Free-riding on Communication: An Experimental Study

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Abstract: This paper experimentally investigates free-riding behavior on communication cost in a coordination game and finds strong indications of such free-riding. Firstly, the subjects tend to wait for others to send a message when communication is costly, which does not happen when communication is costless. Secondly, the proportion of games where no communication takes place is much higher when communication is costly compared to when it is free. Thirdly, the form of communication also strongly suggests free-riding.

Keywords: Free-riding, Communication, Coordination.

JEL: C72, C91, D43.

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1. Introduction

Starting with the seminal work by Cooper et al. (1989, 1992), there is now a large strand of experimental literature documenting the effects of cheap-talk communication in coordination games (see Blume and Ortmann, 2007 for a recent overview).[1] From this literature we know that such communication is effective in achieving coordination in many situations. However, the bulk of this literature has dealt with games where the choice of communication has been exogenous and costless. From a real world perspective such choices can be challenged on several grounds. For example, it is not hard to argue that communication is usually endogenously chosen by individuals. Moreover, in many situations communication is associated with a cost (e.g. the cost of a phone call or advertising costs). In a companion paper, AH (Andersson and Holm, 2010), we investigate the effect of endogenous costly communication in coordination games. Using the particular communication protocol employed in that paper, we take a closer look in this paper at the dynamics of the choice of communication and the effect on outcomes as the cost increases.[2] We find that there are considerable attempts to free-ride on the communication cost, by waiting for the opponent to send a message when communication is costly. As a consequence, this leads to subsequent failure to coordinate in the underlying game when tacit coordination cues are absent. To the best of our knowledge we are the first to document this type of free-riding behaviour.

One might argue that what we observe is just an instance of the well documented free-riding behaviour in public goods games (see e.g., Isaac et al., 1984 and Isaac and Walker, 1988). There are at least two arguments against this. Firstly, the

[1] For instance, in worker-manager situations Brandts and Cooper (2007) find that cheap-talk communication is more effective than financial incentives in overcoming coordination failure.
[2] Subjects had the opportunity to start a costly free-form chat session during a 90-second window before playing the game.

two incentive structures are quite different. In most cases it is a dominant strategy to free-ride in a public goods game, but in the coordination game it is only an equilibrium to free-ride if the opponent communicates (and solves the coordination problem). Secondly, it is not obvious that free-riding in communication is a dominating mechanism, the reason being that other behavioral mechanisms may dominate in the communication stage. Fehr and Gächter (2000) provide a convincing illustration of "secondary" free-riding not seeming to dominate in public good games which include a stage where it is possible to punish co-players at a certain cost. In that study, free-riding in the punishment stage can be expected, but the dominating observation is the opposite; subjects punish (i.e., do not free-ride) even if no rational (non-emotional) reason for this can be given. Furthermore, the mechanisms behind free-riding in communication are likely to differ from those involved in punishment, which has been subject to some recent research.[3] Since communication typically takes place before the actions in the underlying game, the structure of the entire game is fundamentally different from a game with punishment. In contrast to punishment actions, communication actions cannot be made contingent on the actions in the underlying game. Thus, negative emotions against free-riders, as emphasized by e.g. Hirschleifer (1987) and Fehr and Gächter (2000), cannot explain communication behavior. In contrast, the counteracting mechanism to free-riding in communication is likely to be forward-looking and based on expectations. This does not necessarily mean that these mechanisms are weaker than the ones in punishment. For instance, the choice of not free-riding in the communication stage may be motivated by the fear of being punished in the succeeding subgame, a behavior that would be consistent with some observations in Fehr and Gächter (2000), but also with (non-emotional)

[3] Studies of punishment directly or indirectly include Ostrom, Gardiner, and Walker (1992), Saijo and Nakamura (1995), Fehr and Gächter (2000), Carpenter and Matthews (2002), Sefton, Shupp and

equilibrium behavior. In addition, and again in contrast to the game with punishment, it is possible that communication (i.e., not free-riding) is motivated by the willingness to signal kind intentions (see Rabin, 1993, Dufwenberg and Kirchsteiger, 2004) before the underlying game is played. Thus, the mechanism related to free-riding in a communication stage is likely to be different from the mechanism related to free-riding in a punishment stage, and therefore interesting as a separate case study of secondary "free-riding". Thus, there are obviously strong mechanisms that counteract secondary free-riding, which implies that what to expect in these situations is not obvious. Our results are related to those of endogenous timing games. In a recent series of papers Huck, Müller and Normann (2002) and Fonseca, Huck and Normann (2005) investigate a quantity competition game where firms can choose to produce in one of two periods. In those models there is a first mover advantage from producing early (as compared to our second-mover advantage in the communication stage) and taking the Stackelberg leader role. Contrary to this theoretical prediction, their experimental finding is that subjects fail to exploit this strategic opportunity to raise profits. Instead, they wait and produce according to the Cournot prediction. The authors attribute their results to fairness and reciprocity behaviour. Hence, in light of these results our findings are neither trivial nor without related counter examples.

