# Costly Preplay Communication and Coordination in Stag-Hunt Games

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**Abstract**

In this paper, we experimentally investigate the impact of costly indirect and direct messages on coordination levels in a stag-hunt game. We also compare the coordination rates with costly pre-play communication to the rates with costless pre-play communication. Three main insights emerge from our experiments. First, we find a significant decrease in message usage with message cost in both treatments and a higher decrease in the indirect-message treatment. Second, we find that although there is no significant effect of costless or costly indirect messages on the frequency of risky actions, both costless and costly direct messages significantly increase the frequency of risky actions. Third, while we find a significant increase in the coordination rate on the payoff-dominant equilibrium from costless indirect message treatment to costly indirect message treatment, this rate significantly decreases from costless direct message to costly direct message treatment. Our findings show that depending on the structure of messages, message cost may increase or decrease the coordination rates on the payoff-dominant equilibrium.

**Keywords:** coordination, cheap talk, pre-play communication, risk information, costly messages

**JEL classification codes:** C72, C91

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# 1 Introduction

People may use signals to convey some information about themselves to their opponents in strategic interactions under incomplete information. Depending on the message type or to make the message more credible, people may be willing to bear some cost, e.g., investing in education for the job search, reciprocal altruism or voting by social image concerns. This paper analyzes the impact of optional and costly messages on the coordination levels in a stag-hunt game when the message is indirect or direct. The effect of using these messages on socially desirable efficient coordination is also compared to the cases in which there are no messages (or pre-play communication) or the messages are costless.[1]

For the indirect message or signal case, we give a chance to one of the players to signal her risk attitude to the other player. Such an indirect message is important for the game when the payoffs from the game are monetary and strategic risk exists in the game. In a stag-hunt game, players choose between strategically safe and risky actions (respectively, Action A and Action B in Table 1). Depending on a player's own action choice as well as her opponent's action choice, they may end up in the payoff-dominant equilibrium ((Action B, Action B)) indicating socially desirable efficient coordination, in the risk-dominant equilibrium ((Action A, Action A)), or out of equilibrium ((Action A, Action B), (Action B, Action A)). For the direct signal case, we give a chance to one of the players to signal his intented action choice before playing the game.

Table 1: 2x2 Stag-Hunt Game ($b > a > c > 0$)

| | Action A | Action B |
|---|---|---|
| Action A | $a, a$ | $a, c$ |
| Action B | $c, a$ | $b, b$ |

The stag-hunt game with costly messages falls in the class of "money burning" games.[2] Ben-Porath and Dekel (1992) show that as long as only one of the players has the option to send a

[1] We study costly pre-play communication to make both senders and receivers think about the effects of the messages more. Our aim is to concentrate on the impact of credible messages, not cheap-talk, on the efficient coordination. See Büyükboyacı and Küçükşenel (2016) for more on the impact of costless messages or cheap talk on efficient coordination.

[2] The games that are similar to money burning games require players to apply forward induction reasoning while playing the game. The common feature of most experiments using such games is that there is a two-stage game. In the first stage, a player can typically choose an outside option, burn money, or pay an entrance fee. In the second stage, there is typically a game with a coordination problem such as the battle of the sexes or pure coordination

costly message, playing the efficient action without sending a message is the unique outcome that survives iterated admissibility.[3] In our paper, we give the opportunity to communicate to the sender. The sender chooses to send a message about how risk averse he is when the message is indirect and which action he would choose in the game when the message is direct. As Ben-Porath and Dekel (1992) suggest, the prediction of our game is the sender does not send a costly message independent of whether the message is direct or indirect and players are still able to coordinate on the payoff-dominant equilibrium.

There are only few experimental papers testing costly signaling in coordination games. The first one is Fehr (2011) in which he looks at the effect of costly communication when two groups with diverging precedents have to interact. To have precedent, subjects play the weakest-link game repeatedly in the first part and the experimenter merges two groups with diverging precedents into a larger group in the second part. This leads to coordination failures as expected. Subjects can decrease these failures by choosing communication with a small fee. Nevertheless, subjects from groups with an efficient precedent in the initial phases do not care about coordination failures and choose not to communicate.

