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Abstract
In a laboratory experiment with 754 participants, we study the canonical one-shot moral hazard problem, comparing treatments with unobservable effort to benchmark treatments with verifiable effort. In our experiment, the players endogenously negotiate contracts. In line with contract theory, the contractibility of the outcome plays a crucial role when effort is a hidden action. If the outcome is contractible, most players overcome the hidden action problem by agreeing on incentive-compatible contracts. Communication is helpful, since it may reduce strategic uncertainty. If the outcome is non-contractible, in most cases low effort is chosen whenever effort is a hidden action. However, communication leads the players to agree on larger wages and substantially mitigates the underprovision of effort.

Keywords: Moral hazard; Hidden action; Contract theory; Incentive theory; Laboratory experiments.

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1 Introduction

Economic relationships are often governed by contracts. Research in contract theory explores what contracts are optimally signed depending on the prevailing information structure (see Hart and Holmström, 1987).[1] In particular, much attention has been devoted to "moral hazard" environments with post-contractual informational asymmetries due to hidden action (where a party's action, e.g. an effort level, is unobservable) and hidden information (where a party obtains private information about a state of the world, e.g. a realized profit level).[2] Contract theory argues that under certain circumstances, suitable contracts can overcome the hurdles posed by these informational asymmetries, while under different circumstances, hidden action and hidden information may lead to second-best results which are inferior to the first-best results that would be achieved under symmetric information. In the present paper, we report about a laboratory experiment with 754 participants that was designed to capture the essence of moral hazard theory. Our aim is to explore to what extent actual human behavior is consistent with the contract-theoretic considerations.

Our paper builds on the important work by Charness and Dufwenberg (2006), who have conducted the most prominent experiment featuring a hidden action problem. In the canonical one-shot hidden action model, the agent chooses an effort level, which stochastically influences the outcome (i.e., the principal's return). Charness and Dufwenberg (2006) have exogenously fixed an outcome-independent contract, since their goal was to study the psychological connections between trust, guilt, communication, and cooperation. In contrast, we allow the players to endogenously negotiate individual contracts. Following the contract-theoretic approach, we compare treatments in which effort is a hidden action with benchmark treatments where effort is verifiable. Moreover, our treatments vary in whether or not the outcome is privately known by the principal and whether or not communication is possible.

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[1] For comprehensive textbook expositions of contract theory, see Laffont and Martimort (2002) and Bolton and Dewatripont (2005).

[2] Following Hart and Holmström (1987), in this paper we consider settings in which the contractual parties are symmetrically informed when the contract is signed. While not all authors use the same taxonomy, Hart and Holmström (1987, p. 76) refer to contract-theoretic models in which there is symmetric information at the time of contracting as "moral hazard" models, with the two subcategories "hidden action" and "hidden information" (sometimes called "hidden knowledge"), following Arrow (1985). In contrast, models in which the agent has precontractual private information are categorized under the heading of "adverse selection." For experimental tests of adverse selection theory, see Asparouhova (2006), Cabrales et al. (2011), and Hoppe and Schmitz (2013, 2015).

Specifically, in the first part of our experiment we focus on the standard hidden action setup in which the principal's return is contractible. We study four treatments. In two treatments, there is no communication, while in the other two treatments, we allow for free-form communication. In each of the two cases, we compare a treatment in which effort is a hidden action with a benchmark treatment in which effort is verifiable. In our experiment, the players can negotiate a contract in an alternating offers bargaining game.[3] It turns out that when the principal's return is contractible and effort is unobservable, the players often overcome the hidden action problem by agreeing on incentive-compatible contracts that correspond closely to theoretically optimal contracts. When we compare our hidden action treatment with the benchmark treatment in which effort is verifiable, then in the absence of communication we find that hidden action somewhat reduces the fraction of cases in which high effort (i.e., the first-best decision) is chosen. Yet, in the presence of communication the chosen effort levels do not differ significantly when we compare the hidden effort and the verifiable effort treatments. Hence, we conclude that the welfare loss due to hidden action that we observe in the absence of communication is mainly driven by strategic uncertainty, which is reduced by communication.[4]

In the second part of our experiment, we conduct four additional treatments in order to study the combination of hidden action (on the side of the agent) with hidden information (on the side of the principal). Specifically, these four treatments correspond to the four treatments of the first part except that only the principal learns her return, such that outcome-contingent wages are no longer feasible. Given that the principal's return is non-contractible, contract theory predicts that a second-best efficient contract inducing low effort will be signed when effort is a hidden action, while high effort would be specified when effort is verifiable.[5] Indeed, while we find that the vast majority of players sign contracts specifying high effort in the treatments in which effort is verifiable, low effort is the most frequently observed decision when effort is a hidden action. In the

[3] In line with the theoretical analysis that Charness and Dufwenberg (2006, p. 1581) perform in order to find the wage that they fix exogenously, we thus give both parties approximately equal bargaining powers.

[4] Note that when effort is a hidden action, the principal may feel uncertain about whether the agent has understood that given an incentive-compatible contract, exerting high effort will be in the agent's self-interest (while this is not a problem when effort is verifiable). Communication can reduce this strategic uncertainty.

[5] Combinations of hidden action (on the side of the agent) and hidden information (on the side of the principal) such as the one explored here have been studied theoretically by Schmitz (2002) and Aghion et al. (2012, section V).

absence of communication, high effort is extremely rare when effort is a hidden action. In by far most cases, the players do not agree on high wages which might give reason to expect high effort in the presence of distributional fairness preferences or positive reciprocity. In line with Charness and Dufwenberg (2006), communication in the form of promises increases the fraction of high effort significantly, which may be explained by guilt aversion. While they have shown that for an exogenously fixed (large) wage, communication increases the occurrence of high effort, we complement their results by showing that communication increases the wages that the parties negotiate in the first place.[6] Yet, given that the principal's return is non-contractible, low effort remains the most frequent decision even when free-form communication (before and during the negotiations) is possible.

Taken together, standard contract theory assuming risk-neutral preferences correctly predicts the most frequently chosen effort level in all of our eight treatments. However, in particular with regard to the effects of communication, the experimental results also illustrate that it is desirable to enrich contract theory in order to embrace a broader range of human behavior.

Related literature. Contract theory is devoted to incentive problems caused by some form of private information. Hence, contract-theoretic models are notoriously difficult to test using field data, because by definition we do not have access to unobservable variables.[7] For this reason, as has also been pointed out by Landeo and Spier (2009, 2012) and Huck et al. (2011), conducting controlled laboratory experiments is a particularly useful way to directly test contract-theoretic models.[8]

Our experiment is based on the pioneering work by Charness and Dufwenberg

[6]Recently, Brandts et al. (2016) have also studied the impact of communication on the design of endogenously negotiated contracts, albeit in a very different context. Building on Hart and Moore (2008), they consider the choice between rigid and flexible contracts in a setting with symmetric information. Yet, they already point out that it is also important to explore the power of communication in contract design in environments with asymmetric information, which is what we do in the present paper.

[7]For empirical evidence supporting the basic premise of contract theory that people do respond to monetary incentives, see e.g. the studies by Lazear (2000), Paarsch and Shearer (2000), Shearer (2004), and the earlier literature survey by Prendergast (1999). See also the recent work by DellaVigna and Pope (2017), who have shown that even small piece rates are more effective than many academic experts had predicted. Note that these papers do not study principal-agent games where contracts are endogenously chosen.

[8]In their experiments, Landeo and Spier (2009, 2012) have investigated the effects of exclusive dealing contracts, while Huck et al. (2011) have explored incentives provided by deferred compensation.

(2006), who have studied “a one-shot principal–agent game designed to capture the essence of hidden action as treated in contract theory” (p. 1594). The starting point of their paper is a standard moral hazard problem with binary effort and binary return; i.e., they consider the simplest possible setup that incorporates hidden action.[9] Since Charness and Dufwenberg's (2006) study is the most prominent experiment based on a hidden action problem so far, we have used their numerical specification to facilitate the comparison of the experimental results. Charness and Dufwenberg (2006, p. 1582) point out that they deliberately do not consider “the usefulness of contracts that make the wage contingent on the principal's return.” Instead, they theoretically derive a contract that would be optimal when effort was verifiable and they exogenously fix this outcome-independent wage in order to show that non-binding preplay communication fosters cooperation, which can be explained by guilt aversion. Our paper is complementary to their work, as we let the players endogenously design a contract. We allow the agent's effort decision to be a hidden action and/or the outcome to be the principal's hidden information, and we compare the findings to benchmarks where effort and/or outcome are verifiable.