The rest of the paper is organized as follows. Section 2 describes the game and the experimental procedures. Section 3 contains the results and section 4 concludes the paper.

Walker (2002), Page, Putterman and Unel (2005) , Sutter, Haigner, and Kocher (2010).

2. The game and the experiment

We use data from an experiment with free-form communication described and motivated in AH.[4] The underlying game is a market entry game that combines aspects of coordination and conflict of interest. Two players, $i = 1,2$, can choose one of four alternatives: enter market *X* or *Y*, both markets (*B*) or do not enter either market (*N*). Two parameterizations are used in the experiment, one with tacit coordination cues and one without, denoting the Asymmetric (A) and the Symmetric (S) game respectively. Figure 1 gives the normal form representation of these two games.

Symmetric game

	N	X	Y	B
N	12, 12	12, 24	12, 24	12, 36
X	24, 12	8, 8	24, 24	8, 20
Y	24, 12	24, 24	8, 8	8, 20
B	36, 12	20, 8	20, 8	4, 4

Asymmetric game

	N	X	Y	B
N	12, 12	12, 22	12, 26	12, 36
X	26, 12	10, 6	26, 26	10, 20
Y	22, 12	22, 22	6, 10	6, 20
B	36, 12	20, 6	20, 10	4, 4

Figure 1. The games in the experiment

The main difference between these games is that A contains a tacit coordination cue; each firm has an advantage in entering a particular market whereas no such advantage is present in S. Yet, the set of pure strategy Nash equilibria is invariant to these parameterizations and given by the diagonal elements starting at the bottom left corner.[5] Apart from the market sharing strategy pairs (X,Y) and (Y,X) the games also entail the market domination strategy pairs (B,N) and (N,B). In the experiment,

[4] This paper is mainly focussed on the resulting equilibria, welfare effects and the type of communication with a specific emphasis on market entry situations. It does not discuss the general phenomenon of free-riding in the communication stage, an aspect discovered relatively late while scrutinizing the additional aspects of the experimental data (like the timing of communication).

[5] Although the set of equilibria is identical in the two treatments, the ability to reach either one of them is quite different. In the asymmetric treatment the strategy-pair (X,Y) is focal since each firm has a cost advantage in entering its respective market. Hence, coordination could be achieved without communication. No such focal point is present in the symmetric entry cost treatment.

however, we very rarely observed these as outcomes in either the communication stage or the action stage.[6] One reason for this might be that they seemed unfair or that players did not think that they could credibly implement them. Therefore, we abstract from these in the following discussion.

In the experiment the cost of communication was varied, so that communication was either costless ($c = 0$) or costly ($c = 3$ or $c = 5$).[7] The cost was set to be substantial, but low enough to give players an incentive to use the communication opportunity, at least in S. Indeed, in the absence of communication the most plausible outcome in S is the mixed Nash equilibrium wherein both players earn 12. Hence coordination by communication would be profitable under both $c = 3$ and $c = 5$. This is less obvious in A, since it contains tacit coordination cues. However, we know from previous literature on games with pareto-ranked equilibria that coordination can be difficult without a communication device (see Devetag and Ortmann, 2007 for a recent survey). Hence, we might expect players to use the communication device in A as well.

Both players were instructed that they could send messages, for a duration of 90 seconds, to the other player through a “chat” function before they made their strategy choice in the game.[8] In particular, they were allowed to send any message they wanted, except for messages that allowed them to identify themselves. In treatments with $c > 0$, the cost of communication was only incurred to each player the first time (in each round) he sent a message.

[6] The occurrence of the (B,N) outcomes varied between 0 and 6 percent of the coordination outcomes. See Table 3 in AH for a presentation of the outcomes.
[7] The difference in communication cost (c=3 and c=5) was motivated by the desire to study effects of variation in positive communication cost in AH we will not make use of this treatment difference in this paper.
[8] Instructions are available in Appendix B.