The second one is Blume, Kriss and Weber (2014) in which they look at the effect of endogenous and costly two-way pre-play communication on the outcome of a 2x2 stag-hunt game. They show that even small costs dramatically reduce message usage, but efficient coordination of actions occurs with high frequency (i.e. as much as the one that is observed under costless communication). In both costless and costly communication treatments they asked subjects to send the message of which action they would take in the game. In addition to direct messages similar to theirs, we also ask senders to send indirect messages about their risk preferences through which they would signal how likely they are to choose Action A or Action B. With this one-way communication (only one of the players can send a message) or message, the receiver can indirectly infer the possible action choice of the sender.

To test the effect of such signaling on coordination in stag-hunt games, we design an experiment

game. There is still an ongoing debate about validity and robustness of forward induction as an equilibrium selection criterion. Although some experiments (Cooper et al., 1989, 1992; van Huyck et al., 1993; Cachon and Camerer 1996; Shahriar 2014) find support for forward induction argument, some (Cooper et al., 1993; Brandts and Holt, 1995; Huck and Muller, 2005; Brandts et al., 2007; Balkenborg and Nagel, 2008) did not. The main focus of this study is to understand how costly communication affects the coordination rates depending on the message type. It is not whether subjects understand and apply forward induction reasoning particularly.

[3]They show that this does not hold when both players have the option to send a message though.

with three stages. In the first stage, we use a common technique (Holt and Laury, 2002) to elicit subjects' risk aversion. This technique involves two lotteries: one risky and one safe. The riskiness of the lotteries is determined by the difference between the high and low payoffs. There are ten different situations and individuals are asked at which situation they want to switch from a 'safe' lottery to a 'risky' lottery (hereafter, the situation at which a subject switches from the 'safe' lottery to the 'risky' lottery is named as her 'risk threshold'). At a given situation the probability of obtaining the high payoff is identical in both lotteries. These probabilities range from 1/10 to 1 in increments of 1/10 between situations. The expected payoff of the risky lottery becomes higher than the expected payoff of the safe lottery after Situation 5. Depending on agents' being risk loving, risk averse, or risk neutral, they can switch from the safe lottery to the risky lottery before, after, or at Situation 5, respectively.

In the second stage (communication stage), there are four treatments: costless-indirect message, costless-direct message, costly-indirect message, and costly-direct message. At the beginning of this stage, the subject group is divided into two: one group is composed of senders and the other group is composed of receivers. Senders and receivers are matched to play the game in Table 2. However, before playing the game, in the first (third) treatment, senders are asked whether they want to send any information to their matches about their choices in the first stage, at no cost (at a cost). If they want, senders were able to send which of the three groups they belong to according to their choices in the first stage. If a sender switched from Option A to Option B in situations 1, 2, 3, and 4 in the first stage, she belongs to "Group 1"; if she switched from Option A to Option B in situations 5, 6 and 7 in the first stage, she belongs to "Group 2", and if she switched from Option A to Option B in situations 8, 9 and 10 in the first stage, she belongs to "Group 3". In the second (fourth) treatment, senders are asked to send which action they would choose in the game, at no cost (at a cost). If they want, senders were able to send which action they would choose in the game. Nevertheless, the sender does not need to send true message in any of the treatments. When the communication is costly, only the sender bears the cost. The cost of communication is subtracted from the payoffs that belong to sender in Table 2.

Table 2: Experimental Stag-Hunt Game

| | Action A | Action B |
|---|---|---|
| Action A | $570, 570$ | $570, 70$ |
| Action B | $70, 570$ | $770, 770$ |

In the third stage, senders and receivers play the game in Table 2 with their matches. After both players tell their action choices, subjects see a feedback screen in which they see their action choices, payoffs, sender's announcement and sender's true type or action.

