)

We offer the following interpretation of this result.

Interpretation 3: An asymmetric convention has been generated endogenously in the playing of these games which modifies the influence of social context.

Note that the asymmetric play cannot be explained through reference to the personal characteristics of the people who play the R and C roles because each subject plays both roles with equal frequency. Accordingly the asymmetry must come from each subject increasingly regarding the play of the R role as different from the play of the C role. In particular, whereas we have argued that social context in the form of a shared moral orientation explained why both R and C players would play cooperatively with roughly equal frequency in Game 2, by the conclusion of Games 3 and 5 the subjects follow a convention which loosens the grip of this moral orientation on R players while intensifying it for C players.

What is the source of this asymmetric convention? Formally, the playing of Games 2, 3 and 5 only differ because the pay-offs to each role are different; otherwise the rules and structure of the game were identical. In this sense, the difference must reside in characteristics of the role. Of course in the real world, when two players meet and this asymmetric array of pay-offs captures the interaction, the asymmetry could in part reflect personal differences as well as the structure of the interaction. But to repeat: in this experiment we have purged the influence of personal characteristics by assigning each player with equal frequency to each roles and built the asymmetry into the structure of the interaction through asymmetric pay-offs.

Furthermore it is not difficult to see how the asymmetry might have arisen between Games 2 and 3, at least as far as the R role is concerned: just inspect the pay-offs. There is an encouragement for R to play R1 in Game 3 as compared with Game 1. However, it is only an encouragement once 'trembles' are expected. Thus it depends on an expectation of 'trembles' which we have associated with the existence of a shared moral orientation. Games 4 and 5 provide an interesting comparison in this regard because they build asymmetry into what conventional game theory regards as the basic structure of the game---that is, the asymmetry in the pay-offs is to be found in the undominated part of the matrix. However, in this instance, the asymmetry favours C players. Yet the results for Game 5 show the same pattern of R cheating while C cooperates. In other words, the asymmetry which comes from acknowledging a shared moral orientation (and that makes the third column relevant) seems to dominate a contrary asymmentry which would otherwise seem to be the salient one.

Indeed it is difficult to escape the conclusion that a background shared moral orientation is playing a significant part in these results once we turn to the explanation of why C players increasingly cooperate. After all, there is an incentive for C players to play cooperatively provided they expect some cooperation from R players (that is, they share a moral orientation). So some degree of cooperation might be expected, but why does it increase as R players demonstrate less cooperation? Of course, the ex-post return from cooperation, although falling, remains almost always above the ex-post return from any other strategy in Table 5, so perhaps an instrumental logic is reasserting itself here. But against this, the ex-post returns were not important in the choice of strategies in Game 2, when it favoured switching to C1. Instead, the rising cooperation seems more likely to reflect some developing feature of the way that a moral orientation is affecting play by C.

Two interpretations seem possible. First, we may be witnessing a piece of 'wishful thinking' in the sense that C players hope to encourage R players away from R1 by showing an ever stronger willingness to cooperate. Perhaps in support of this view there is further evidence on the distinctiveness of the two roles in the data on predictions of opponent play. In particular, our players predicted correctly their opponents play when in the R role 824 times. When assigned the C role, the number of correct forecasts fell to 750 (see Appendix B for more detail). Furthermore, the differential in forecasting success is greatest in the case of Games 3 and 5.

Alternatively, the social context of a shared moral orientation might itself contain an acknowledgement that morality is, as Nietzsche suggested, the recourse of the 'weak'. The column role is undoubtedly the 'weak' role and it does increasingly encourage a moral orientation towards cooperation. Perhaps the introduction of the asymmetry in the game enables the players to identify the 'weak' and the 'strong' and so implement their shared Nietzschian perspective on moral orientations. This, however, seems a rather far-fetched interpretation of Cs' behaviour. Firstly, it would be difficiult to reconcile with the influence of moral orientations when there is no clear asymmetry. Secondly, given the controversial status of Nietzsche's views, it would be extremely surprising to find that his views were influential in this way across such a varied ethnic sample of players.