When $c = 0$ a player is indifferent to whether she, her opponent, or both solve the coordination problem by sending a message. To the contrary, with $c > 0$ a player would prefer to free-ride and let the opponent solve it. Clearly, with $c > 0$, the game allows for many equilibria, but this does not necessarily imply free-riding. For instance, in the following equilibrium profile both players bear the same communication cost: I.) The Row player sends the initial message that they should play (X,Y) and then plays X if he gets a confirmation from the Column player that she will play Y. If Row does not get this confirmation, he plays a mixed strategy consistent with Nash-equilibrium. II) The Column player initiates communication, but if she receives the suggestion to play "(X,Y)" she sends a confirming message and acts according to the message. If she does not get this message, she will play a mixed strategy consistent with Nash-equilibrium. Still, even if this profile shows that some equilibrium behavior excludes free-riding in communication, there may be an incentive to free-ride since many probably consider the confirmation message to be redundant. We end this section by stating the following theoretical conclusion: *The incentive to free-ride on communication is stronger when the cost of communication is positive.*

In every treatment, ten rounds of each game were played where subjects were re-matched with an anonymous subject not played against before (i.e., a strangers' matching protocol was used). Subjects were informed about the outcome after each round. In total the experiment consisted of six sessions (with 16-24 subjects) and three treatments in each.[9] A session took between 75 and 90 minutes. Subjects were recruited from introductory and intermediate Economics courses at the School of

[9] In Appendix A we present a figure containing the exact treatment design.

Economics and Management, Lund University. The subjects' total average earning was SEK373.[10]

3. Results

We start this section with some short notes on the data. Since the subjects took part in several treatments, there were potential order effects. We investigated this in AH and found no such tendency; hence, in this paper we have pooled the different subsessions with the same treatment design. Moreover, theoretically there should be no clear cut difference between treatments with $c = 3$ and $c = 5$. Since we have not observed any difference in the experimental data either, we have pooled across such treatments as well.

It is reasonable to interpret hesitation in sending the first message as a sign of intent to free-ride. We measure this by the time from which communication was possible until a player sent the first message.[11] In line with the theoretical discussion in section 2, one should expect the average time of the first message to be shorter when communication is costless compared to the case when communication is costly. In Figure 2 the distributions of times to the first message is shown for the sessions with costless communication and those with costly communication in the S (2A,2C) and A (2B,2D) treatments, respectively. There is a clear difference in the distribution of time to the first message between costly and costless communication. With costless communication the distribution is unimodal with a peak in the very beginning of the communication window. To the contrary, with costly communication the distribution

[10] The total average earnings corresponded to USD57 at the time the experiments were conducted. The hourly earning was substantially higher than the hourly salary for this group.

[11] Other issues relating to the timing in communication have received some interest. This is the case for the so called "deadline" effect (see e.g., Roth, Murnighan and Schoumaker, 1988, and Roth 1995).

is u-shaped and much more spread out over the entire communication window.[12] Interestingly, there is no difference between the A and S treatments. In all we have observations from twelve subsessions, where subjects could communicate. If we treat the mean time of the first message of a whole subsession as one observation, we do not have to worry about interaction effects. The mean starting times in the six subsessions with costless communication were 4.6, 1.8, 7.6, 10.4, 5.5, and 8.7 seconds. The corresponding six mean starting subsessions with costly communication were 41.5, 37.3, 34.1, 53.1, 17.8 and 33.3.[13] A Wilcoxon-Mann-Whitney test (n=12, p=0.005) strongly rejects the possibility that the distributions of mean first message times come from the same underlying distribution. An alternative test, which also avoids interaction effects, is to compare the distributions of first message times of each pair in the first period of the first subsessions. Again, using a Wilcoxon-Mann-Whitney test (n=42, p= 0.0007), we strongly reject the likelihood that the first message times of the costly and costless subsessions come from the same underlying distribution.

[12] Although not strong, one can see a "deadline effect" (cf Roth, Murnighan and Schoumaker, 1988) when communication is costly.

[13] Since there is no apparent difference between S and A in the timing of communication, given the communication cost, we have pooled these observations.