Three main insights emerge from the experiments. First, subjects' message usage decreases significantly both under direct or indirect message treatments with a cost but a higher decrease is observed when the message is indirect. Second, we find that although there is no significant effect of costless or costly indirect messages on the frequency of risky actions, both costless and costly direct messages increases the frequency of risky actions significantly. Third, while we find a significant increase in the coordination rate on the payoff-dominant equilibrium from costless indirect message treatment to costly indirect message treatment, this rate significantly decreases from costless direct-message treatment to costly direct-message treatment. Our findings show that depending on the structure of messages, costly message or communication may increase or decrease the coordination rates on the payoff-dominant equilibrium and hence socially desirable efficient coordination.

The rest of the paper is organized as follows: *Section 2* describes the experimental design and procedures. In *Section 3*, we present the results of our experiment. We close the paper with a discussion and some concluding remarks in *Section 4*. All supplementary material, including the instructions for the experiment, are presented in the *Appendix*.

## 2 Experimental Design

The experiment was conducted at the METU-FEAS Behavioral and Experimental Laboratory (BEL) at the Middle East Technical University (METU). Subjects were recruited by e-mail using the BEL database, which consists of undergraduate students at METU. Overall, 240 subjects participated in the experiment. The data coming from 144 subjects is taken from Büyükboyacı and Küçükşenel (2016). There were twenty sessions and each lasted 45 minutes. Each subject participated in only one session. All sessions were computerized using z-tree (Fischbacher, 2007). Throughout the experiment, payoffs were described in terms of "tokens". 100 tokens corresponded to one Turkish lira. A subject earned 15.24 TL on average, including a 5 TL participation fee.[4] The experiment for the baseline consisted of two stages and the treatments were three stages.[5]

[4]As of January 2016, the minimum wage rate is 8.13 TL per hour in Turkey.

[5]The instructions in a session were read in two groups: First, the instructions for the first stage is read then instructions for the second and the third stage were read together. Full instructions for the stages of costly indirect-

In the first stage, we elicite the risk attitude of each subject by Holt and Laury's (2002) method. According to this method, subjects must choose one of two lotteries available for ten different situations (Figure 1 in Appendix A).[6] In Situation 1, the less-risky lottery (Option A) has a higher expected payoff than the more-risky one (Option B). Hence, only very strong risk lovers pick Option B in this situation. Moving further down the table in Figure 1, the expected payoff difference between the lotteries in Option A and in Option B decreases and eventually turns negative in Situation 5. In Situation 10, all subjects must choose between a sure payoff of 400 tokens (Option A) and a sure payoff of 770 tokens (Option B). Since all rational individuals prefer the latter one in the last situation, by then all subjects should have switched from Option A to Option B. In this experiment, a consistent subject should switch from Option A to Option B just once. However, earlier experiments using Holt and Laury's (2002) method showed that some subjects may go back and forth between Option A and Option B. To prevent such behavior in our experiment, we asked subjects when they wanted to switch from Option A to Option B.

The payoffs for the lottery choices in the experiment were selected so that the point at which they switched from Option A to Option B, would provide an interval estimate of a subject's constant relative risk aversion (CRRA). With these payoffs, it is optimal for a risk-neutral subject to switch from Option A to Option B in Situation 5. Similarly, it is optimal for a risk-averse (risk-loving) subject to switch from Option A to Option B after (before) Situation 5. The payment for this stage was determined according to a randomly chosen row among these ten situations and the subject's lottery choice in that particular row. Subjects learned their earnings from this stage at the end of the experiment.

The second stage differs according to the treatment. There are five treatments in our experiment: baseline, costless indirect message, costless direct message, costly indirect message, and costly direct message.[7] In the baseline (No Communication) treatment, subjects play the game in Table 2 for twelve periods with re-matching after every period. Each period, participants are anonymously and randomly re-matched, play the one-shot game, and see the results of that period. In every period after the first, players see their own choice, opponent's choice and resulting outcome, but do not know the identity or history of their current opponent.

message signalling treatment can be found in Appendix A.