Consequently, it seems more plausible to argue that a Nietszche-like convention has been endogenously generated in the playing of these games through a suitable asymmetric change in the pay-offs.

Let us now turn to the specific predictions associated with the last two games. First to Game 4. Recall **Prediction 7*** which suggested that Rs would receive the $5 three times more often than the Cs. In reality the Cs got the $5 98 and the Rs 39. Table 2 shows that, in comparison with Game 1, our players chose

consistently more often in Game 4 (257 times in Game 1 and 346 in Game 4). One reason is, of course, that they progressively got the hang of our games. There may be an additional reason: the introduced asymmetry which makes it easier to read a game in which one side has a clear advantage.

Tables 3 and 4 (see the entries corresponding to Game 4 in the first two columns of each table) confirm that our subjects predicted (before choosing their own strategies) the advantage that Cs would enjoy. There is only one conclusion to be drawn: The equilibrium mixed strategy story (EMS) predicts quite awfully: contrary to Harsanyi's rationalisation of equilibrium mixed strategies (EMS), it is clear that our population did not, on average, entertain expectations consistent with EMS. Also note the fact that the subjects had already played other games which might have created a certain intertia, is not credible. For the previous games generated a bias against the Cs. EMS predicts that Game 4 would favour the Cs. If anything, our subjects swam against the tide of 'group learning' in order to violate the EMS scenario.

Lastly, in Game 5, we find no evidence to support the greater use of C2 in this game (**Prediction 8***); and this is hardly surprising given the absence of any evidence earlier in support of EMS behaviour. Finally we have already noted that contrary to **Prediction 9** the play of R3 falls while the play of C3 rises between Games 5 and 2.

Section 5 A few indicative associations

In this section we draw attention to statistical associations between the frequency of cooperative behaviour and other variables. These associations are designed to provide a statistical support for some of the arguments in the previous section, especially those around **Interpretations 2 and 3** concerning the determinants of cooperative behaviour.

A 'Z' variable was compiled as follows: For each session and every round we subtracted the number of times players *predicted* cooperation on the part of their opponents (in Games 2,3 and 5) from the number of times they *chose* cooperatively. For R (C) players, variable Z equals the third row of Table 3 (Table 4) minus the sixth row. We like to think of Z as an index of the *inverse* of the willingness to cooperate (for Games 2,3 and 5). As Z rises, we imagine players become less willing to cooperate. Alternatively, the greater Z the larger the distance between predictions of cooperation and cooperative attempts. Table 6 reports.

Z-analysis

	Overall	Rows	Columns	Row-Men	Row-Women	Column Men	Column Women
Mean	0.53	0.71	-0.19	0.778	0.67	-0.2	-0.21
St. Dev.	0.49	0.4	0.54	0.48	0.49	0.61	0.68

Out of 13 sessions, in 8 the value of Z (across all four rounds) rose from Game 2 to Game 3 while it fell in 7 from Game 3 to Game 5.

Table 6

Table 6 confirms that the un-willingness to cooperate differs across roles, pointing to the existence of a convention. The difference in our Z index between R and C players is highly significant. As expected, Cs are a lot more willing to risk cooperative behaviour than Rs, even though each player plays the both roles. Next, we focus on another statistic, one which measures the frequency of consistency by our subjects in Games 1 and 4 and which we encountered earlier. Recall the CON variables in Tables 2, 3 and 4. They record the number of times a certain strategy was chosen when the expectation on which the agent based his or her choice was consistent with the actual choice. For example, in either Game 1 or 4, a C-player who played C2 when he expected R to play R1 has chosen inconsistenly. Table 7 presents a correlation matrix involving the following variables: (i) The total number of consistent choices in Games 1 and 4, (ii) P3P3 (that is, instances of reciprocal cooperation in Games 2,3 and 5), (iii) Z (our index of the un-willingness to cooperate), and (iv) the estimated time trend parameter of P3P3 in each session and across the twelve rounds of Games 2,3 and 5 (the parameter was estimated by means of a semi-log trend including dummies for each game).