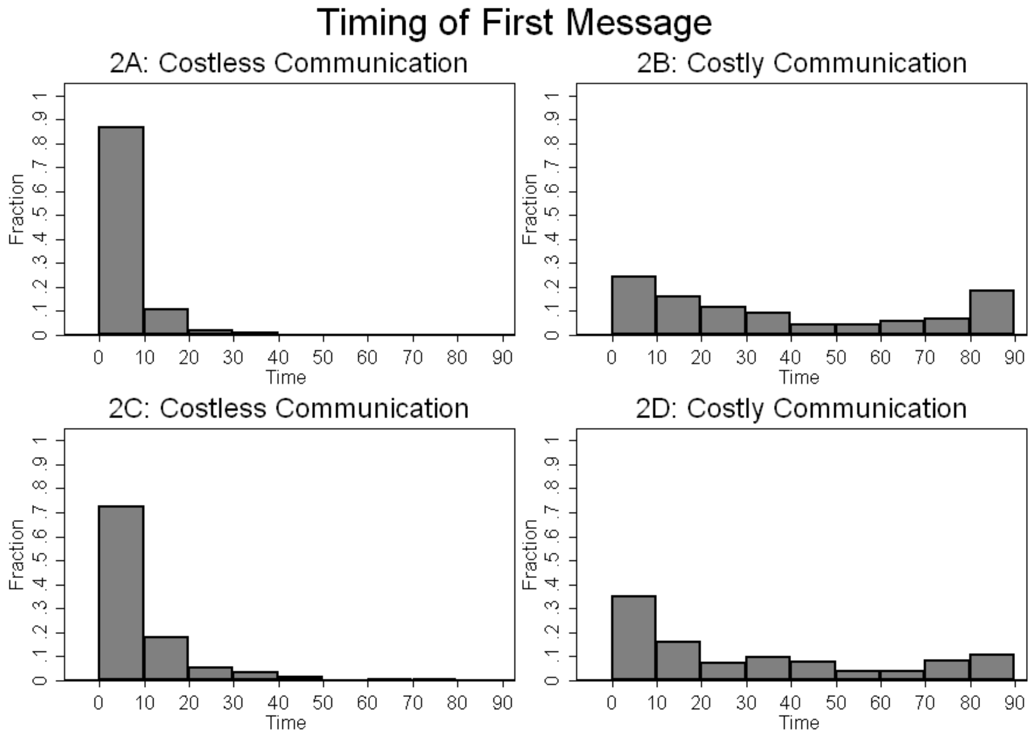

Figure 2: Distributions (in seconds) of the times to the first message.

A second indication of the tendency to free-ride is that, in a substantial proportion of the rounds (namely, 27-33 percent), no message at all was sent when communication was costly. This was detrimental to the players' payoffs in S, since the players were then likely to end up in an uncoordinated outcome. Indeed, in S subsessions, the average per period profit was 12.4 (which is very close to the mixed Nash equilibrium outcome) if no one in the group communicated, compared to 21.3 if someone in the group sent a message. Thus, even if the communication cost is well below the communication gains, the free-riding motive is frequently sufficiently powerful to prevent players from realizing this gain. The proportion of communication rounds without any communication was never higher than 1 percent with costless communication.

The third indication of free-riding is the fraction of communication rounds that is one-way. In the game it is possible for the player who sends the first message to achieve coordination without any response from the other player, who can then free-ride. The latter player may of course want to send a message to the former player to reassure him that they have an agreement.[14] However, since this is costly in the treatments with communication cost, we should expect a higher proportion of one-way communication in treatments with costly communication compared to those with costless communication. The results strongly support this conjecture. The proportions of one-way communication in the subsessions with costless communication were 1, 0, 2, 0, 0, 3 percent and the corresponding percentages with costly communication were 59, 58, 53, 84, 48 and 65.

Our final indication is that in some communication rounds at least one of the players clearly indicated the intent to free-ride as the following dialogue reveals:

Player 1: “I can pick X or Y”

Player 2: “you take X then I will take Y”

Player 1: “ok”

Player 2: “well done, you got me to write as well… nice work! :P”

4. Concluding remarks

This paper finds robust evidence of free-riding on communication cost. It is important to take this tendency into consideration when designing institutions and contracts where there are costs associated with communication. This conclusion is reinforced by the observation that free-riding motives may obstruct efficient coordination even if the communication costs are small relative to the communication gains. It should be

[14] As noted by Crawford (1998), reassurance may have a strong effect on coordination success.

noted that whereas the mere direct (technical) cost of communication today is often negligible, the indirect expected cost can be substantial. For instance, a firm that wants to collude with its competitors takes the risk that the initiation of such communication can be used against it in a future trial. The policy implication here is that making the intent to collude illegal and subject to penalties may effectively prevent such coordination, not only for reasons of deterrence but also because of the free-riding mechanism.[15]

Free-riding on communication may also be relevant more directly. For instance, when telephone companies design their fees, awareness of this behavioral tendency can be essential. A phone company with substantially higher start-up fees than other companies can expect its subscribers to be somewhat less inclined to initiate calls in comparison to its competitors' subscribers.[16] As a consequence (and disregarding complications such as termination fees), while the company's subscribers free-ride on the communication cost, it is the competitors who get the major revenues from the telephone bills.