[6]The first stage to elicit risk attitute of each subject in all treatments is identical to Büyükboyacı and Küçükşenel (2016).

[7]The baseline treatment, costless indirect message, and costless direct message treatments are identical to Büyükboyacı and Küçükşenel (2016).

In costless indirect message (Costless Type-Message) treatment the subject group was divided into two: senders and receivers. In each period, before playing the game in Table 2, senders had the option of not sending a message or sending a message about their choices in the first stage. If they wanted to send a message, they were able to send which of the three groups they belong to according to their choices in the first stage. If a sender switched from Option A to Option B in situations 1, 2, 3, and 4 in the first stage, she was actually in "Group 1", risk-loving group; if she switched from Option A to Option B in situations 5, 6 and 7 in the first stage, she was actually in "Group 2", medium risk-averse group, and if she switched from Option A to Option B in situations 8, 9 and 10 in the first stage, she was actually in "Group 3", high risk-averse group. The senders and receivers were told that senders did not need to send true message about which group they actually belonged. Either the message sent or not, subjects played the game in Table 2 in the third stage. Subjects repeated the described game 12 periods with new matches by keeping their roles during the whole session. A subject remained as a sender or receiver in a whole session.

In costless direct message (Costless Action-Message) treatment the subject group was divided into two: one group was composed of senders and the other group was composed receivers. In each period, before playing the game in Table 2, senders had the option of not sending a message or sending a message about which action they would like to choose. If they wanted to send a message, they were able to send a message about which action they would choose in the third stage "Action A", safe action or "Action B", risky action. The receivers were told that senders did not need to send true message about which group she actually belonged. Either the message sent or not, subjects played the game in Table 2 in the third stage. Subjects repeated the described game 12 periods with new matches by keeping their roles during the whole session.

In costly indirect message (Costly Type-Message) treatment, different than the Costless Type-Message treatment, if a sender wants to send any information about her choices in the first stage, she has to pay for sending that information to a receiver. Similarly, in costly direct message (Costly Action-Message) treatment, different than the Costless Action-Message treatment, if a sender wants to send information about which action she would choose in the game, she has to pay for the cost of message. Again the message does not need to be true in either of the costly treatments. The cost of the message was 70 tokens for the sender and nothing for the receiver. In the case of such communication, subjects played the game in Table 3 in the third stage. If a sender does not want to send any information about her choices in the first stage (or her potential action choices), in the third stage the sender and the other player, receiver, play the game in Table 2.

Table 3: The Game if Costly Preplay Communication Occurs

| | Action A | Action B |
|---|---|---|
| Action A | $500, 570$ | $500, 70$ |
| Action B | $0, 570$ | $700, 770$ |

Subjects' payoffs were determined according to their action choices in the third stage in the costless-message treatments and their decision in the third stage plus whether they send a costly message or not in the costly-message treatments. In every period after the first, a player sees her own choice, opponent's choice and resulting outcome, the sender's announcement, true group of the sender, but does not know the identity or history of her current opponent. Subjects are paid a randomly drawn period's payoff for the experiment in both treatments to avoid potential wealth effect.

# 3 Results

Forward-induction reasoning allows us to predict high coordination rates on the payoff-dominant equilibrium independent of the message content when there is a cost for sending a message. In particular, we expect high coordination rates both in Costly-Type and Costly-Action treatments. Since earlier studies show that high coordination rates on the payoff-dominant equilibrium can be achieved by Costless Action-Message treatment, we expect coordination rates on the payoff-dominant equilibrium in Costly-Type and Costly-Action treatments as high as Costless Action-Message treatment. That is to say that the cost of the message should not have any significant effect on coordination rates according to forward induction argument.