Keser and Willinger (2000, 2007) have also conducted experiments in which effort is a hidden action. They allow for outcome-contingent wages and their main results are that the agent's wage typically covers his effort costs, the wage is larger if the good outcome is realized than if the bad outcome is realized, and the principal does not get less than half of the total surplus. Both the experimental setup and the focus of their work are different from our paper. In particular, they do not consider any of the three treatment variations that we study (verifiable vs. hidden action, contractible vs. non-contractible outcome, communication vs. no communication). Since they do not consider treatments in which effort is verifiable, their experiments do not isolate the effects that the unobservability of effort has, which contrasts with the contract-theoretic approach that is focused on the question what consequences informational asymmetries have compared to situations with symmetric information. Moreover, recall that according to contract theory, the effects of effort unobservability crucially depend on whether or not the outcome is contractible (i.e., whether or not the principal has private information about her return). The present paper seems

[9] As has been emphasized by Charness and Dufwenberg (2006, p. 1582), by definition a hidden action problem requires a stochastic relationship between effort and return: “If, by contrast, outcomes were perfectly correlated with the effort choice, then the agent's choice could arguably be inferred once the payoffs were realized. This would render the unobservability interpretation implausible.”

to be the first experimental test of this prediction.

Finally, it should be noted that our experiment is complementary to the important and influential experimental literature on gift-exchange (cf. Fehr et al., 1993, Brown et al., 2004, and the literature survey by Fehr et al., 2009). The focus of this literature is quite different, since gift-exchange experiments usually consider situations in which by assumption incentive contracts cannot be used, while we study how people adapt the design of incentive contracts to variations of the environment. In the gift-exchange literature, there is a deterministic relationship between effort and outcome, such that the principal can observe the agent's effort decision.[10] In contrast, following the contract-theoretic approach, we study situations in which the agent's effort is a hidden action and compare them to benchmarks where the effort decision is verifiable.[11]

Organization of the paper. The remainder of the paper is organized as follows. In Section 2, we present the contract-theoretic analysis of the hidden action problem that motivates our experimental study. The experimental design is introduced in Section 3 and predictions are stated in Section 4. In Section 5, we present and analyze our experimental results. Concluding remarks follow in Section 6. In the Appendix, we present further results concerning the contract negotiation stage and we provide some examples of the messages sent by the experimental subjects in the treatments with communication.

2 The theoretical framework

Following Charness and Dufwenberg (2006), we consider two risk-neutral parties, party A (the principal) and party B (the agent), who contemplate forming a partnership in which a project can be carried out. If no contract is signed, the project is not carried out and each party gets its outside option payoff of 5. If the partnership is formed, then the agent can make a binary effort decision,

[10] Brown et al. (2004) have shown that gift-exchange is not very powerful in one-shot encounters, even when effort is observable. However, it should be noted that when communication is possible, we find some evidence for gift-exchange behavior even in our more challenging environment where effort is a hidden action (see Section 5.2.5 below).

[11] Note that there are also contract-theoretic models in which action and/or outcome are observable by the contractual parties, yet unverifiable by third parties such as the court. While contract theorists such as Laffont and Martimort (2002) usually do not subsume this information structure under the heading of moral hazard, it plays a central role in the literature on the hold-up problem, where contracts are by assumption incomplete and renegotiation cannot be prevented (see Hart, 1995; cf. also Hoppe and Schmitz, 2011, for an experimental study).

$e \in \{0, 1\}$. The agent's effort costs are $4e$. The project can have two outcomes, yielding either a high or a low revenue for the principal. Specifically, if the agent exerts high effort ($e = 1$), then with probability 5/6 the principal's revenue is 26, while with probability 1/6 the principal's revenue is 14. If the agent exerts low effort ($e = 0$), then the principal's revenue is 14.

Note that the expected total surplus is 20 if high effort is exerted, 14 if low effort is exerted, and 10 if no partnership is formed.[12] Hence, the first-best solution is achieved if the partnership is formed and high effort is exerted.

Suppose first that the agent's effort decision is verifiable and the project's outcome is contractible.[13] The contract can then specify an effort level that the agent must choose and a wage depending on the project's outcome. Let w_1 denote the wage if the outcome is good (i.e., if the principal's revenue is 26), and let w_0 denote the wage if the outcome is bad (i.e., if the principal's revenue is 14). Hence, the principal's expected payoff is

$$u_A(w_1, w_0, e) = e\left[\frac{5}{6}(26 - w_1) + \frac{1}{6}(14 - w_0)\right] + (1 - e)(14 - w_0)$$

and the agent's expected payoff is

$$u_B(w_1, w_0, e) = e\left[\frac{5}{6}w_1 + \frac{1}{6}w_0 - 4\right] + (1 - e)w_0.$$

In line with Charness and Dufwenberg (2006, p. 1581), we suppose that both parties have the same bargaining power, so the outcome of their contract negotiations is given by the regular Nash bargaining solution. Hence, the parties agree on $e = 1$ and $w_1 = \frac{84}{5} - \frac{1}{5}w_0$, such that both parties' expected payoff is 10. Note that the optimal contract ($e = 1, w_0, w_1 = \frac{84}{5} - \frac{1}{5}w_0$) is not unique.

As long as effort is verifiable, the parties still implement the first-best solution when the outcome is not contractible such that $w_0 = w_1$ must hold (i.e., when the principal has private information about her revenue). In this case, the parties agree on the contract ($e = 1, w_0 = w_1 = 14$).[14]

However, when effort is unobservable, the contractibility of the outcome is decisive for whether or not high effort is implementable.

[12] Throughout, we adopt the convention that "total surplus" refers to the gross total surplus (i.e., we do not subtract the outside option payoffs).

[13] Note that contractibility of the outcome means that the agent's wage payment can depend on the realized return. Verifiability of the effort means that the effort level can be directly specified in the contract (as in Charness and Dufwenberg, 2006, footnote 5) since it can be enforced by court (see e.g. Laffont and Martimort, 2002, chapter 4).

[14] In their paper, Charness and Dufwenberg (2006, p. 1581) exogenously fix the contract $w_0 = w_1 = 14$, which has been derived under the assumption that effort is verifiable.

Specifically, if effort is unobservable (i.e., it is a hidden action) but the outcome is contractible, a contract consists of the wages w_1 and w_0. According to standard contract theory, if the parties want to implement high effort, the contract must then satisfy the incentive-compatibility constraint

$$u_B(w_1, w_0, 1) \geq u_B(w_1, w_0, 0),$$

which can be rewritten as $w_1 \geq w_0 + \frac{24}{5}$. Observe that the optimal contract $(w_0, w_1 = \frac{84}{5} - \frac{1}{5}w_0 | w_1 \geq w_0 + \frac{24}{5})$ still is not unique. An optimal contract induces the agent to choose high effort and yields expected payoffs of 10 for both parties. Thus, given risk-neutrality and contractible outcomes, the fact that the agent's effort is unobservable does not pose a problem.

Yet, if effort is unobservable and the outcome is not contractible such that $w_0 = w_1$ must hold, the incentive compatibility constraint cannot be satisfied. Hence, in this case the parties will agree on the contract $w_0 = w_1 = 7$ and the agent will choose low effort only, so the payoffs of both parties are 7.

3 Experimental design

Our experiment consists of eight treatments. In each treatment, half of the participants in each session were randomly assigned to the role of principals and the others to the role of agents. Each treatment was run in three to four sessions. No subject was allowed to participate in more than one session. In total, 754 subjects participated in the experiment. All subjects were students of the University of Cologne from a wide variety of fields of study.[15] All interactions were anonymous; i.e., no subject knew the identity of its partner.

Following Charness and Dufwenberg (2006), each session consisted of a one-shot interaction; i.e., there were no repetitions and this was known to the subjects.[16] At the beginning of each session, written instructions were handed out to each subject.[17] Before the experiment started, each subject had to answer

[15] The computerized experiment was programmed and conducted with zTree (Fischbacher, 2007) and subjects were recruited using ORSEE (Greiner, 2004).

[16] Many other experiments with free-form communication also use pure one-shot designs (see e.g. Ellingsen and Johannesson, 2004a,b; Charness and Dufwenberg, 2011). The players could easily recognize their partner from earlier communication if random matching was used. When a perfect stranger matching protocol is used, only very few rounds could be implemented if we want to ensure a reasonably large number of independent observations. However, in future research it may also be interesting to conduct experiments explicitly focused on learning in a moral hazard context.

[17] The instructions for all treatments are in the Supplementary Material.

several comprehension questions. A session lasted between 45 and 60 minutes. We made use of the experimental currency unit ECU. At the end of each session, the players' payoffs were converted into euros. The minimum, median, maximum, and average profits made in the experiment are 5, 12.92, 26.78, and 13.44 euros, respectively, including a 5 euros show-up fee.

In the instructions of the experiment, we used a neutral wording in line with Charness and Dufwenberg (2006). Specifically, the players were called A and B (instead of principal and agent), high effort was referred to as "rolling a die" and low effort was referred to as "not rolling a die."

