Trying to Overcome Coordination Failure in a Tough Environment*

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April 2013

Abstract

Using experimental methods, this paper investigates whether leadership can be successful in overcoming a history of coordination failure in a tough environment. The environment is a weak-link game in which a player's payoff is positively related to the minimum effort in the group and negatively related to his own effort. All players exerting a high effort is the payoff dominant Nash equilibrium, but the parameters are such that the benefits of coordination are low compared to the cost of mis-coordination. Given this tough environment, play converges to the most inefficient equilibrium in the initial phase of the experiment. We then explore whether the introduction of a leader would help the group to climb out of the coordination trap. We consider two types of leader: a cheap talk leader who suggests an effort level, and a first mover whose choice of effort is observed by the rest of the group. We use the strategy method to measure the responsiveness of the followers, and we also elicit the leader's beliefs about the followers' response. Some leaders exhibit strategic teaching behavior, and most followers are quite responsive towards the leader's choice. The first mover treatment has a higher proportion of matching strategies, in which followers replicate the leader's choice. However, no group escapes the coordination trap, due to some leaders choosing the lowest effort or due to a minority of followers who chose the lowest effort in response to any choice of the leader. Leadership changes the behavior of some players in the short run but has little effect on the minimum group effort in both short and long run.

Keywords: minimum effort game, coordination failure, leadership, learning

JEL Codes: C92, D23, D83.

*This work has been financially supported by CeDEx and the authors would like to thank CeDEx for providing access to experiment infrastructure.

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1 Introduction

In the contemporary society, excellence is rarely determined by a single element. Instead, a successful outcome usually means the coordination of a set of key elements. For example, the overall performance of a restaurant depends on the coordination of the manager, the chef and the waitress. If one element in that group fails, the overall result will be largely affected.

This paper attempts to model certain aspects of such a situation using a simple coordination game. Specifically, we are focusing on the strategic interactions between different parties. In this game, each player's payoff not only depends on his own choice but also on the minimum choice in his group. This is to model the situation where the final outcome is determined by the weakest link in the production chain. This game is therefore called minimum effort game or weak-link game in the literature. Everyone prefers a larger minimum, while anybody picking a number higher than the overall minimum will be penalized.

Van Huyck *et al.* (1990) are among the early pioneers to study this game experimentally. As opposed to Harsanyi and Selten (1988)'s concept of payoff dominance, they show that failure to coordinate on the efficient outcome is persistent in laboratory setting. They pointed out that coordination failure[1] is due to the high degree of strategic uncertainty. In other words, each player faces unknown probability about other players' decisions. This phenomenon has been confirmed by later studies (Camerer, 2003) and has led to an active research agenda to find a solution to raise the efficiency of coordination through changing certain features of this game. Recent studies about minimum effort game suggest that coordination failure could be *prevented* given certain mechanisms. Examples include communication, competition and group identity (see section 2 for the related literature).

However, another question worth asking under the coordination game setting is how one can climb out of coordination failure once the group is already trapped there. This question is interesting due to the fact that life is an ongoing process: a mechanism that works with zero-experience groups might not work with groups what have a certain history. A system that helps to start a new company might not work in terms of restructuring the company. Since the repeated version of the minimum effort game features a path-dependent dynamic[2], it is therefore natural to ask whether tools that help to prevent coordination failure will still work in terms of getting groups out of it.

[1]There are two possible ways of interpreting coordination failure in minimum effort game. In this paper, coordination failure generally refers to a situation where subjects coordinated on a Pareto-dominated equilibrium. The other situation where subjects do no exert the same effort thus not coordinate at all is referred to as "mis-coordination" in this paper.

[2]Path-dependence means the behaviour in the current period depends on the behaviour in previous periods. See more in section 2

This paper directly tackles the research question of whether an organization can *overcome* coordination failure by focusing on two specific mechanisms. One mechanism involves communication. It is to mimic the situation where one of the group members could suggest a coordination point for group members to follow. The other mechanism is to allow a randomly picked player to act as leader moving prior to his followers. Both mechanisms have been proved useful in terms of preventing coordination failure while their effect of *overcoming* it remains unknown. Section 2 provides a general background and related literature about minimum effort game. Section 3 proposes an experiment design to address the research questions and describe how the experiment has been conducted. Finally, experiment results are discussed in section 4.

2 Background and related literature

The general payoff function of minimum effort game is as follows:

$u_i(x_1, x_2, ..., x_n) = a \min\{x_1, ..., x_n\} - cx_i + b$

where $x_i \geq 0$ denotes the strategy (or effort level in the literature) chosen by player i and a, b, c are exogenous constants with $a > c > 0$.

This game has multiple Nash equilibria in the sense that any common choice constitutes a Nash equilibrium. Strategies of the players are strategic complements because higher efforts of the other player provide an incentive to choose the same higher effort as well. A costly unilateral increase in x incur a deviation cost and a unilateral decrease will reduce the minimum. Multiple Nash equilibria can be Pareto-ranked according to the player's choice: any equilibrium with higher chosen number Pareto-dominates any equilibrium with lower chosen number. Every player choosing the highest number is an appealing equilibrium since it features Pareto efficiency. But it is equally appealing for everyone to choose the lowest number because the coordination outcome is then independent of other player. For example, some attendants may want to be the last to come to the meeting to avoid waiting time. Therefore, this game nicely illustrates the tension between shared interest resulting in a mutually beneficial outcome and the individual interest of security due to the strategic uncertainty about others' behaviour.