We first check how frequency of risky action choice, coordination rate (coordination both under risk-dominant and payoff-dominant equilibrium) and coordination on the payoff-dominant equilibrium change as treatment changes. In Table 4, we summarize these frequencies under the baseline (with no pre-play communication), Type-Message Treatment (subjects have the option to announce their risk group) when the messages are costless and costly and Action-Message Treatment (subjects have the option to announce which action they would choose in the game) when the messages are costless and costly. As can be seen from the last four columns of the Table 4, when the message is costly, while the frequency of risky action choice increases in Type-Message treatment (costly message increases frequency of risky action choice from 27% to 31%), it decreases in Action-Message

Treatment compared to no cost situation (costly message decreases frequency of risky action choice from 73% to 54%).[8] Similarly, while the message cost increases the coordination rates in Type-Message treatment (costly message increases coordination rate from 66% to 71%), it decreases coordination rates in Action-Message treatment (costly message decreases the coordination rates from 86% to 68%).[9] However, coordination rates are higher in all treatments than in the baseline. Lastly, while with costly messages, coordination rate on the payoff-dominant equilibrium significantly increases in Type-Message treatment (costly message increases coordination rate on the payoff-dominant equilibrium from 9% to 16% and this difference in percentages is significant according to two-sample test of proportions, $p = 0.01$), with costly messages coordination rate on the payoff-dominant equilibrium significantly decreases in Action-Message treatment (costly message decreases coordination rate on the payoff-dominant equilibrium from 67% to 38% and this difference in percentages is significant according to two-sample test of proportions, $p = 0.00$). Further, coordination rates on the payoff-dominant equilibrium are significantly different between Costless-Action Message treatment and Costly-Type Message treatment (Costly-Action Message treatment). As in Blume, Kriss and Weber (2014), we found that message usage decreases significantly (the first two rows of Table 6) when the messages are costly. However, unlike them we observe that this decrease in the message usage did not affect the risky action frequency as predicted for both costly Type or Action-Message treatments. In other words, subjects failed to follow forward-induction reasoning and it is observed that this reasoning depends on the message content.

Table 4: Frequency of Risky-Action Choice and Coordination According to Treatments

| | Baseline | Type-Message Treatment | | Action-Message Treatment | |
|---|---|---|---|---|---|
| | | Costless | Costly | Costless | Costly |
| Frequency of risky action choice | 30% | 27% | 31% | 73% | 54% |
| Coordination rate | 61% | 66% | 71% | 86% | 68% |
| Coordination rate on the payoff-dominant equilibrium | 11% | 9% | 16% | 67% | 38% |

[8] Although the change in the frequency of risky action in Type-Message treatment is not significant ($p = 0.13$), it is significant in Action-Message treatment($p = 0.00$) according to a two-sample test of proportions.

[9] Although the change in the coordination rates in Type-Message treatment is not significant ($p = 0.20$), it is significant in Action-Message treatment($p = 0.00$) according to a two-sample test of proportions.

The potential reason of subjects' failure for forward-induction reasoning may be related to level of thinking. Subjects should first figure out that sending a message and choosing Action A is a strictly dominated strategy and they should find the equilibrium outcome when the message is sent, then the game will be similar to the games with outside option for the sender. Even either sender or receiver sees forward-induction reasoning, it may not be enough for them to choose strategies accordingly, because if either of them fails to do such reasoning, they won't be able to coordinate.