Each treatment consisted of two stages, a contract negotiation stage and a contract execution stage. In the contract negotiation stage, we implemented an alternating offers bargaining game. Specifically, player A first makes a contract offer to player B. Player B can then react in three ways. He can accept the offer such that the contract execution stage is reached, he can reject the offer and terminate the contract negotiations such that both players obtain their outside option payoffs, or he can reject the offer and make an alternative contract offer. In the latter case, the second round of the contract negotiation stage is reached and player A can analogously react to player B's offer in the three ways just outlined. In particular, if player A rejects player B's offer and makes a counteroffer, the third round of the contract negotiation stage is reached, where it is again player B's turn to react in one of the three ways, and so on. According to standard theory, the alternating offers bargaining game has a unique subgame-perfect equilibrium that converges to the regular Nash bargaining solution when the parties' discount factor $\delta < 1$ goes to one (see Rubinstein, 1982). Specifically, in our experiment subjects obtained 0.99^R euros per ECU, where R is the number of rounds that the negotiation stage lasted. This way of converting ECU into euros gave the subjects an incentive to finish the negotiations in early rounds and it approximately balances their bargaining powers.[18]

In the contract execution stage, if the action "roll" is chosen, the computer randomly draws a number out of $\{1, 2, 3, 4, 5, 6\}$ with equal probabilities. The outcome that corresponds to a successful project occurred if the die came up 2, 3, 4, 5, or 6. If the die came up 1 or in case of the action "don't roll," the outcome corresponds to an unsuccessful project.

We employed a 2 x 2 x 2 design. In particular, the treatment variations refer to whether the action is verifiable or hidden, whether the outcome is contractible

[18] According to standard theory, in the subgame-perfect equilibrium of the alternating offers bargaining game the parties reach an agreement in the first round, and given a discount factor of $\delta = 0.99$, party B gets $\delta/(1 + \delta) = 49.7\%$ of the pie.

or not, and whether communication is possible (see Table 1).

	Outcome is contractible	
	Agent's effort is a hidden action	Agent's effort is a verifiable action
No communication	HA	VA
Free-form communication	HA_C	VA_C

	Outcome is not contractible	
	Agent's effort is a hidden action	Agent's effort is a verifiable action
No communication	HA^-	VA^-
Free-form communication	HA_C^-	VA_C^-

Table 1. The eight treatments. HA and VA refer to hidden action and verifiable action, respectively. The subscript indicates whether or not communication is possible, while the superscript indicates whether or not the outcome is contractible.

Hidden action treatment HA. In the hidden action treatment a contract offer consists of two numbers X and Y, which correspond to the wages w_0 and w_1 in the theoretical framework.[19] If in the contract negotiation stage one player terminates the negotiations, then both players get their outside option payoffs of 5. If a contract offer is accepted, then the contract execution stage is reached, in which player B decides between "roll" and "don't roll." Player A cannot observe player B's decision. If player B chooses "roll," then with probability 5/6 player A's payoff is $26 - Y$ and player B's payoff is $Y - 4$, while with probability 1/6 player A obtains $14 - X$ and player B obtains $X - 4$. If player B chooses "don't roll," player A's payoff is $14 - X$ and player B's payoff is X.

Verifiable action treatment VA. In the verifiable action treatment, a contract offer either consists of the action "roll" and two numbers X and Y, or of the action "don't roll" and a number Z. If in the contract negotiation stage one player terminates the negotiations, then both players get their outside option payoffs of 5. If a contract offer is accepted, then the contract execution stage is reached. If the accepted contract prescribes the action "roll," then with probability 5/6 player A's payoff is $26 - Y$ and player B's payoff is $Y - 4$, while with

[19] In each treatment, the wages had to be integers and they had to be chosen such that the contract could not lead to a loss for any player.

probability $1/6$ player A obtains $14 - X$ and player B obtains $X - 4$. If the accepted contract prescribes the action "don't roll," player A's payoff is $14 - Z$ and player B's payoff is Z.

Hidden action with non-contractible outcome treatment HA^-. In the HA^- treatment, a contract offer consists of a number X. If in the contract negotiation stage one player terminates the negotiations, then both players get their outside option payoffs of 5. If a contract offer is accepted, then the contract execution stage is reached, in which player B decides between "roll" and "don't roll." Player A cannot observe player B's decision. If player B chooses "roll," then with probability $5/6$ player A's payoff is $26 - X$ and player B's payoff is $X - 4$, while with probability $1/6$ player A obtains $14 - X$ and player B obtains $X - 4$. If player B chooses "don't roll," player A's payoff is $14 - X$ and player B's payoff is X.

Verifiable action with non-contractible outcome treatment VA^-. In the VA^- treatment, a contract offer either consists of the action "roll" and a number X, or of the action "don't roll" and a number Z. If in the contract negotiation stage one player terminates the negotiations, then both players get their outside option payoffs of 5. If a contract offer is accepted, then the contract execution stage is reached. If the accepted contract prescribes the action "roll," then with probability $5/6$ player A's payoff is $26 - X$ and player B's payoff is $X - 4$, while with probability $1/6$ player A obtains $14 - X$ and player B obtains $X - 4$. If the accepted contract prescribes the action "don't roll," player A's payoff is $14 - Z$ and player B's payoff is Z.

Communication treatments HA_C, VA_C, HA_C^-, VA_C^-. These treatments are identical to the corresponding treatments described above, except that before the beginning of the contract negotiation stage player A and player B could send each other free-form text messages, and in the contract negotiation stage a player could always add a free-form text message to his contract offer.[20] Note that we allow for free-form communication both before the negotiations and while the negotiations are taking place in order to give communication a maximum chance of being effective.[21]

[20] A text message could contain up to 500 characters. The participants were not allowed to reveal their identity through the messages.

[21] See also Charness and Dufwenberg (2010), who have pointed out that free-form communication can be more effective than more restricted forms of communication.

4 Predictions

According to standard contract theory, when all subjects are risk-neutral the predictions are very clear, as has been explained in Section 2. If effort is verifiable, the players will always agree on high effort. In contrast, if effort is a hidden action, high effort will be implemented if and only if the outcome is contractible, while low effort will be chosen otherwise. In particular, if effort is a hidden action and the outcome is contractible, the players will agree on incentive-compatible contracts. Communication has no impact on these predictions, since words alone cannot change the payoffs.

Yet, recall that the results predicted by standard theory assume that it is common knowledge that all parties behave in a rational and profit-maximizing way. While in the light of previous experimental results we do not expect that all subjects' behavior will strictly adhere to these assumptions, we hypothesize that in each treatment in the majority of cases the actual effort level will correspond to the predicted one.

With regard to comparisons of the expected total surplus levels between the different treatments, under the assumption of risk-neutrality standard theory would lead to the following hypotheses.[22]

Hypothesis 1. Hidden action versus verifiable action.
(i) The expected total surplus levels do not differ between HA and VA.
(ii) The expected total surplus levels do not differ between HA_C and VA_C.
(iii) The expected total surplus levels are smaller in HA^- than in VA^-.
(iv) The expected total surplus levels are smaller in HA_C^- than in VA_C^-.

Hypothesis 2. Contractible outcome versus non-contractible outcome.
(i) The expected total surplus levels are larger in HA than in HA^-.
(ii) The expected total surplus levels do not differ between VA and VA^-.
(iii) The expected total surplus levels are larger in HA_C than in HA_C^-.
(iv) The expected total surplus levels do not differ between VA_C and VA_C^-.

Hypothesis 3. Communication versus no communication.
(i) The expected total surplus levels do not differ between HA and HA_C.
(ii) The expected total surplus levels do not differ between VA and VA_C.

[22]Note that the total surplus level depends both on whether or not the parties agree on a contract and on the chosen effort level if a contract is signed. In Section 5, we will also present tests for the effort decisions given that a contract was signed. Moreover, we will study in detail the agents' chosen effort levels for given contracts and whether or not incentive-compatible contracts are written, even though here for brevity we do not present formally all hypotheses that follow from the analysis in Section 2.

(iii) The expected total surplus levels do not differ between HA^- and HA^-_C.
(iv) The expected total surplus levels do not differ between VA^- and VA^-_C.

While the canonical hidden action problem is a cornerstone of contract theory, we are not aware of any previous experimental work that directly tests the effects of effort verifiability (Hypothesis 1) or the effects of outcome contractibility (Hypothesis 2). With regard to Hypothesis 3, as has been explained in the Introduction, Charness and Dufwenberg (2006) have studied the effects of communication in a hidden action framework; yet, they did so for an exogenously fixed (outcome-independent) contract.