The presence of multiple Nash equilibria is sometimes unsatisfactory for economists, since it provides no clear prediction of behaviour in such games. From a theoretical point of view, Harsanyi and Selten (1988) propose two different equilibrium refinement criteria: payoff dominance and risk dominance. They argue that when these two criteria are in conflict, payoff dominance should be the first criterion to be applied. However, this argument is more assumed rather than being proved formally from more basic principles. Recent experimental literature suggests that risk dominance might have larger drawing power (Straub, 1995). Maximizing potential might be seen as a generalization of risk dominant equilibrium to n player game (Monderer and Shapley, 1995; Goeree and Holt, 2005). Theoretically, in minimum effort game, it predicts players coordinate on the highest effort level if $nc < a$ and coordinate on the lowest effort level if $nc > a$. Most of the empirical evidence from experimental studies support this conclusion (Chen and Chen, 2011). Predictions from strategic thinking model, for example level-k (Nagel, 1995) and cognitive hierarchy (Camerer *et al.,* 2004), also suggest that the final result would be related to the parameters n, c, a, although their prediction is less extreme compare to potential game approach: $x = 1 - (c/a)^{\frac{1}{n-1}}$ for the continuous effort level case. Those theoretical predictions give guidance of how the setting of the game (i.e., the number of players, cost and reward parameters) might alter the final coordination result.

Another interesting feature of this game is the path-dependency. Crawford (1995) proposes a premise that in environment with strategic uncertainty, experiences from analogous game may serve as an anchor for players. With repeated-game structure, it is highly likely that previous play of the stage game provides suggestive information for the subsequent play. Given this path-dependent property of the game, it is natural to think that the process of mis-coordination will be irreversible. For example, suppose a group of players coordinated on $x = 0$ at one period. If one player in the group wants to increase her effort level by one unit, she will definitely incur a cost of c for this increase. Unless she believe that, with probability c/a that all other three group members will increase their effort level simultaneously, she does not have the incentive to increase her effort level. Therefore, the higher c/a is, the less likely she will increase her effort. This example also illustrates that the belief formation process is essential to analyze this game. If a player does raise his effort level, it is likely that he *believes* with a certain probability that others will raise effort too.

Because of the inconclusive nature of theory predictions due to the presence of multiple Nash equilibria, an alternative and perhaps more practical way to study minimum effort game is through experimental methods. Since Van Huyck *et al.,* (1990)'s seminal paper about equilibrium selection in the context of minimum effort game, laboratory experiments have shown widespread failure to coordinate on the efficient equilibrium. This observation has led to active research agenda to increase the efficiency of coordination through changing certain features of the minimum effort game. One strand of literature investigating the effect of *pre-play* communication to foster coordination efficiency. In Chaudhuri *et al.,* (2009), a participant in a previous minimum effort game can offer an advice to a "successor" in the current minimum effort game. With large group of eight members, public free form message is able to increase coordination to the highest level. In a similar manner, Brandts and Cooper (2007) show that centralized communication raise effort level even more than higher financial incentive. Blume and Ortmann (2007) have a design where prior to actual play, subjects are allowed to communicate their *intended* effort choice to other group members. The overall efficiency significantly increases relative to the baseline treatment without cheap talk. Weber *et al.* (2004) shows that if subjects know the moves of all players in their group who move before them, they are more likely to coordinate on high effort equilibrium.

One suspicion about the studies above is that whether the effect of communication is due to a good start. Experiment in both studies observe a high initial coordination level which might be caused by zero-experience subjects. The effect of communication device in the situation with the presence of bad precedent is not clear. In other words, if subjects start at low effort level, after that, even if pre-communication stage is added, the ability to foster a high coordination level is in doubt. This is because subjects are suppose to understand the strategic uncertainty more clearly after bad experience. Consequently, the effectiveness of communication might diminish.

This leads to the main research question of this paper, i.e., how to *rebuild* coordination after the performance trap has occurred. Empirically, not every circumstance is completely new, an inefficient situation might already exist in some organizations, so a mechanism to resolve it is in demand. Unfortunately, relevant literature on this area is thin. Therefore, following experiment is designed to test whether mechanisms such as cheap talk or first mover that has been proven useful in *preventing* coordination failure would work on *overcoming* coordination failure. Brandts and Cooper (2006) illustrate that financial incentive is an effective way to rebuild coordination. Hamman *et al.* (2007) find a similar result. In Brandts *et al.* (2012), a combination of financial incentive and pre-play communication work together to help groups to achieve the pareto dominant equilibrium. Le Lec *et al.* (2012) also suggest monetary punishment plays an important role in overcoming coordination failure. This paper attempts to expand this line of literature. The following experiment is designed to test the effect of introducing a leader, in the sense of either pre-play communication or pre-play commitment, to restore efficient coordination after the coordination failure has occurred.

3 Experiment Design and Procedures

The Baseline game we investigate is based on the repeated version of minimum effort game modeled after Brandts and Cooper (2006). In this game, a group of 4 players play a game where they simultaneously choose an effort level from a set of discrete integers, $x_i \in \{0, 10, 20, 30, 40\}$. The payoff of player i is a decreasing function of his own effort x_i and an increasing function of minimum effort of all players in the group: $u_i = 6 \min x - 5x_i + 200$ (see Table 1).