Table 5: Results on Risky-Action Choices

| Results of Probit Regression<br>Standard Errors are Clustered at the Subject Level<br>Dependent Variable: Choosing the Risky Action | | |
|---|---|---|
| | Costless-Type | Costly-Type |
| Independent Variables | #Subjects=96<br>#Observations=1152 | #Subjects=96<br>#Observations=1152 |
| Treatment (TypeMessage=1,Baseline=0) | −0.05(0.06) | −0.01(0.06) |
| Gender Indicator (Male=1, Female=0) | −0.05(0.06) | −0.09(0.06) |
| First stage decision (from 1 to 10) | −0.01(0.02) | −0.01(0.02) |
| Period | −0.02***(−0.004) | −0.02***(−0.004) |
| Coefficients represent marginal effects at the average of independent variables<br>Standard Errors are in the parantheses.<br>***=statistically significant at 1% level | | |

We also check what affects a subject's likelihood of choosing risky action. To this end, we code our dependent variable as a bivariate one which takes the value 1 if a subject chooses Action B (the risky action) in a given round and 0 if he or she chooses Action A (the safe action). Then, we run marginal effect probit regression analyses with the gender, level of risk aversion, number of prior rounds in which he or she played the game, and the treatment (Treatment variable takes value 1 if the data come from Costless Type-Message Treatment for the analysis on the second column and it takes value 1 if the data come from Costly Type-Message Treatment for the analysis on the third column, 0 if the data come from Baseline, for both analyses). In the random effects probit regression analyses, standard errors are clustered at the subject level. The results are presented in Table 5. As can be seen from the table only Period (the number of prior rounds) negatively affects

the probability of risky action in both analyses.[10] Contrary to what is expected according to forward-induction reasoning, subject's likelihood of choosing risky action did not change in Costly Type-Message treatment compared to the baseline or Costless Type-Message treatment.

Table 6: Frequency of Messages and the Actions Given the Sent (Received) Messages

| | Sent (Received) Message Type | Number of Messages | Given the message, frequency of risky action choice by Sender (Receiver) |
|---|---|---|---|
| Costless | No Message (Type) | 59(20%) | 22% (27%) |
| | *No Message (Action)* | *23(8%)* | *38%(15%)* |
| Costly | No Message (Type) | 259(90%) | 25%(29%) |
| | *No Message (Action)* | *130(45%)* | *35%(42%)* |
| Costless | Group 1 | 58(20%) | 34% (29%) |
| | *Action A* | *36(12%)* | *6%(8%)* |
| Costly | Group 1 | 19(7%) | 84%(58%) |
| | *Action A* | *39(14%)* | *18%(8%)* |
| Costless | Group 2 | 77(27%) | 23% (23%) |
| | *Action B* | *229(80%)* | *86%(88%)* |
| Costly | Group 2 | 6(2%) | 33%(66%) |
| | *Action B* | *119(41%)* | *84%(83%)* |
| Costless | Group 3 | 94(33%) | 31% (23%) |
| | – | – | – |
| Costly | Group 3 | 4(1%) | 50%(25%) |
| | – | – | – |

Table 6 shows how the frequency of messages and given the message, the frequency of risky actions by senders change in the Type- and Action-Message treatments when the message is costly or costless. Subjects chose to send messages in Action-Message treatment significantly more frequently than Type-Message treatment when the messages are costless (92% and 80%, respectively) and costly (55% and 10%, respectively).[11] The message cost lead to a significant drop in sent messages in either treatment but a much higher drop in Type-Message treatment. This may be due

[10] We do not run a regression with action data due to high collinearity between treatment variable and dependent variable, risky action choice.

[11] A two-sample test of proportions is used.

to the fact that subjects believe the effect of their messages more, in Action-Message Treatment.[12] Given subjects send no message, while the percentages of senders and receivers choosing the risky action are similar under Type-Message treatment and the percentages of senders choosing the risky action are similar under Action-Message treatment when the messages are costless or costly, the percentage of receivers choosing the risky action under Action-Message treatment is significantly higher when the messages (42%) are costly than they are costless (15%). Meaning that, receivers expect to receive a message to choose the risky action in costless Action-Message treatment, they do not expect that in costly Action-Message treatment. According to Ben-Porath and Dekel (1992), if one of the players has the option to send a costly message, playing the efficient action without sending a message is the equilibrium. This result should hold independent of the message content. Nevertheless, neither in Type-Message treatment nor in Action-Message treatment, when the messages are costly and senders do not send messages, neither senders nor receivers choose the risky action more than 42% of the time.