	CON	P3P3	Z	TREND
Mean Consistent Play in Games 1&4 [CON]	1	0.42647	0.234	0.304
Mean 'Predict Strategy 3 and Play Strategy 3' [P3P3]		1	-0.76	0.3231
Z			1	-0.65
TREND of P3P3 (estimated by a semi-log trend regression)				1

Variables CON, P3P3 and Z are adjusted for population size for each session. The trend variable is a parameter estimated by means of a semi-log trend regression in each session which includes dummy variables for each game. In other words, that parameter is positive for sessions in which the P3P3 trend over time is positive after having controlled for the changes engendered by the differences between games 2,3 and 5.

Table 7

Table 7 gives the result, referred to earlier, which finds that consistency is positively associated with the behaviour P3P3. It also shows that a positive correlation between the consistency variable and 'growth' of reciprocal cooperation. Finally on a smaller point, notice the correlation between P3P3 and the trend of P3P3 (0.32). Conceivably, a declining (rising) incidence of reciprocal cooperation is more likely when the mean is lower (higher) if agents' attitudes depend on the group's dynamics.

The results in Table 7 are strengthened by the reflection that the other correlations are also consistent with common sense. For example, it reports (as anticipated) a strong negative link between the un-willingness to cooperate (Z) and reciprocal cooperation (P3P3). Similarly with the inverse relationship between Z and the trend of P3P3. Another way of making use of these varibales is to run a regression. The implied causality runs from variables CON and Z to P3P3. This is a defensible proposition on logical grounds since the willingness (or otherwise) to cooperate and the logical consistency of choices in Games 1 and 4 must, surely, be determinants of the decision to predict cooperation and to respond cooperatively to such a prediction. We estimated two specifictions, one for the R and one for the C role.

The case of Rs

$$P3P3 = \underset{(1.16)}{-7.32} \; \underset{(-3.23)}{-2.9\,Z} \; \underset{(3.7)}{+2.7\,CON} \qquad R^2\% = 58\%$$

(t-ratios in brackets)

The case of Cs

$$P3P3 = \underset{(1.95)}{16.72} \; \underset{(-1.18)}{-1.59\,Z} \; \underset{(3.9)}{+3.95\,CON} \qquad R^2\% = 35\%$$

The difference in constant terms indicates both a greater optimism and a greater determination regarding cooperative behaviour on the part of the C-role. For role R, it is clear that our index of the un-willingness to cooperate is a prominent determinant. However, it does not work so well for the C role. Could it be that the C role engenders such a strong cooperative norm that positive expectations (such as those that define Z) become less important than normative expectations? Perhaps there is a complementary explanation of why Cs' reciprocal cooperation turned out to be relatively inelastic to reductions in expectations of cooperation by R players? Setting such speculation aside, the one message that comes across 'loud and clear' is the robust positive effect of consistent play in Games 1 and 4 on reciprocal cooperation in Games 2,3 and 5. It points to the possibility that players can be, at once, consistent and cooperative.

	R- P3P3	C- P3P3	R- Cheat	C- Cheat	R Z	C Z	CON
Row P3P3	1						
Column P3P3	0.68	1					
Row Cheat	-0.34	0.18	1				
Column Cheat	0.032	-0.29	-0.53	1			
Row Z	-0.39	-0.026	0.86	-0.59	1		
Column Z	0.24	0.016	-0.5	0.67	-0.49	1	
Consistent Play in Games 1&4	0.35	0.2	-0.16	-0.09	-0.04	0.07	1

Table 8

Table 8 offers a disaggregated view of Table 7 for Rs and Cs. The additional insights from Table 8 are, mainly, (a) the strong correlation between R players unwillingness to cooperate and their willingness to 'cheat'; (b) the positive correlation between CON and P3P3 which is significantly stronger for the R role; (c) the negative correlation between CON and the propensity of Rs' to 'cheat'. The latter suggests that acting with consistency in Games 1 and 4 does not go hand in hand with cheating in the 3X3 games. By constrast, consistency in the 2X2 games corresponds better to incidents of reciprocal cooperation in the 3X3 games.