Perhaps Van Huyck *et al.*, (1990)'s payoff matrix ($a = 0.2, c = 0.1, b = 0.6$) is the most widely used payoff matrix in minimum effort game literature. However we adopt

Table 1: Minimum Effort Game with $a = 6, b = 200, c = 5$

		Smallest Value of x Chosen				
		40	30	20	10	0
Your Choice of x	40	240	180	120	60	0
	30	-	230	170	110	50
	20	-	-	220	160	100
	10	-	-	-	210	150
	0	-	-	-	-	200

Table 2: Experimental Design

Session	Round 1-10	Round 11-20	Round 21-30
CT (15 groups)	Baseline	Cheap Talk	Baseline
FM (15 groups)	Baseline	First Mover	Baseline
Control (5 groups)	Baseline	Baseline	Baseline

Brandts and Cooper's version for two reasons. First of all, usually a group of 8 to 16 subjects are employed to study Van Huyck *et al.,*(1990)'s game, but the effect would be similar using Table1with smaller group size. Second reason to use Brandts and Cooper's payoff matrix is to keep the same game structure to facilitate further comparison with the existing literature about "turnaround" behaviour (c.f., Brandts and Cooper, 2006; Hamman et al., 2007; Fehr, 2011).

The experimental procedure consists of three blocks of ten rounds (see Table 2). The purpose of the first block is to let groups establish a history of coordination failure, which is an important precondition for the implementation of different treatments in second block. The second block involves a change in communication protocol within the group. A random leader will be selected to help the group to climb out of the coordination failure. The third block is a replication of the first part to examine the sustainability of the treatment implemented in the second block, which is in total 30 rounds per session. The group size is $n = 4$ and is fixed matching through all sessions. At the end of each round, subjects will be shown a summary statistics from earlier round and the effort level selected by all four subjects. These efforts are then sorted from highest to lowest, and do not include any identifying information about which subjects corresponding for which effort level. Note all blocks have in common the number of rounds, the group size and the feedback after each round.

All sessions were conducted in March 2013 and in total 140 students (87 female and 53 male) from various fields of study participated in this experiment. The experiments were run in the CeDEx (Center for Decision Research and Experimental Economics) experimental laboratory at the University of Nottingham. The experiment was computerized using software toolkit z-tree (Fischbacher, 2007) and subjects were recruited with ORSEE (Greiner, 2004). To minimize experimenter demand effects and ensure subjects' anonymity, we adopt a double-blind procedure. Upon arrival, subjects were asked to randomly draw a number from a bag and they would also receive an envelope containing their unique four digit participation ID number. They were then instructed to sit according to their drawn number and were told that their actions would only be linked to the participation ID number. Subjects received the instructions for the relevant part of the experiment, i.e., they were not aware of the second part when they are in first part. The instructions were framed in a corporate context where the four players in the group are referred to as "employees" and are told that they are working for a "firm". But strong connotations such as "effort" are avoided and replaced by neutral abstract terminology[3] Before the beginning of each part, subjects were required to answer several quiz questions regarding the payoff function and procedure details. For a sample of the instructions see the Appendix. The experiment only started after all subjects had had answered all questions correctly. At the end of the experiment, subjects had to complete a questionnaire contain questions about demographic information, risk attitude test and personality test. Subjects in control treatment also had to answer questions related to communication treatment. Subjects were paid in private the amount of experimental points earned after the experiment. The conversion rate is 400 points=1 pound. The session lasted about 75 minutes and subjects earned on average £14.5.

4 Experimental Results

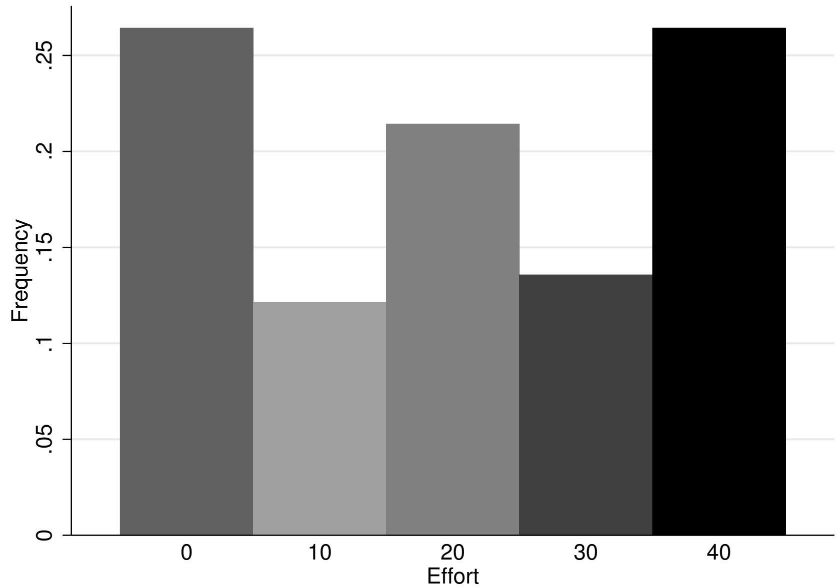
4.1 First round and coordination failure

First round result is interesting in the sense that this is the only round without previous history. It is likely that subjects have different perceptions about the payoff matrix prior to the actual play. Some of them might form certain beliefs about other players' choice and play the best response accordingly. While other subjects might simply pick one number at random with the intention to test what will happen. Figure 1 shows the effort distribution in round 1, the choice is symmetric around 20.

The reason we introduce either CT or FM treatment is to see whether those treatments would help to *overcome* coordination failure. Therefore, a necessary condition to analyze the treatment effect is to have groups suffer from coordination failure. We call a group suffer from coordination failure when the average effort in that group is zero at round

[3]The use of a corporate context was meant to ease subjects' understanding about the instruction. Previous literature also use this framing in the turnaround game (Brandts and Cooper, 2006).