In Type-Message treatment, subjects in the sender role send most messages by saying that they belong to Group 1, risk-loving group, (7%) if they choose to send a message. Given they sent such a message, 84% of senders and 58% of receivers chose the Action B (Risky Action). The difference between the percentages for senders and receivers may stem from the fact that receivers cannot put themselves into senders' shoes. In other words, they may not be able to understand the strategic motivation of senders through such a message. Compared to costless type message treatment, the percentage of senders choosing the risky action may be higher when the message is costly since the senders pay a cost for the message they may think more throughly while sending the message and choosing an action afterwards.

Although sending a costly Action A message is a strictly dominated strategy[13], the percentage of subjects sending Action A messages is 14%.[14] Given using a dominated strategy, Action A message, 18% of the senders chose Action B (Risky Action) by increasing their chance for a coordination failure and guaranteeing 0 token.[15] The frequency of sending Action A message is similar when the

[12]One may expect a higher usage of costly messages when the message is indirect to increase credibility of the message.

[13]This is because a subject can earn 570 tokens (5.7 TL) by choosing the safe action without sending a costly message.

[14]Rational subjects would not choose a strictly dominated strategy. Subjects usually avoid dominated strategies with frequencies greater than 90% of the time (Crawford, 1997).

[15]According to questionnaire data, some subjects thought that cheating their partner is the aim of the game, hence they chose actions that contradict with their announcement.

message is costless or costly. The percentage of subjects who chose to send Action B (Risky Action) message in Action-Message treatment is quite high (80%) when the message is costless. Further, among those senders, i.e., sending Action B message chose the risky action 80% of the time and receivers receiving this message chose the risky action 88% of the time. The percentage of subjects who chose to send Action B (Risky Action) message in Costly Action-Message treatment drops to 41%. Among these senders (receivers) 84% (83%) of them chose Action B (risky action).

An agent should expect the likelihood of risky action should decrease as his opponent is more risk averse. Further, he should think that his message creates a similar effect on his opponent. As a result, we expect the frequency of risky action choice to decrease as the sender sends a message saying he belongs to a higher risk group. Similarly for the receiver, we expect the frequency of risky action choice to decrease as the receiver receives a message saying his opponent belongs to a higher risk group. As seen in Table 6, although this prediction does not hold when the messages are costless, it holds when the messages are costly.[16]

# 4 Conclusion

We report experimental results of a stag-hunt game related to coordination rates with one-way costly or costless pre-play communication. According to our findings, subjects do not follow forward induction reasoning, i.e., eventhough the message cost decreases the sent message rates the subjects do not choose the risky action in the subgame. Nevertheless, we find that depending on the message type (whether it is direct or indirect), message cost can help subjects to coordinate more often on the payoff-dominant equilibrium. In particular, when the message is indirect (direct), subjects coordinate on the payoff-dominant equilibrium more (less) often under costly message than costless message.

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# 5 Appendix: Instructions

Welcome and thank you for participating in our experiment.

We will read the instructions together. Please do not touch the keyboard for now and listen to these instructions carefully.

This is an experiment about economic decision making. All participants will earn some money during the experiment. The money you earn might be different from the other participants earnings. This amount is dependent on your decisions as well as the decisions of other participants. Please do not talk with each other during the experiment. We will have to terminate the experiment if you violate this rule. We will now describe the experimental procedures. It is very important that you understand all the parts. Please raise your hand if you have a question.

There will be two parts in our experiment. You will learn about these parts right before they start. Your aim in both parts is to earn as much money as possible. At the end of the experiment, you will learn about your total earnings from each part. Your earnings will be in tokens. 100 tokens = 1 TL. Your total earnings will be rounded to the nearest 25 kurus. In addition to your earnings in the experiment, you will be paid a 5 TL participation fee.