Thus, we are interested in investigating which contracts subjects negotiate depending on the verifiability of the effort, the contractibility of the outcome, and whether or not free-form communication is possible. Specifically, is outcome contractibility indeed essential to incentivize agents to exert unobservable effort? Or are behavioral forces such as reciprocity and guilt aversion so strong that high effort will be chosen even if the outcome is non-contractible and effort is a hidden action, in particular when communication is possible?[23] Do the subjects always agree on high effort when effort is verifiable, or are risk-aversion and (in the case of non-contractible outcomes) ex post inequity aversion so strong that low effort may be preferred?

5 Results

5.1 Overview

5.1.1 Descriptive statistics

This section summarizes our central results. Table 2 shows the main descriptive statistics of our eight treatments. Observe that in each treatment the most frequently chosen effort level corresponds to the one predicted by standard contract theory given risk-neutrality.

[23] In particular, given Charness and Dufwenberg's (2006) insights, we might expect a larger total surplus in HA^-_C than in HA^-. Note that standard theory predicts a wage of 7 in these two treatments, while Charness and Dufwenberg (2006) exogenously fixed the wage 14. It is therefore interesting to find out what wage the parties will actually agree on when they are allowed to negotiate the contract endogenously.

	HA	VA	HA_C	VA_C
High effort	$28/46 = 60.9\%$	$38/47 = 80.9\%$	$38/47 = 80.9\%$	$41/47 = 87.2\%$
Low effort	$15/46 = 32.6\%$	$6/47 = 12.8\%$	$9/47 = 19.1\%$	$5/47 = 10.6\%$
No contract	$3/46 = 6.5\%$	$3/47 = 6.4\%$	$0/47 = 0\%$	$1/47 = 2.1\%$
Mean of exp. total surplus	17.39	18.60	18.85	19.15
Mean of principals' exp. profits	9.07	9.78	9.49	9.83
Mean of agents' exp. profits	8.32	8.82	9.36	9.32
Mean of principals' exp. profits (high eff.)	10.76	10.65	10.27	10.20
Mean of agents' exp. profits (high eff.)	9.24	9.35	9.73	9.80
Mean of principals' profits (low eff.)	6.73	6.67	6.22	7.80
Mean of agents' profits (low eff.)	7.27	7.33	7.77	6.20
Mean number of rounds	1.83	2.02	1.30	1.60

	HA^-	VA^-	HA_C^-	VA_C^-
High effort	$3/47 = 6.4\%$	$33/47 = 70.2\%$	$19/48 = 39.6\%$	$31/48 = 64.6\%$
Low effort	$37/47 = 78.7\%$	$11/47 = 23.4\%$	$28/48 = 58.3\%$	$13/48 = 27.1\%$
No contract	$7/47 = 14.9\%$	$3/47 = 6.4\%$	$1/48 = 2.1\%$	$4/48 = 8.3\%$
Mean of exp. total surplus	13.79	17.96	16.29	17.54
Mean of principals' exp. profits	6.51	10.74	8.15	9.94
Mean of agents' profits	7.28	7.21	8.15	7.60
Mean of principals' exp. profits (high eff.)	10.33	12.48	11.26	11.87
Mean of agents' profits (high eff.)	9.66	7.51	8.74	8.13
Mean of principals' profits (low eff.)	6.49	7.09	6.14	6.85
Mean of agents' profits (low eff.)	7.51	6.91	7.86	7.15
Mean number of rounds	2.43	3.28	1.67	1.65

Table 2. Descriptive statistics. All profits are in ECU.

In particular, consider first the upper half of Table 2, where the outcome is contractible. If effort is a hidden action, nearly all players agree on a contract and the majority of the agents subsequently choose high effort. If effort is verifiable, by far most players agree on a contract that specifies high effort.[24] Next, consider the lower half of Table 2, where the outcome is non-contractible. If effort is a hidden action, the vast majority of players agree on a contract and subsequently low effort is the most frequent decision of the agents. In contrast,

[24] However, note that even when effort is verifiable, the parties do not always agree on choosing high effort. Hence, it is clearly important to conduct benchmark treatments with verifiable effort if we want to isolate the consequences of the unobservability of effort in moral hazard problems.

if effort is verifiable, most players agree on a contract that specifies high effort. Observe that these results hold regardless of whether or not communication is possible.

Table 2 also shows the means of the expected total surplus levels. Recall that the expected total surplus is 20 if high effort is chosen, the total surplus is 14 if low effort is chosen, and 10 if no contract is signed.[25] Moreover, Table 2 displays the means of the principals' and agent's (expected) profits as well as the principals' and agents' (expected) profits given high and given low effort.[26] Finally, the table also indicates for each treatment the mean number of rounds that the contract negotiation stage lasted.[27]

While in each treatment the most frequently chosen effort level corresponds to the theoretically predicted one, Table 2 also illustrates that in some cases there are large deviations from the point predictions. However, we are primarily interested in comparisons between the treatments in order to find out whether the treatment variations have the predicted effects. Thus, in the next subsection we will present formal tests of the hypotheses derived in Section 4. We will then have a closer look at the deviations from theory in Section 5.2 below.

5.1.2 Hypotheses tests

Let us now study the implications of the verifiability of effort, the contractibility of the outcome, and the possibility of communication. Tables 3, 4, and 5 show p-values for pairwise comparisons between our treatments.[28] Regarding the effect of the effort's verifiability, we find support for three of the four predictions made in Hypothesis 1. Specifically, consider first the case where outcome is contractible (see the first two columns of Table 3). In line with Hypothesis 1(ii) the expected total surplus levels do not differ significantly if communication is possible. However, in the absence of communication the expected total surplus levels are significantly smaller if the action is hidden, which is in contrast to Hypothesis 1(i). Next, consider the case of non-contractible outcomes. In line

[25] Note that in case of high effort we take the expected values instead of the realized random numbers drawn by the computer.

[26] Recall that the principals' and agent's (expected) profits always add up to 20 given that high effort is chosen and to 14 given that low effort is chosen. Hence, in Tables 3, 4, and 5 below, for a given effort level the pairwise comparisons between the principals' profits lead to the same p-values as the comparisons between the agents' profits.

[27] For more detailed results on the contract negotiation stage, see Appendix A.

[28] Throughout, we use two-tailed Mann-Whitney U tests in the case of surplus levels, profits, and wages, while we use two-tailed Fisher exact tests in the case of categorical data.

with Hypotheses 1(iii) and 1(iv), regardless of whether or not communication is possible, the expected total surplus levels are significantly smaller if the action is hidden, compared to the case where the action is verifiable.

With regard to the effects of the outcome's contractibility, in line with Hypotheses 2(i) and 2(iii), when effort is a hidden action, the expected total surplus levels are larger when the outcome is contractible (regardless of whether or not communication is possible). The differences are highly significant (see Table 4). In line with Hypothesis 2(ii), the outcome contractibility does not significantly affect the expected total surplus levels when effort is verifiable and there is no communication. However, in contrast to Hypothesis 2(iv), in the presence of communication and a verifiable effort decision, the expected total surplus levels are significantly larger when outcome is contractible than when outcome is non-contractible.

Now consider Table 5, which shows the effects of communication. In line with Hypotheses 3(ii) and 3(iv), communication has no significant effects on the expected total surplus levels when effort is verifiable (regardless of whether the outcome is contractible or not). However, in contrast to Hypotheses 3(i) and 3(iii), when effort is a hidden action, the expected total surplus levels are significantly larger if communication is possible (regardless of whether the outcome is contractible or not).

	HA vs. VA	HA_C vs. VA_C	HA^- vs. VA^-	HA_C^- vs. VA_C^-
Contract vs. no contract	1.000	1.000	0.316	0.362
High effort vs. low effort	0.025	0.386	0.000	0.006
High eff. vs. low eff./no contr.	0.041	0.287	0.000	0.024
Exp. surplus	0.0501	0.4318	0.0000	0.0479
Principal's exp. profit	0.8329	0.6579	0.0000	0.0077
Agent's exp. profit	0.0152	0.9843	0.5963	0.2729
Exp. profits (high eff.)	0.0215	0.9203	0.0151	0.1501
Profits (low eff.)	0.5500	0.1197	0.4261	0.3085
Rounds	0.4371	0.4813	0.0529	0.7433

Table 3. The effect of effort verifiability.

	HA vs. HA^-	VA vs. VA^-	HA_C vs. HA_C^-	VA_C vs. VA_C^-
Contract vs. no contract	0.316	1.000	1.000	0.362
High effort vs. low effort	0.000	0.280	0.000	0.035
High eff. vs. low eff./no contr.	0.000	0.337	0.000	0.016
Exp. surplus	0.0000	0.2676	0.0000	0.0098
Principal's exp. profit	0.0000	0.0150	0.0114	0.4414
Agent's exp. profit	0.0707	0.0000	0.0011	0.0000
Exp. profits (high eff.)	0.2951	0.0000	0.0231	0.0001
Profits (low eff.)	0.3248	0.7073	0.8074	0.0904
Rounds	0.0469	0.0020	0.3741	0.6442

Table 4. The effect of outcome contractibility.