Figure 1: Effort Distribution in Round 1



ten. During the first ten rounds, the trend towards lower effort level seem irreversible. Specifically, 32 out of 35 groups suffer from coordination failure after first ten rounds in all treatments.[4]

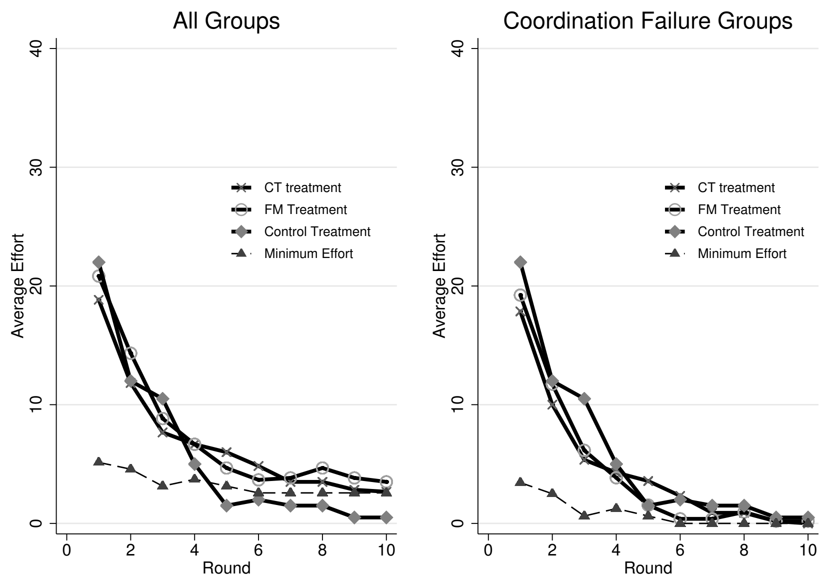
Result 1 *Coordination failure is common in the first ten rounds.*

The average effort in CT and FM treatment is slightly higher compared to the control treatment. However, once we exclude those three groups who do not have zero effort in round ten, the pattern looks extremely similar across all three treatments (see Figure 2). This result is expected since the experimental procedure is exactly the same across all treatment in the first ten rounds.

Those experimental data replicate the widely cited result in previous literature (Brandts and Cooper, 2006; Weber et al., 2007). The result of coordination failure after ten rounds is not surprising if one realizes how tough the situation each subject faces. If players mis-coordinated in the first round, then it requires players who chose relative high effort to wait for others and players who chose relative low effort to catch up quickly. However, note that in each round, the cost of not being the minimum-effort-player is even higher compared to the most efficient equilibrium. Therefore, it is rare for groups to manage a successful coordination.

[4]There is one group in CT treatment coordinated on 40 and two groups in FM treatment coordinated on 20 and 30 respectively from round 2 onwards. By "coordination failure groups" we exclude those three groups.

Figure 2: Average Effort for Round 1-10



4.2 Trying to overcome coordination failure

4.2.1 Round 11, average effort and minimum effort

At the start of part 2, restart effects are observed across all three treatments. In other words, average efforts bounced up to various extents in round 11. About 53% of the subjects choose 0 in this round while 27% of the players choose 40 in this round. Average effort in round 11 is 14.6 which is lower compared to the first round average effort. Note that in all treatments, effort zero is always the mode choice and effort forty in the experimental treatments is the second most popular choice in round 11 (see Figure 3). The effort distribution in round 11 neither looks like the distribution in round 1 ($\chi^2_{(4)} = 151.8, p = 0.000$) nor uniform distribution ($\chi^2_{(4)} = 127.6, p = 0.000$). However the average effort in both CT and FM seems higher compared to the control treatment ($\chi^2_{(4)} = 98.2, p = 0.000$ for CT and $\chi^2_{(4)} = 210.0, p = 0.000$ for FM). The distribution in both CT and FM treatments does not seem to differ ($\chi^2_{(4)} = 5.65, p = 0.227$).

Table 3 shows ordered probit regression results of the factors that affect subjects' choice in round 11. It seems that average effort during rounds 1-10 and the risk attitudes are two major determinants of the effort round in round 11.[5]

From round 12 onwards, average effort gradually slides back to zero along with the time. All groups that suffer from coordination failure in round 10 are all coordinated on zero effort level again in round 20. Those three groups who coordinate on non-zero

[5]Risk attitude is elicited in the questionnaire at the end of the experiment.