**PART 1**

You will see a table something like this in stage 1. In this part, you will face 10 different rows.

fhFU6.7594in2.9014in0ptInstructions Part 1risk.gifEach row provides two options, Option A and Option B. You will slide the bar in the middle to show which option you chose for that situation.

These options are basically lotteries that indicate your chances of winning a certain payoff. For each row, you will be asked to choose one among option A and option B. If you choose Option B for one row, you will have to choose this option for the remaining rows.

For instance, consider row 1. In Row 1 Option A offers 400 tokens with probability 1/10 and 320 tokens with probability 9/10. In Row 1 Option B offers 770 tokens with probability 1/10 and 20 tokens with probability 9/10. Your earnings from this part will be determined as follows: First the system will pick a number between 1 and 10. This number will tell us the row that will be used in determining your earnings from this part.

Suppose that this number turns out to be 7 and that you have chosen option A for row 7. The system will choose another number between 1 and 10. If this number is 7 or smaller (with probability 7/10 ), you will earn 400 tokens. If this number is 8 or larger (with probability 3/10 ), you will earn 320 tokens.

**PART 2**

You will be grouped into three according to your choices in the first stage: Group 1: You belong to this group if you have switched from Option A to Option B in situations 1, 2, 3, or 4 in the first stage, Group 2: You belong to this group if you have switched from Option A to Option B in situations 5, 6, or 7 in the first stage, Group 3: You belong to this group if you have switched from Option A to Option B in situations 8, 9, or 10 in the first stage.

In this stage, there will be 12 periods that are similar to each other. In each period some of you will be a sender; some of you will be a receiver. Each of you will keep your roles as sender or receiver during the experiment. On the top of the screen you can see whether you will be sender or receiver during the whole stage. In each period senders will be matched to receivers randomly. You will not be informed about whom you were matched with at any time.

Senders can send one of the following messages before playing the game: "I belong to Group 1"; "I belong to Group 2"; "I belong to Group 3" or "I do not want to send a message." Senders are allowed to send any message they want regardless of in which group they are. If senders choose to send a message, they play the first game matrix, if they choose not to send a message, they play the second game matrix, where row player is sender and column player is receiver:

| | Action A | Action B |
|---|---|---|
| Action A | $500, 570$ | $500, 70$ |
| Action B | $0, 570$ | $700, 770$ |

| | Action A | Action B |
|---|---|---|
| Action A | $570, 570$ | $570, 70$ |
| Action B | $70, 570$ | $770, 770$ |

Your and other person's period earnings will be determined by the actions you chose in the described game when a sender did not send a message: If both you and the other person chose Action A, both of you will earn 570 tokens. If you chose Action A but the other person chose Action B; then you will earn 570 tokens and the other person will earn 70 tokens. If you chose Action B but the other person chose Action A; then you will earn 70 tokens and the other person will earn 570 tokens. If both you and the other person chose Action B, both of you will earn 770 tokens.

Your and other person's period earnings will be determined by the actions you chose in the described game when a sender sent a message: If both the sender and the receiver chose Action A, the sender will earn 500 tokens and the receiver will earn 570 tokens. If the sender chose Action A but the receiver chose Action B; then the sender will earn 500 tokens and the receiver will earn 70 tokens. If the sender chose Action B but the receiver chose Action A; then you will earn 0 tokens and the receiver will earn 570 tokens. If both the sender and the receiver chose Action B, the sender will earn 700 tokens and the receiver will earn 770 tokens.

You will see the following information on the screen after you made your action choices. Your and the other person's action choices, the announcement made by senders and which group actually s/he belongs to, your earnings at that period.

Then you will start new period as explained and will be matched someone else in the new period. At the end of the experiment, one of 12 periods will be drawn and your earnings at that period will be counted as your earnings from the second stage. Since each period has an equal chance in drawing, you should make your decision in each period carefully.