Summary and Concluding Remark:

Conventional game theory generates several predictions with respect to these games which are not obviously borne out by the results (for instance, **predictions 1, 2* 7* and 8***). The anomalies, as far as **predictions 1** and **2** are concerned, are consistent with the influence of a social context which prioritises row players. Once conventional game theory admits 'trembles', the evidence from our games is consistent with some of its predictions (for instance, **prediction 3, 4, 5 and 9**). However, it is difficult to interpret these 'trembles' as 'execution errors'. Rather the evidence suggests that they reflect an influence of social context in the form of a shared moral orientation towards cooperation which overrides instrumental calculation. This interpretation together with the additional recognition of a Nietzsche-like convention, which applies this orientation differently depending on role, helps explain better the disaggregated evidence on **prediction 5 and 9** and it helps explain the failure of **prediction 6**.

In short, although the importance of strategic considerations is not in doubt, this paper provides further evidence on the importance of social context. Social context, in the form of a shared moral orientation, seems able to override strategic calculation based on instrumental rationality. Our main new finding is that the extent to which these normative expectations matter in shaping an agent's choices varies, not only with the type of game played, but also with the social role assigned to the player. Thus it is not merely a question of players having imported

into the laboratory unbending moral positions that lead to deviations from payoff-driven, strategic behaviour. Instead, players' cooperativeness *evolves* in the course of the experiment along with the social roles that are alternately assigned to each one of them. Somewhat surprisingly a Nietzsche-like convention emerged with the result that the 'weak' role became increasingly cooperative while the 'strong' role became increasingly less cooperative.

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APPENDIX A: The total number of protagonists in each session and the gender breakdown

Session	Male	Female	Total
1	5	3	8
2	5	5	10
3	5	5	10
4	5	5	10
5	7	3	10
6	6	6	12
7	3	9	12
8	3	9	12
9	4	4	8
10	8	2	10
11	8	6	14
12	10	2	12
13	6	4	10

APPENDIX B: The number of correct predictions of players' choices in each session. The first number in each cell coresponds to the number of correct predictions by R players and the second to the correct predictions by C players.

Session	Overall appr. per centage of correct R and C predictions	Game 1	Game 2	Game 3	Game 4	Game 5
1	54%-53%	9 - 10	12 - 11	9 - 5	9 - 8	4 - 8
2	62%-52%	14 - 11	13 - 13	15 - 8	9 - 13	11 - 7
3	57%-65%	12 - 9	7 - 11	12 - 10	13 - 12	13 - 7
4	54%-66%	11 - 14	9 - 13	11 - 11	12 - 15	11 - 13
5	59%-69%	13 - 12	13 - 14	9 - 15	14 - 12	10 - 16
6	53%-62%	12 - 13	10 - 13	18 - 15	10 - 16	14 - 17
7	62%-49%	15 - 14	13 - 14	18 - 17	18 - 12	10 - 14
8	56%-50%	15 - 15	12 - 14	10 - 8	17 - 9	13 - 14
9	53%-48%	8 - 8	6 - 5	9 - 10	11 - 11	8 - 4
10	65%-58%	8 - 10	11 - 11	12 - 10	18 - 18	16 - 9
11	66%-55%	14 - 16	17 - 19	21 - 13	16 - 15	24 - 14
12	54%-43%	17 - 8	11 - 12	14 - 11	12 - 12	11 - 9
13	56%-42%	12 - 10	7 - 9	13 - 8	11 - 7	13 - 8
Game Sum	60%-54%	160/150	141/159	171/141	170/160	182/140

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