In a recent survey of the literature on coordination failure, Devetag and Ortmann (2007) maintain that communication can be seen as a successful solution to coordination failure. They also conclude that since communication is often observed in real life, coordination failure should be seen as an exception rather than a rule both inside and outside the lab. Although we agree with this conclusion our results suggest that the exception might be more prevalent than we first thought.

[15] Of course one should always be careful when extrapolating results to the policy domain. The effect of costly communication has been shown in the different context of infinitely repeated Bertrand games, both theoretically (McCutcheon, 1997) and experimentally (Andersson and Wengström 2007), to facilitate collusion.

[16] Even if the fee for one call is small, a free-riding strategy over time may involve substantial cost savings.

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Appendix A

Table A1. Treatment Design

Session (# subjects)	***Treatment subsession 1***	***Treatment subsession 2***	***Treatment subsession 3***
1(18)	*No communication*	*c=0*	*c=5*
2(24)	*c=0*	*c=3*	*No communication*
3(20)	*c=3*	*c=0*	*No communication*
4(16)	*No communication*	*c=0*	*c=5*
5(24)	*c=0*	*c=3*	*No communication*
6(20)	*c=3*	*c=0*	*No communication*

Note: Sessions 1-3 entail an S treatment whereas sessions 4-6 entail an A treatment.

Appendix B: Instructions for the experiments

This is a translation of the instructions given to the subjects in the two experiments. We will only present instructions for the S treatments. The instructions for A treatments only differed in the payoff matrix. Our comments are given in *italics*.

General Information

You are going to participate in an economic experiment. You receive SEK 100 for your participation and you can earn additional money on the choices you make during the experiment. The amount you earn depends on your and your co-players' choices. In the experiment you earn experimental "daler", which will be converted to SEK when the experiment is finished according to the exchange rate 1 daler = SEK 0.45. We ask you to be silent during the experiment. If you have any questions, please raise your hand, so that the experimenters can come to you and answer your questions.

You will make your choices by clicking on your computer screen. It is important that you understand the structure of the game, you are therefore asked to carefully read the instructions to make sure that you fully understand it before the experiment starts.

You will make choices in three different strategic situations. Each strategic situation will be repeated 10 times.

Strategic Situation *S*

The choice you are about to make concerns entry on two markets. This situation will be repeated 10 times. In each round you will be paired with a new co-player. You will not receive any information about who you have been matched with.

You are asked to choose one out of four possible strategies in this situation:

- Stay out
- Only enter market x
- Only enter market y
- Enter both markets

Below you will find information on the amounts you will earn in this situation for different choices (the amount earned by your co-player is given in parenthesis):

The co-player:	stay out	enters x	enters y	enters both
Your strategy :				
stay out	12 (12)	12 (24)	12 (24)	12 (36)
enter x:	24 (12)	8 (8)	24 (24)	8 (20)
enter y:	24 (12)	24 (24)	8 (8)	8 (20)
enter both:	36 (12)	20 (8)	20 (8)	4 (4)

Before you choose strategy you and your co-player have the opportunity to communicate via the computer terminal. To open your side of the communication channel you will pay an initial fee of *c* daler.[17] When you send your first message the fee will be deducted automatically from what you earn. Neither you nor your co-player is however required to do what you may have said in your messages. In the following page there is a graphic illustration of how the communication procedure. **Note: It is forbidden to write messages where you identify yourself by for example name, sex, or appearance. Violation against this rule will lead to that the entire payment will be withdrawn.**

[17] *c was set to 0,3 or 5*

Computer screen (above). Translation of the text in the boxes:

Top box: Here you are able to see those messages that you and your co-player sent. Note that it does not cost anything to look at your co-players messages.

Middle box: You write the messages you want to write here. You send a message by pressing Return.

Bottom box: During 90 seconds you have the opportunity to communicate with the other group participant. It costs 0 daler to open your side of the communication channel.