	HA vs. HA_C	VA vs. VA_C	HA^- vs. HA_C^-	VA^- vs. VA_C^-
Contract vs. no contract	0.117	0.617	0.031	1.000
High effort vs. low effort	0.102	0.755	0.000	0.811
High eff. vs. low eff./no contr.	0.041	0.574	0.000	0.663
Exp. surplus	0.0258	0.3727	0.0000	0.5507
Principal's exp. profit	0.9690	0.6636	0.0032	0.1410
Agent's exp. profit	0.0019	0.6755	0.0211	0.2475
Exp. profits (high eff.)	0.0072	0.8308	0.2875	0.0986
Profits (low eff.)	0.3727	0.2434	0.5326	0.5953
Rounds	0.1215	0.1052	0.0068	0.0001

Table 5. The effect of communication.

Note that the expected total surplus levels result from the contract versus no contract decision and the chosen effort level in case a contract was signed. According to agency theory, a contract should always be signed in all treatments, so there should be no differences between the treatments in this regard. Indeed, in eleven out of the twelve pairwise comparisons in Tables 3, 4, and 5, we do not find a significant difference regarding the contract versus no contract decision. Only when we compare the HA^- treatment to HA_C^-, we find a statistically significant difference. This difference is in line with the fact that in HA_C^- communication is very often used in a clarifying way (see Section 5.2.2. below), thus making it less likely that the players fail to agree on a contract.

In the three tables, we also provide p-values for pairwise comparisons of the treatments with regard to the fraction of high effort provided that a contract is signed and the fraction of high effort among all observations. Note that we find a significant difference between two treatments regarding the expected total surplus levels whenever there is a significant difference regarding the fraction of high effort among all observations.[29]

Taken together, contract theory with risk-neutral preferences correctly predicts the most frequently chosen effort level in each of our eight treatments. While thus the theory clearly provides a useful organizing framework for our data, there are non-negligible deviations. In the next section, we therefore take a closer look at the data and analyze the negotiated contracts in more detail.

5.2 A closer look at the data

5.2.1 Incentive compatibility

Figure 1 shows the distributions of the contracts (X, Y) on which the players agreed in the treatments with contractible outcomes. In the treatments where effort is a hidden action, the blue circles depict the cases in which the agent chose high effort, while the red triangles depict the cases in which the agent chose low effort. Note that in the treatments with verifiable effort, only the cases in which the players contractually specified high effort are shown (since otherwise the contract contained only a single wage Z).

The figure illustrates that the contract-theoretic considerations are indeed useful to organize the data. Consider first the benchmark treatments with verifiable effort. Recall that each player gets 5 when no contract is signed. Now suppose a contract is signed which specifies high effort. In this case, the agent's expected payoff is $\frac{5}{6}Y + \frac{1}{6}X - 4$ and the principal's expected payoff is $\frac{5}{6}(26 - Y) + \frac{1}{6}(14 - X)$. Thus, a contract must lie above the orange line ($Y = \frac{54}{5} - \frac{1}{5}X$) to satisfy the agent's participation constraint and it must lie below the green line ($Y = \frac{114}{5} - \frac{1}{5}X$) to satisfy the principal's participation constraint. The yellow line ($Y = \frac{84}{5} - \frac{1}{5}X$) depicts the contracts which yield the same expected payoffs for principal and agent.[30] Recall that standard theory predicts that risk-neutral players with equal bargaining powers will agree on high effort and choose a wage pair that lies on the yellow curve.

[29] In eleven out of the twelve comparisons, the fractions of high effort given that a contract is signed differ between two treatments whenever the expected total surplus levels differ. Comparing the HA and HA_C treatments, we find no significant difference in the fractions of high effort given that a contract was signed, while the expected total surplus levels (which are also influenced by the contract vs. no contract decisions) differ significantly.

[30] Note that if a contract is signed that specifies low effort, the agent's and the principal's participation constraints are satisfied if Z is larger than 5 and smaller than 9, and $Z = 7$ would yield equal payoffs.

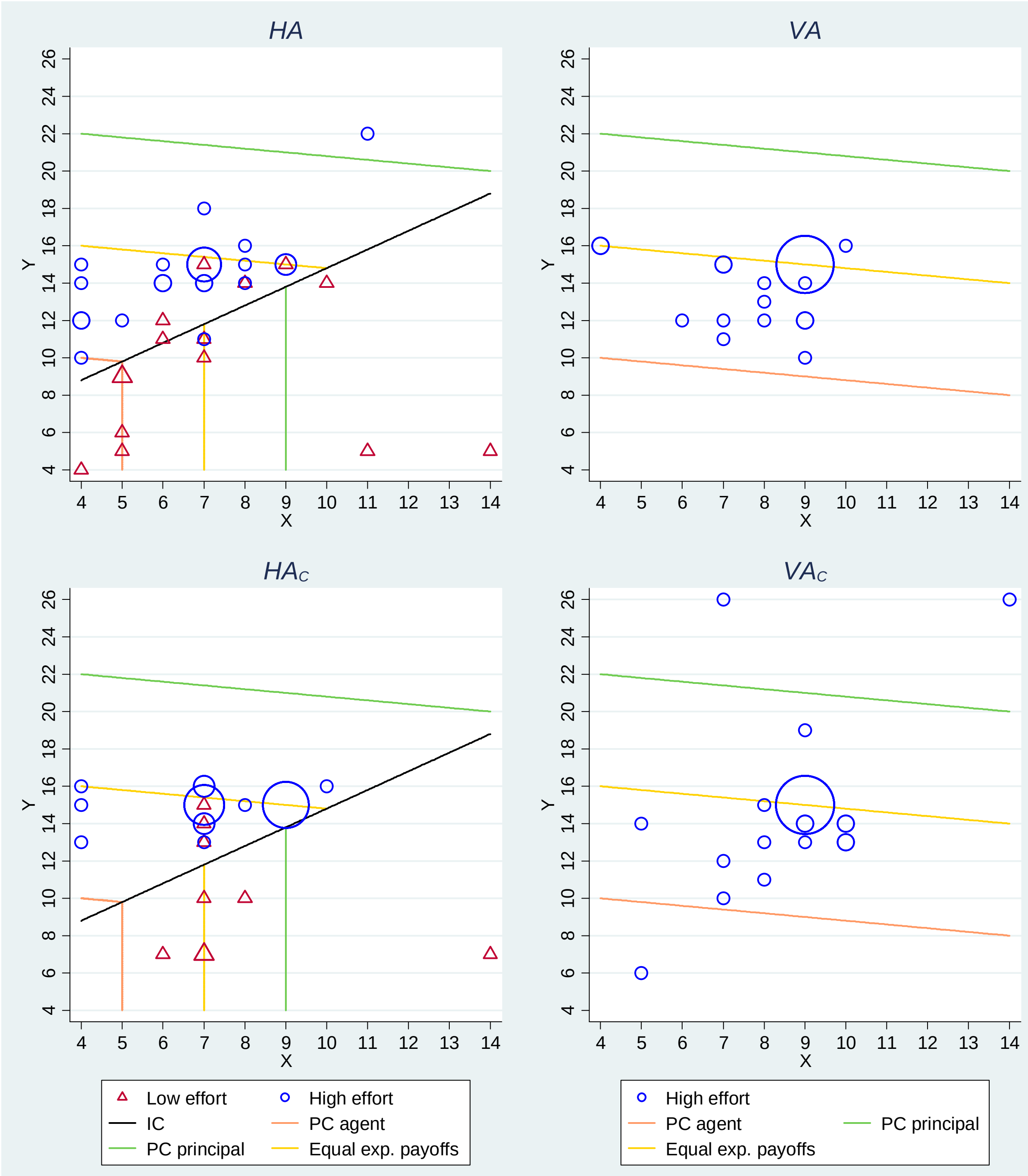

Figure 1. The distributions of the agreed-upon contracts (X, Y) in the treatments with contractible outcomes. In each treatment, the size of the symbol is proportional to the relative frequency of the respective contract. The panels of the treatments with verifiable effort show only those cases in which the players agreed on high effort. In the cases in which the players agreed on low effort, in the treatment VA the wages were $Z = 7$ (four times), $Z = 6$ (one time), and $Z = 10$ (one time), while in the treatment VA_C the wages were $Z = 7$ (three times), $Z = 4$ (one time), and $Z = 6$ (one time).