Figure 3: Effort Distribution in Round 11

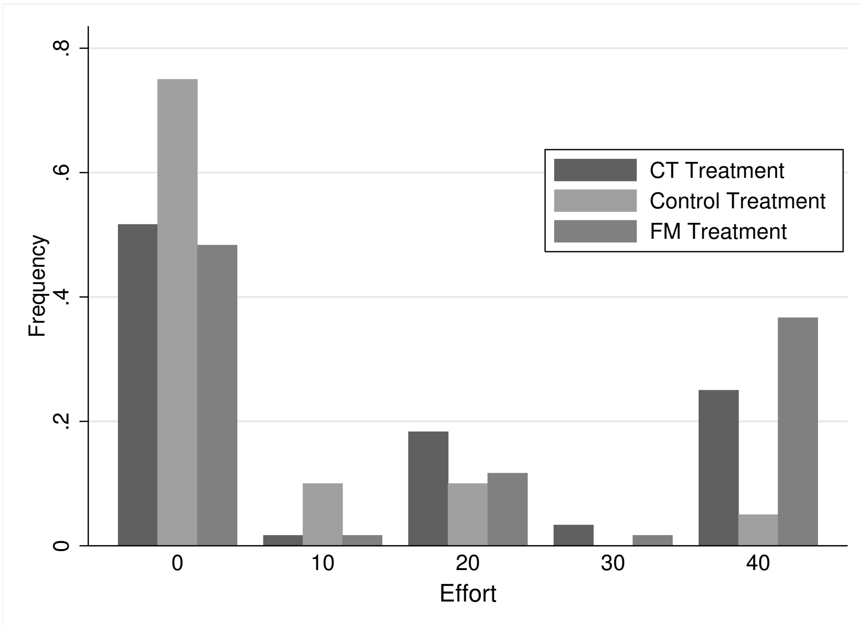
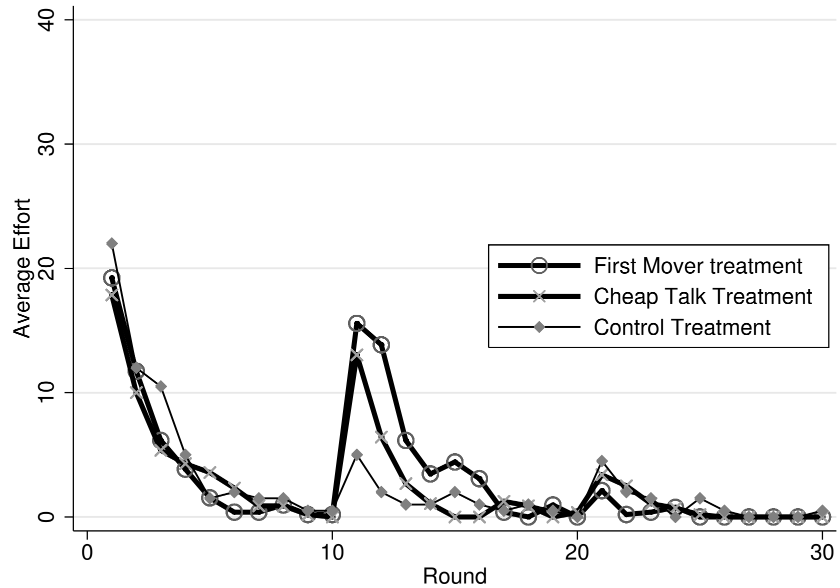


Table 3: Ordered Probit Regressions on the Effort Level in Round 11

dependent variable:	Effort in Round 11			
	(1)	(2)	(3)	(4)
Avg. effort in periods 1-10	0.052*** (0.002)	0.052*** (0.002)	0.050*** (0.003)	0.052*** (0.002)
Risk averse		-0.037*** (0.013)	-0.036*** (0.013)	-0.041*** (0.013)
Effort in period 1			0.001 (0.001)	
Leader or Follower				-0.097** (0.042)

* p<0.10, **p<0.05, ***p<0.01

Figure 4: Average effort for coordination failure groups



effort level in the first ten rounds continue to coordinate on that level for the rest of the experiment. Figure 4 presents the average effort for 32 groups who coordinated on 0 in round 10. The minimum effort in most groups is zero during all 30 rounds (see Figure 5). 2 out of 13 coordination failure groups in FM treatment manage to coordinate on 40, however, the minimum effort for all those 32 groups is zero in round 20. Therefore, we could conclude that in the long-term neither cheap talk nor first mover help to *overcome* coordination failure.

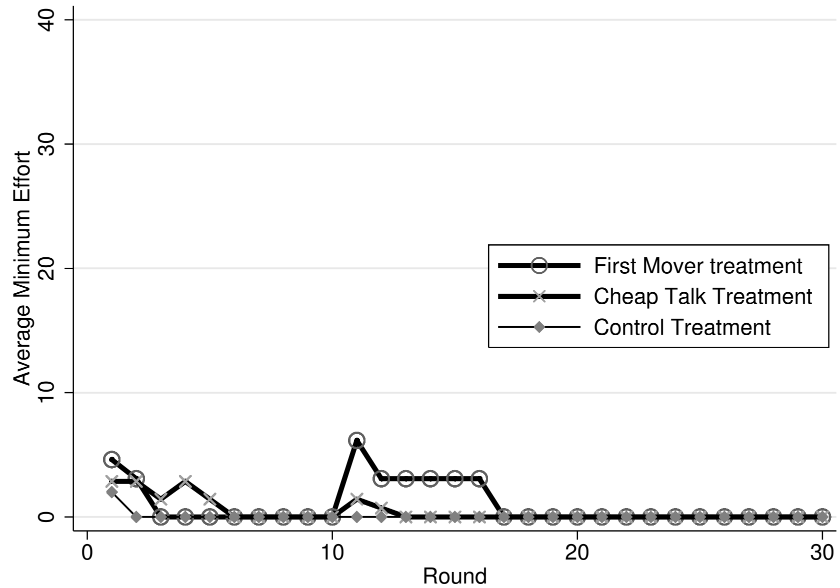
Result 2 *Neither cheap talk nor first mover mechanism help to overcome coordination failure in the long term in this tough environment.*

Two interesting questions worth asking here are: a) how groups slide down to zero again and b) why groups did not manage to coordinate on a higher effort in round 11. In order to answer these two questions, we have to zoom in to look at leaders and follower's behaviour separately.