Observe that almost all observations in the treatments VA and VA_C satisfy both players' participation constraints.[31] In both treatments, the by far most frequently observed contract specifies high effort and the wage pair $X = 9$, $Y = 15$, which lies on the yellow curve.[32]

Now consider the treatments in which effort is a hidden action. The agent's expected payoff when he exerts high effort ($\frac{5}{6}Y + \frac{1}{6}X - 4$) is larger than his payoff when he exerts low effort (X) whenever the incentive compatibility constraint $Y \geq X + 24/5$ is satisfied. Thus, standard theory predicts that risk-neutral agents choose high effort for contracts above the black curve ($Y = X + \frac{24}{5}$) and low effort for contracts below the black curve. Given this behavior, above the incentive compatibility curve the participation constraints and the contracts yielding equal expected payoffs are still depicted by the same curves as in the panels showing the treatments with verifiable actions. Below the incentive compatibility curve, when low effort is chosen, the principal's participation constraint is satisfied left of the green curve ($X = 9$), the agent's participation constraint is satisfied right of the orange curve ($X = 5$), and equal payoffs are attained by contracts on the yellow curve ($X = 7$). Recall that standard theory predicts that risk-neutral players with equal bargaining powers will agree on contracts that lie above the black curve and on the yellow curve.

Consider the HA treatment. As is illustrated in the upper left panel of Figure 1, 32 of the 43 agreed-upon contracts (74.4%) satisfied the incentive compatibility constraint. If the incentive compatibility constraint was satisfied, the agents chose high effort in the vast majority of the cases ($27/32 = 84.4\%$). If the incentive compatibility constraint was not satisfied, then the agents chose low effort in 10 out of the 11 cases (90.9%).[33] The most frequently observed contract was $X = 7$, $Y = 15$, which was made in $9/43 = 20.9\%$ of the cases, followed by the contract $X = 9$, $Y = 15$, which was made in $4/43 = 9.3\%$ of the cases.

[31] In particular, in VA the participation constraints are always satisfied except in one case where the parties specified low effort and agreed on $Z = 10$. In VA_C, a participation constraint was violated in only three cases when the parties specified high effort and in one case when they specified low effort.

[32] When the parties agreed on high effort, the contract $X = 9$, $Y = 15$ was chosen in $23/38 = 60.5\%$ of the cases in VA and in $24/41 = 58.5\%$ of the cases in VA_C.

[33] Regarding the 32 incentive compatible contracts, the agent's participation constraint was always satisfied and the principal's participation constraint was satisfied in 31 cases. With regard to the 11 contracts that were not incentive-compatible, the agent's participation constraint was satisfied in 10 cases, while the principal's participation constraint was satisfied in 8 cases.

Next, consider the HA_C treatment. As can be seen in the lower left panel of Figure 1, the incentive-compatibility constraint was satisfied in $41/47 = 87.2\%$ of the cases. Given incentive compatibility, $38/41 = 92.7\%$ of the agents chose high effort. If the incentive compatibility constraint was not satisfied, the agents always chose low effort.[34] The most frequently observed contract was $X = 9$, $Y = 15$, which was chosen in $15/47 = 31.9\%$ of the cases, followed by $X = 7$, $Y = 15$, which was chosen in $12/47 = 25.5\%$ of the cases.

Hence, regarding the contract execution stage, the agents' behavior in both treatments with hidden action clearly indicates that the concept of incentive compatibility has strong predictive power. With regard to the contract negotiation stage, we observe that in both treatments the two most frequently chosen contracts lie above the black curve and on or very close to the yellow curve, confirming the prediction that standard theory makes for risk-neutral players with equal bargaining powers.

5.2.2 Content of the communication protocols

We employed two undergraduate students at the Universities of Bonn and Cologne to independently classify all chats in the communication treatments according to predefined categories.[35] The students did not participate in the experiment and were not informed about the research questions addressed in our study. Depending on the treatment, there were five to eight categories (see Table 6).[36] For each category, the coders could mark either "yes" or "no". Table 6 shows the relative frequencies with which the coders marked "yes".

Coding is subjective and the coders do not always agree on the message classification. In Table 6, we thus provide for each category Cohen's kappa (Cohen, 1960; Krippendorff, 2004), which takes a value of 0 when the amount of agreement is what random chance would imply, and 1 when the coders agree perfectly. Kappa values between 0.41 and 0.60 are often considered "moderate" agreement, while those above 0.60 indicate "substantial" agreement (see Landis

[34] Note that the relevant participation constraints were satisfied by all contracts with the exception of only one contract which was not incentive compatible and violated the principal's participation constraint.

[35] Our content analysis methodology thus follows Cason et al. (2012) and Cason and Mui (2015).

[36] See Appendix B for a more detailed description of the categories. Note that Brandts et al. (2016) have also used the categories friendliness, clarification, and promise in their content analysis.

and Koch, 1977). Observe that some kappa values are very low.[37] Following Cason et al. (2012), we exclude from the further analysis all cases where kappa is smaller than 0.3, and we note that the cases in which kappa is between 0.3 and 0.4 should be interpreted with caution.

	HA_C		VA_C	
	yes	kappa	yes	kappa
Friendliness	65.96%	0.541	63.83%	0.728
Clarification	61.70%	0.735	64.89%	0.860
Incentive comp.	39.36%	0.356		
Distrib. Fairness	53.19%	0.187	48.94%	0.374
Reciprocity	21.28%	0.215		
Promise	38.30%	0.730		
Threat	2.13%	1.000	3.19%	0.657
Risk	30.85%	0.265	12.77%	0.624

	HA_C^-		VA_C^-	
	yes	kappa	yes	kappa
Friendliness	62.50%	0.364	54.17%	0.667
Clarification	79.17%	0.625	59.38%	0.784
Distrib. Fairness	51.04%	0.265	52.08%	0.440
Reciprocity	52.08%	0.833		
Promise	27.08%	0.684		
Threat	8.33%	0.458	17.71%	0.645
Risk	29.17%	0.600	38.54%	0.449

Table 6. For each treatment and each chat category, the table displays the relative frequency with which the coders marked "yes" (agreement resulted in a value of 0 if no one marked "yes" or in a value of 1 if both coders marked "yes", while disagreement between the coders resulted in a value of 0.5). The table also shows Cohens's kappa, a measure of agreement between the coders.

Table 7 shows the relative frequencies with which the coders marked "yes" in the cases in which high effort was chosen, compared to the cases in which either low effort was chosen or no contract was signed. For example, consider friendliness. In the treatment HA_C the relative frequency of friendly chats was

[37] For instance, in the category distributive fairness one of the coders has marked "yes" only when fairness was explicitly mentioned, while the other coder also marked "yes" when the players mentioned something like "equal profits". Also in some cases regarding reciprocity and risk, one coder took the definitions more literally, while the other coder seems to have interpreted the texts more freely.

75% in the cases in which high effort was chosen, while it was less than 28% in the other cases. As shown in Table 7, the difference is statistically significant. Observe that also in the treatment HA_C^- the coders considered significantly more chats to be friendly in the cases in which high effort was chosen. In contrast, in the treatments with verifiable effort the differences are not significant.

We will come back to the content analysis in the following three subsections, where we analyze in more detail the deviations from the theoretical predictions that we have found in Section 5.1.

	HA_C			VA_C		
	high effort	no high effort	p-value	high effort	no high effort	p-value
Friendliness	75.00%	27.78%	0.005	66.67%	40.00%	0.250
Clarification	75.00%	5.56%	0.000	69.05%	30.00%	0.064
Incentive comp.	48.68%	0.00%	0.001			
Distrib. Fairness				51.19%	30.00%	0.272
Reciprocity						
Promise	43.42%	16.67%	0.115			
Threat	2.63%	0.00%	0.627	3.57%	0.00%	0.622
Risk				14.29%	0.00%	0.291

	HA_C^-			VA_C^-		
	high effort	no high effort	p-value	high effort	no high effort	p-value
Friendliness	78.95%	51.72%	0.021	57.81%	46.88%	0.461
Clarification	86.84%	74.14%	0.344	68.75%	40.63%	0.043
Distrib. Fairness				56.25%	43.75%	0.341
Reciprocity	89.47%	27.59%	0.000			
Promise	65.79%	1.72%	0.000			
Threat	0.00%	13.79%	0.036	15.63%	21.88%	0.710
Risk	42.11%	20.69%	0.074	48.44%	18.75%	0.015

Table 7. For each treatment and each chat category, the table displays the relative frequencies with which the coders marked "yes" in the cases in which high effort was chosen and in the cases in which effort was low or no contract was signed. The table also shows the corresponding p-values. Note that the cases in which Cohen's kappa was below the reliability threshold of 0.3 have been excluded.

5.2.3 Strategic uncertainty and communication

While the majority of the agents in the HA treatment chose high effort, we find that (in contrast to the theoretical prediction assuming risk-neutrality) the fraction of high effort in HA is significantly smaller than in VA. As a consequence, in contrast to Hypothesis 1(i) the expected total surplus is smaller in HA than in VA.