4.2.2 Leaders' choice, belief and message

In both CT and FM treatment, leaders only choose effort level 0, 20 and 40. Among the leaders, 43% choose 0 in this round while 30% choose 40. Those figures are not different from followers. In terms of the credibility of the message, most leaders choose what he/she suggested. Only three out of fifteen leaders in CT treatment send a message

Figure 5: Average minimum effort for coordination failure groups



that is higher than their actual decision.[6]

When we compare leader and follower's effort, it is not surprising that leaders' effort is constantly higher than followers' effort (see Figure 6). This is because followers could always maximize their payoff by choosing an effort equal or lower than leader's suggested number (or choice). Furthermore, leader's choice in FM treatment seems always higher compared to CT treatment and so does followers. Note that choosing high effort is costly for the first mover leader, but it also receives more responsive followers.

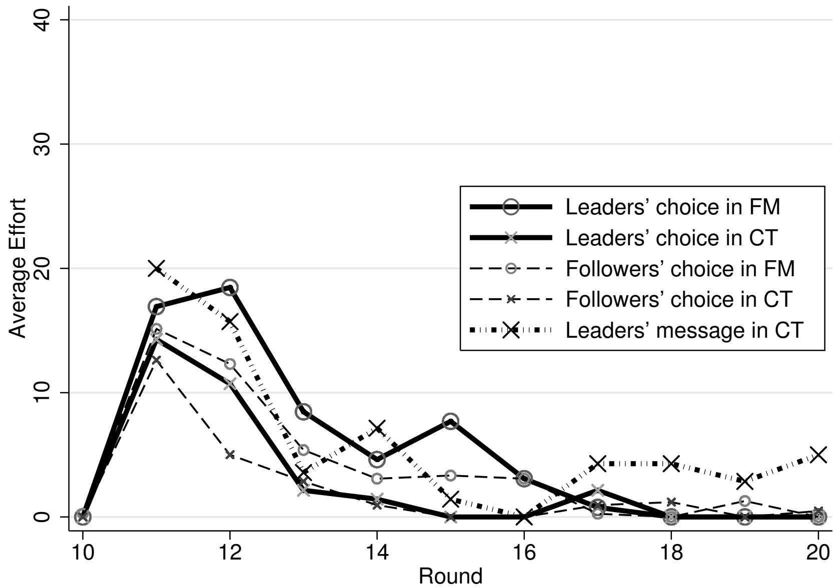
From the data, another intriguing observation worth noting is that *if* a leader chooses an non-zero effort level, she tends to persistently choose that effort level for more than one round, even if it is not the best response for the minimum effort from previous round. This behaviour might be classified as strategic teaching. If the group is fixed, sophisticated players might have an incentive to "teach" adaptive players, by "choosing strategies with poor short-run payoffs which will change what adaptive players do, in a way that benefits the sophisticated player in the long run." (Camerer *et al.*, 2002 p. 139)

One way to look at the leader's motive is to check the leaders' belief. Leaders were asked to provide stated beliefs about the minimum value of other three players from round 11 to round 20.[7] Figure 7 shows leader's choice, belief and the actual minimum effort of followers. At round 11, 13 out of 30 leaders held the correct belief that the minimum

[6]One leader suggests 40 while choosing 0 himself and two leaders suggest 40 while choosing 20.

[7]This belief is incentivized using relatively small amount of money. To reduce income effect, the total profit from correct beliefs is only presented at the end of the experiment.

Figure 6: Leader and follower's effort



effort of others would be zero. From round 11 to 13, leaders' effort is higher compare to their beliefs. Indeed, 11 out of 30 leaders choose an effort that is higher compared to their beliefs. Among them, 7 leaders constantly make choice higher than her belief for more than one period. This asymmetric deviation to the best response of the minimum of other players provide evidence of strategic teaching behaviour. However, this teaching behaviour seem to happen more frequently from round 11 to round 13. As in the later round, leaders realize that it is unlikely to pull groups out of coordination failure, this strategic teaching behaviour ceased.[8]

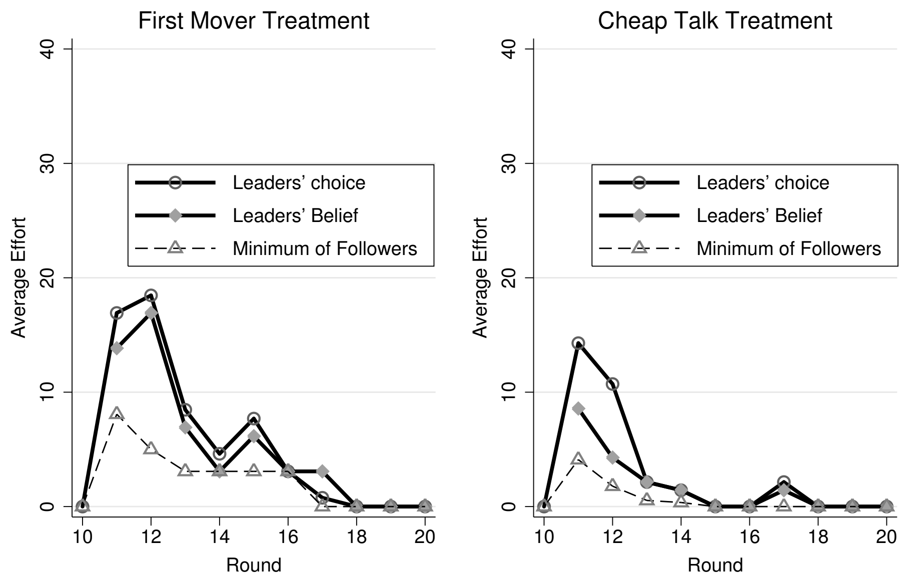
To address the ultimate question of whether the responsibility of overcoming coordination failure lies in leader, we could reframe this question as if leaders could choose differently, whether will the result be different. The answer is no.

4.2.3 Followers' choice

During the experiment, followers were asked to state what he/she would choose if the leader choose a certain effort level. The result is not surprising that leader's effort level have a significant effect on follower's choice (ordered probit regression, $z = -13.2, p = 0.000$). We can classify a follower's type according to his/her strategy in round 11. One type of followers choose zero regardless of what leader has suggested or chose, we label this strategy as zero-effort strategy. 29% of the followers in CT and 18% of the

[8]Note also that a strategic teacher would sacrifice 50 points to gain 10 points. Therefore, by round 15 there is no reason at all to teach.

Figure 7: Leader's choice, belief and the actual minimum value of followers



followers in FM use this strategy. Another strategy proved to be popular is to match what the leader had suggested or chose, we label it as matching strategy. Specifically, this strategy is to play 0 *if* leader suggested (chose) 0; play 10 *if* leader suggested (chose) 10, and so on. 35% of the followers in CT and 53% of the followers in FM adopt this strategy in round 11 (see Table 4 and Table 5). The proportion of the followers chose this matching strategy in FM treatment seems higher compared to CT treatment (test needed). Hence this might be the evidence that costly communication are more credible.

From round 2 onwards, the proportion of matching strategy is diminishing while the proportion of zero-effort strategy is rising. In round 20, only 21% of the players choose matching strategy, while almost 70% players choose to adopt zero-effort strategy regardless of what the leader's choice (see Table 6 and Table 7). Still noticeable however, followers in FM treatment seems play more matching behaviour compared to CT treatment even in round 20 (test needed).

At first glance, the matching strategy seems natural and it seems surprising that this strategy diminishes so quickly. However, one should note that play according to leader suggested or did is not the best response strategy in this game. There are still other two (or three in CT treatment) group members' choices unknown. The best response strategy for each player is to match the minimum effort of all other players. Therefore only matching the leader's choice could sometimes be costly. For example, in FM treatment, if leader chose 40 and there is one player choose to play zero-effort strategy. In this situation, matching leader's choice is not a best response and that's why this

Table 4: CT Treatment: strategy method for round 11

Followers' choice:	If leader suggested 0	If leader suggested 10	If leader suggested 20	If leader suggested 30	If leader suggested 40
0	**95.6%**	40%	42.2%	37.8%	33.3%
10	0%	**51.1%**	0%	6.7%	2.2%
20	0%	4.4%	**53.3%**	8.9%	2.2%
30	0%	2.2%	2.2%	**44.4%**	4.4%
40	4.4%	2.2%	2.2%	2.2%	**57.8%**

Table 5: FM Treatment: strategy method for round 11

Followers' choice:	If leader chose 0	If leader chose 10	If leader chose 20	If leader chose 30	If leader chose 40
0	**84.0%**	24.4%	22.2%	22.2%	24.4%
10	2.2%	**64.4%**	4.44%	4.4%	2.2%
20	2.2%	2.2%	**64.4%**	4.4%	4.4%
30	2.2%	4.4%	2.2%	**62.2%**	4.4%
40	8.9%	4.4%	6.7%	6.7%	**64.4%**

strategy diminishes over time.

4.3 Best responses and payoffs

The best response strategy for each player in this game is to match the minimum effort of other three players in their group. However, since subjects make their decisions simultaneously, they are unable to know their group minimum. One possible way is to form certain beliefs according to previous play. The the minimum effort of other players in the previous round may provide suggestive information about what is likely to be the minimum of others in the current round.

We could define a player play a "Best Response" behaviour if she matches the effort level with the minimum of other players effort level from the previous round. Figure8 present the evolution of percentage of best response subjects for the whole experiment. It is clear that, from round 2 to 10, the proportion of players play best response is non-decreasing. After three round in the second part, almost all players play best response according to previous round's minimum effort of others. Due to the fact that subject's choice is influenced by other group member's minimum effort in last round, it could lead to mis-coordination in the current round. For example, in one group, three players choose 40 and the other one choose 0 in round 1. The one who chose 0 would play best response and choose 40 in round 2 while players who choose 40 might best response to 0 in round 2. Therefore the cost of mis-coordination is extremely high under this

Table 6: CT Treatment: strategy method for round 20

Followers' choice:	If leader suggested 0	If leader suggested 10	If leader suggested 20	If leader suggested 30	If leader suggested 40
0	**97.8%**	84.4%	82.2%	80.0%	77.8%
10	0%	**13.3%**	2.2%	0%	0%
20	0%	0%	**13.3%**	2.2%	0%
30	0%	0%	0%	**15.6%**	2.2%
40	2.2%	2.2%	2.2%	2.2%	**20.0%**

Table 7: FM Treatment: strategy method for round 20

Followers' choice:	If leader chose 0	If leader chose 10	If leader chose 20	If leader chose 30	If leader chose 40
0	**93.3%**	62.2%	64.4%	62.2%	60.0%
10	0%	**31.1%**	0%	2.2%	0%
20	2.2%	2.2%	**31.1%**	0%	2.2%
30	4.4%	4.4%	4.4%	**35.6%**	4.4%
40	0%	0%	0%	0%	**33.3%**

circumstance. Since the minimum effort of all groups are very low across the whole experiment, a best reply to match the minimum effort of previous round inevitably lead to coordination failure.

Around 40-50% of players do not play best response in round 2 and round 11. One possible explanation is that player forms an optimistic believe about other player in those two rounds. Another possibility is that they exhibit strategic teaching behaviour in these particular two rounds.