The difference between HA and VA can be explained by the presence of strategic uncertainty in the contract execution stage of the HA treatment. In VA, once the contract has been negotiated, there are no further actions to be taken by a player. In contrast, in the contract execution stage of HA, the agent must choose between high and low effort. Even when the parties have agreed on an incentive-compatible contract, the principal may have doubts whether the agent will actually choose high effort (since the agent may make mistakes or have non-standard preferences). Recall that there is no significant difference between HA_C and VA_C.[38] Indeed, communication may well reduce strategic uncertainty. In particular, while in the absence of communication the principal may doubt whether the agent has understood that a contract is incentive-compatible, in the presence of communication the agent can clarify that given an incentive-compatible contract it is in his own self-interest to exert high effort.

The content analysis in Table 7 shows for the HA_C treatment that in the cases in which high effort was chosen the chat indeed was classified as containing clarification significantly more often than in the cases in which this was not the case.[39] Similarly, in HA_C the coders marked the category incentive compatibility in almost half of the cases in which high effort was chosen, while this category was never marked otherwise.

These observations are in line with Table 5. There can be no strategic uncertainty in the verifiable action treatments, so communication has no effect when we compare VA and VA_C. Yet, communication can reduce strategic uncertainty when effort is a hidden action, and as a consequence the expected total surplus is significantly larger in HA_C than in HA, which is in contrast to Hypothesis 3(i).

Recall that in the control treatments with verifiable actions the contract specifying high effort and the wages $X = 9$, $Y = 15$ is agreed upon in the majority of the cases. Given high effort, these wages always lead to the same payoffs for both players and thus expose both players to the same amount of risk. While $X = 9$, $Y = 15$ are also the most frequently chosen wages in HA_C,

[38]Note that the difference between HA and VA cannot be explained by risk-aversion, since there is no significant difference between HA_C and VA_C and the players' risk-aversion is independent of whether or not there is communication.

[39]In Appendix B we provide two illustrative chat examples for each communication treatment. The examples for the HA_C treatment show how communication is used to clarify that the agent has an incentive to exert high effort and that there should be no doubt he will actually do so.

the players agree on these wages significantly less often in HA (p-value $= 0.010$), where $X = 7$, $Y = 15$ is the most frequently chosen contract. This finding can be attributed to the fact that compared to the contract $X = 9$, $Y = 15$, the contract $X = 7$, $Y = 15$ provides the agent with stronger incentives and moreover it leads to equal payoffs when the agent chooses low effort, which the principal may fear in the presence of strategic uncertainty. When communication is possible, the agent can remove these doubts and clarify that it is individually rational for him to exert high effort given the wages $X = 9$, $Y = 15$.[40]

5.2.4 Non-contractible outcome and ex post payoffs

Figure 2 shows the distributions of the contracts on which the players agreed in the treatments with non-contractible outcomes. The panels on the left side illustrate the negotiated wages X and the subsequent effort decisions by the agents in the treatments where effort was a hidden action. The panels on the right side illustrate the treatments where the effort level was verifiable. Thus, these panels show the wages Z that were negotiated when the parties contractually specified low effort and the wages X that were negotiated when the parties agreed on high effort.

[40] Note that these considerations are in line with the fact that the agents' expected profits are smaller in HA than in HA_C (while they do not differ significantly between VA and VA_C).

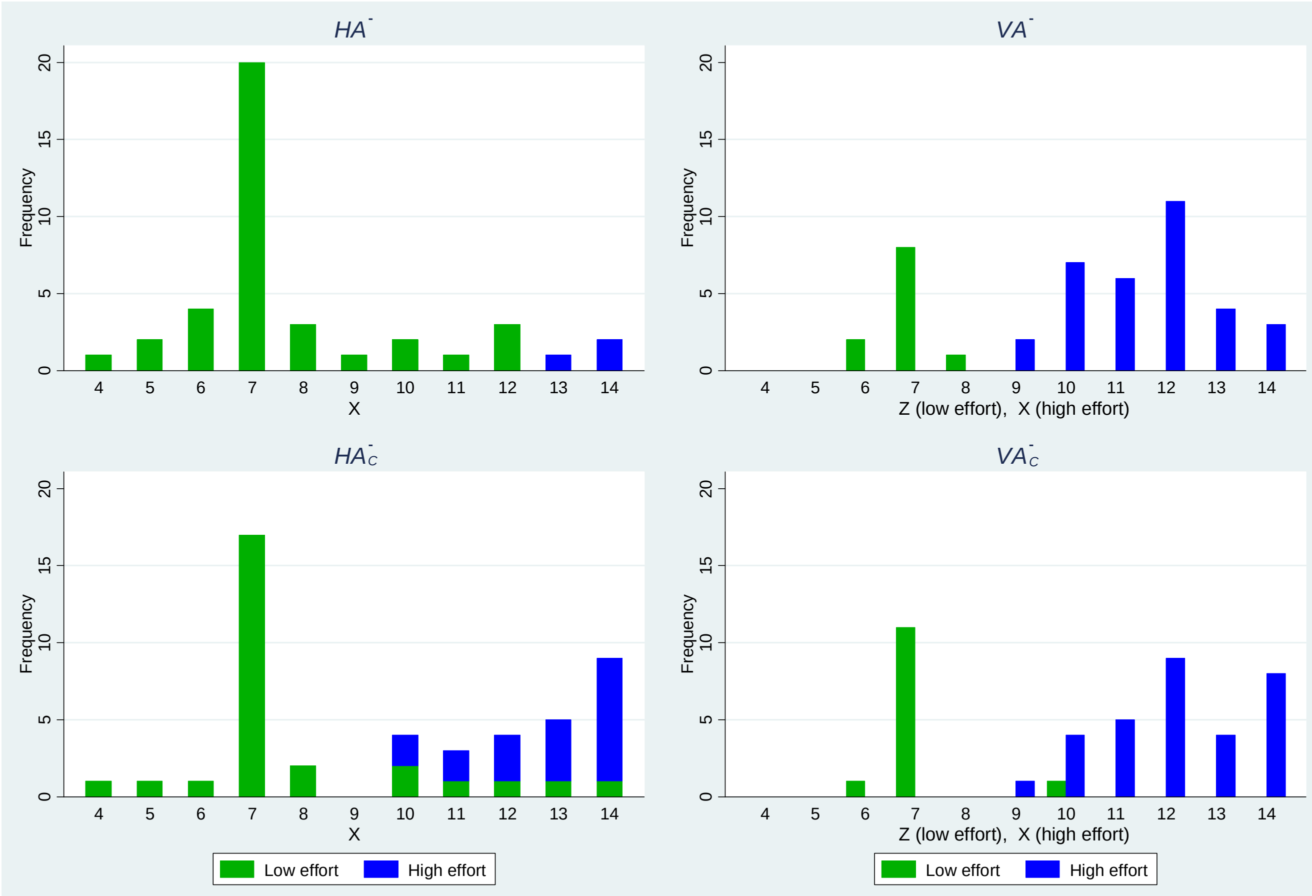

Figure 2. The distributions of the agreed-upon contracts in the treatments with non-contractible outcomes. In the hidden action treatments, the color of the bars indicates for each wage X the effort level that was chosen by the agents. In the verifiable action treatments, the green bars illustrate the frequencies of the wages Z on which the parties agreed when they contractually specified low effort, while the blue bars show the frequencies of the wages X on which the parties agreed when they specified high effort.

Observe that in the treatments where effort is a hidden action, the by far most frequently negotiated contract was $X = 7$ (this wage was agreed upon in $20/40 = 50\%$ of the cases in HA^- and in $17/47 = 36.2\%$ of the cases in HA_C^-), which is in line with the theoretical prediction.

In the treatments where effort is verifiable, the two most frequently negotiated contracts either specified high effort and $X = 12$ or low effort and $Z = 7$.[41]

[41] Specifically, high effort and $X = 12$ was chosen in $11/44 = 25\%$ of the cases in VA^- and in $9/44 = 20.5\%$ of the cases in VA_C^-, while low effort and $Z = 7$ was chosen in $8/44 = 18.2\%$ of the cases in VA^- and in $11/44 = 25\%$ of the cases in VA_C^-.

Recall that according to standard theory, risk-neutral players with equal bargaining powers would agree on high effort and $X = 14$, which yields the same expected payoff of 10 for both parties. The fact that the players often agree on contracts that specify high effort and wages smaller than $X = 14$ can be explained if the principal is risk-averse and hence is willing to bear all the risk only if she obtains a risk premium. Moreover, contracts that specify low effort can be rationalized when the principals are very risk-averse.