If we compare the percentage of best response (Figure8) to the average effort to The average payoff mirrors the average effort (see upper graph of see Figure 9), the reason for best responding could be largely explained by payoffs. Average payoffs paralleled the average best responses.

Additionally, average payoff and average effort also mirrors each other. The higher the average effort is, the lower the average payoff and vice versa. Given this property, it is therefore understandable why neither cheap talk nor first mover helps. Except for the "trying" round at the beginning of ten round block, the average payoff is around 200 in all rounds. The average payoff is quite similar across all three treatment.

The rationale behind the negative correlation between payoff and effort could be explained by the cost of mis-coordination. Note that the "toughness" of the game lies on the fact that the punishment of deviation from the group minimum effort is costly. Therefore, when players try to choose higher effort, it is more likely to be punished.

Figure 8: Percentage of Best Response to Last Rounds's Minimum of Others

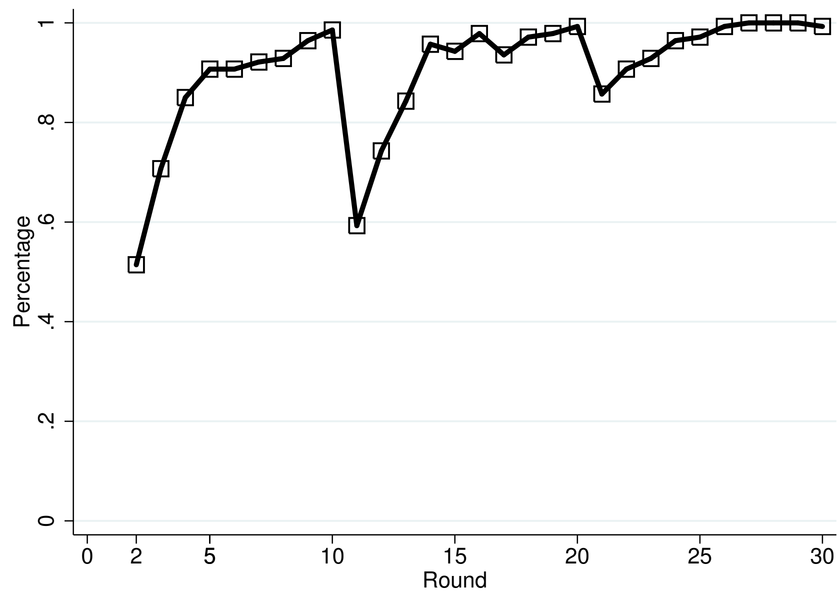
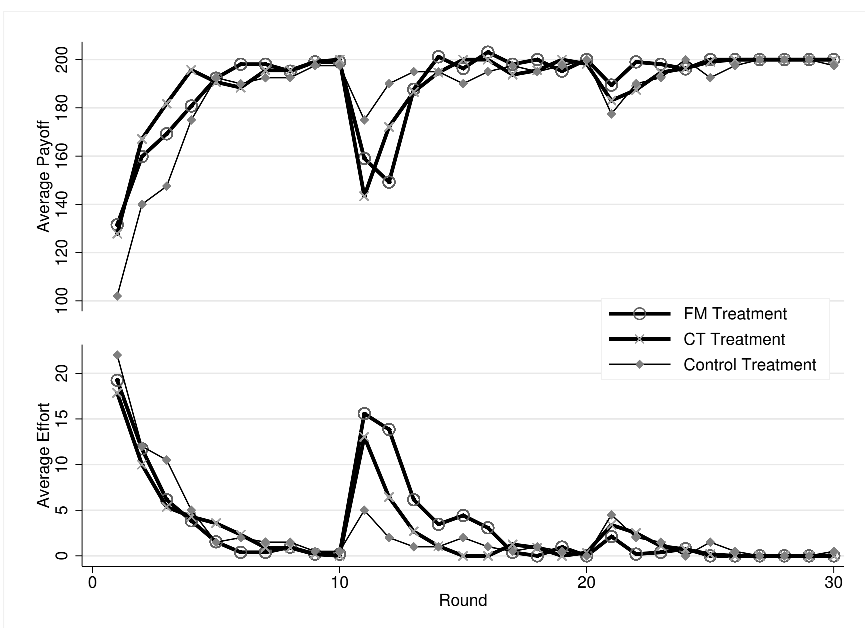


Figure 9: Relationship between average payoff and average effort



The aim of introducing the third block is to see whether the removal of communication mechanisms in the second part would help to sustain a certain coordination level. Due to the fact that neither cheap talk nor first mover mechanisms help to overcome coordination failure, the average effort of all groups still remain close to zero in the entire part 3.

5 Conclusion

Our experiment confirms the findings of Brandts and Cooper (2006) that coordination failure almost invariably happens in this tough variant of the minimum effort game where there is a high cost of mis-coordination relative to the gains from successful coordination. Although on average initial effort was close to the middle of the interval, by round 10 almost all groups chose the lowest effort.

We introduced in this environment two communication mechanisms: cheap talk and commitment to an action (costly communication) by one of the players. Even though most leaders and followers made substantial efforts to overcome coordination failure, neither cheap talk nor the introduction of a first mover were effective in bringing play out of the coordination trap. The "message" in the commitment treatment (costly communication) appeared to be more credible, as more followers chose to match the first mover's choice, compared with the cheap talk treatment. However, the difference was small. Due to the structure of the game where the outcome depends on the minimum effort in the group, the presence of just one player who continued to choose the lowest effort cancelled out the efforts of other players.

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