Indeed, comparing the verifiable action treatments with and without contractible outcomes, we find that in the former case (where the players can share the risk) high effort is contractually specified more often than in the latter case (where the principal has to bear the full risk), though the difference is statistically significant only when communication is possible. In contrast to Hypothesis 2(iv), the expected total surplus is thus larger in VA_C than in VA_C^-. Observe that in line with this explanation, the content analysis shows that in VA_C the players talk about risk only in 12.77% of the cases, while in VA_C^- they do so in 38.54% of the cases (see Table 6).[42]

5.2.5 Non-contractible outcome and communication

When we compare the wages X on which the players agreed in the HA^- treatment with the wages Z on which the players agreed in the benchmark treatment VA^- if they specified low effort, we find no significant difference (p-value $= 0.2534$). In the HA^- treatment, when the wage is negotiated, the vast majority of the players obviously proceeds on the assumption that in the contract execution stage the agent will choose low effort. In contrast, the wages on which the players agree in HA_C^- are significantly different from the wages on which the players agree in VA_C^- when low effort is specified (p-value $= 0.0038$) as well as from the wages on which the players agree in VA_C^- when high effort is specified (p-value $= 0.0028$).

Specifically, while in HA_C^- we find that $X = 7$ is the most frequently agreed-upon wage, the players agree on wages $X \geq 10$ in $25/47 = 53.2\%$ of the cases, which often leads the agent to choose high effort. In line with the literature on gift exchange, the fraction of agents that choose high effort is increasing in the wage.[43] Comparing the treatments HA^- and HA_C^-, we see that communication

[42] The chat examples for the VA_C^- treatment provided in Appendix B illustrate that the principal is often willing to agree on high effort and to bear the full risk only if her expected payoff is larger than the agent's payoff.

[43] In particular, when $X = 10$, $X = 11$, $X = 12$, $X = 13$, and $X = 14$, respectively, then the fractions of high effort are $2/4 = 50\%$, $2/3 = 66.7\%$, $3/4 = 75\%$, $4/5 = 80\%$, and $8/9 = 88.9\%$.

leads the players to agree on wages $X \geq 10$ much more often.[44] As a consequence, in contrast to Hypothesis 3(iii) the expected total surplus is larger in HA_C^- than in HA^-.

Our content analysis shows that in the treatment HA_C^- a promise was made in around 2/3 of the cases in which high effort was chosen, while in the other cases a promise was almost never made (see Table 7). Similarly, the players explicitly talked about reciprocity significantly more often in the cases in which high effort was chosen. In contrast, note that the relative frequency of promises does not differ significantly between the cases with and without high effort in the treatment HA_C, where the outcome was contractible so that the players could write incentive-compatible contracts.

In line with Charness and Dufwenberg (2006), the effect of communication when outcome is non-contractible can be explained if agents experience a utility loss due to guilt when they let down the principal by breaking their promise to choose high effort. Note that reciprocity alone cannot explain the deviations from standard theory that we observe in HA_C^-, because otherwise we should observe similar deviations in HA^-.[45] However, in HA^- the players agree on large wages only very rarely. Analyzing the contract negotiation stage, we actually find that even when the agents make a contract offer, there are hardly any cases in which they propose a wage of $X = 14$ (implicitly suggesting that they will exert high effort), while in most cases they propose relatively small wages (thus making it quite clear that they plan to exert low effort).[46]

Recall that in Charness and Dufwenberg (2006) the wage is exogenously fixed to $X = 14$, and they find that communication increases the fraction of cases in which the contract is signed and high effort is chosen. In contrast, we allow the players to endogenously negotiate the wage and we find that when communication is possible the players agree on larger wages than in the absence of communication. Hence we identify an additional channel through which communication works in the hidden action problem.

[44] In the treatment HA^-, the players agree on wages $X \geq 10$ in only $9/40 = 22.5\%$ of the cases.

[45] Recall that there are only two effort levels, hence even in the absence of communication it is obvious which effort decision the principal expects from the agent when they agree on a high wage.

[46] See Figure A4 in the Appendix.

6 Conclusion

In this paper, we have experimentally studied a one-shot principal-agent problem explicitly designed to capture the essence of moral hazard as it is usually treated in contract theory. It has turned out that contract theory indeed provides a useful organizing framework and correctly predicts the most frequently taken effort decision in each treatment.

However, some of our results cannot be explained by standard theory. In particular, communication turns out to be very helpful. When the principal's return is contractible, then in line with contract theory the parties can typically overcome the hidden action problem by agreeing on incentive-compatible contracts. Yet, even in this case communication is useful, since it can reduce strategic uncertainty. Moreover, when the principal's return is her private information, such that contracts cannot be outcome-contingent, then in line with contract theory in most cases high effort is agreed upon when effort is verifiable, while low effort is chosen when effort is a hidden action. Yet, the severe problem caused by the unobservability of the agent's effort is substantially reduced when communication is possible. Thus, our experiment illustrates that it is desirable to further enrich moral hazard theory to contribute to a better understanding of real human behavior.

Appendix

A. The contract negotiation stage

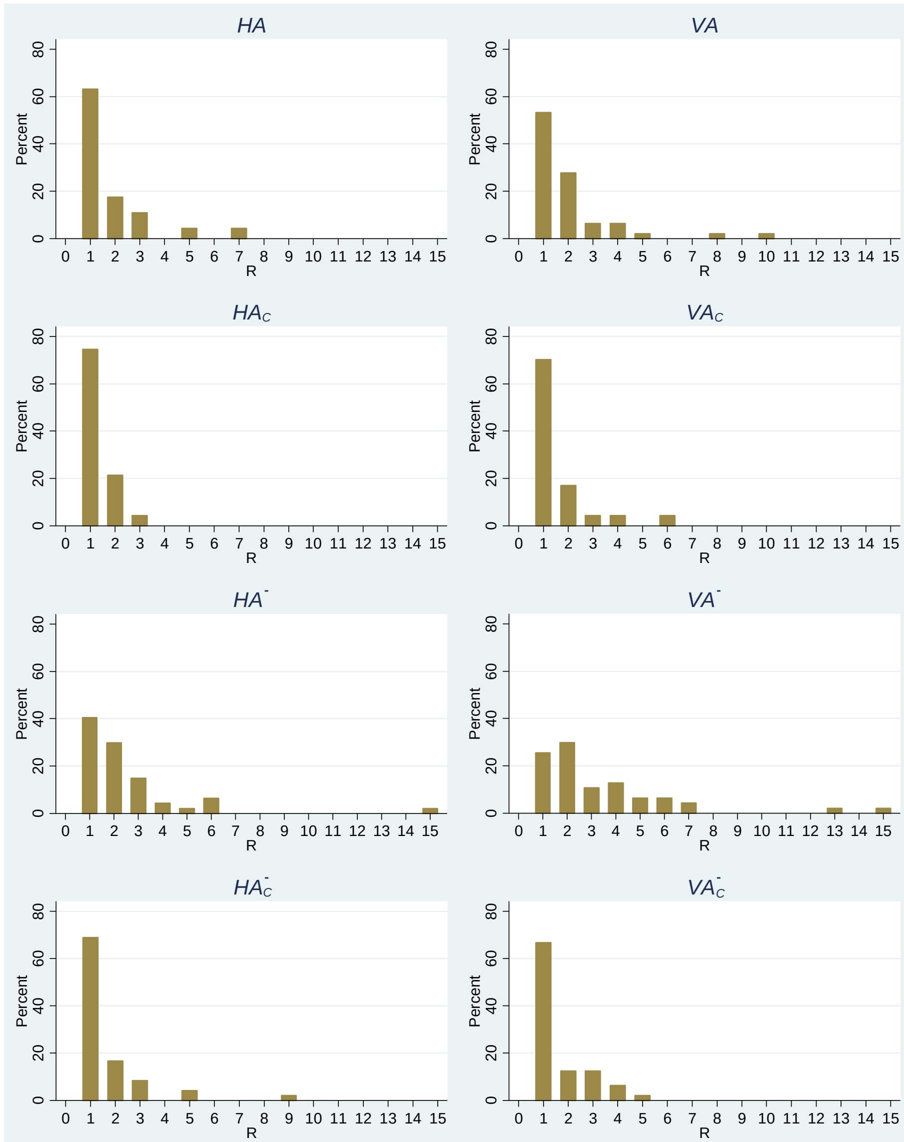

Figure A1. For each treatment, the figure shows the distribution of the number of rounds taken in the contract negotiation stage until an agreement was reached or the negotiation was terminated. As one might have expected, in the treatments in which preplay communication was possible we observe smaller numbers of negotiation rounds than in the respective no-communication treatments (however, the difference is significant only in the case of non-contractible outcomes; cf. Table 5). Moreover, note that in the absence of communication, when the outcome was non-contractible the negotiations took significantly more time than when the outcome was contractible (cf. Table 4).

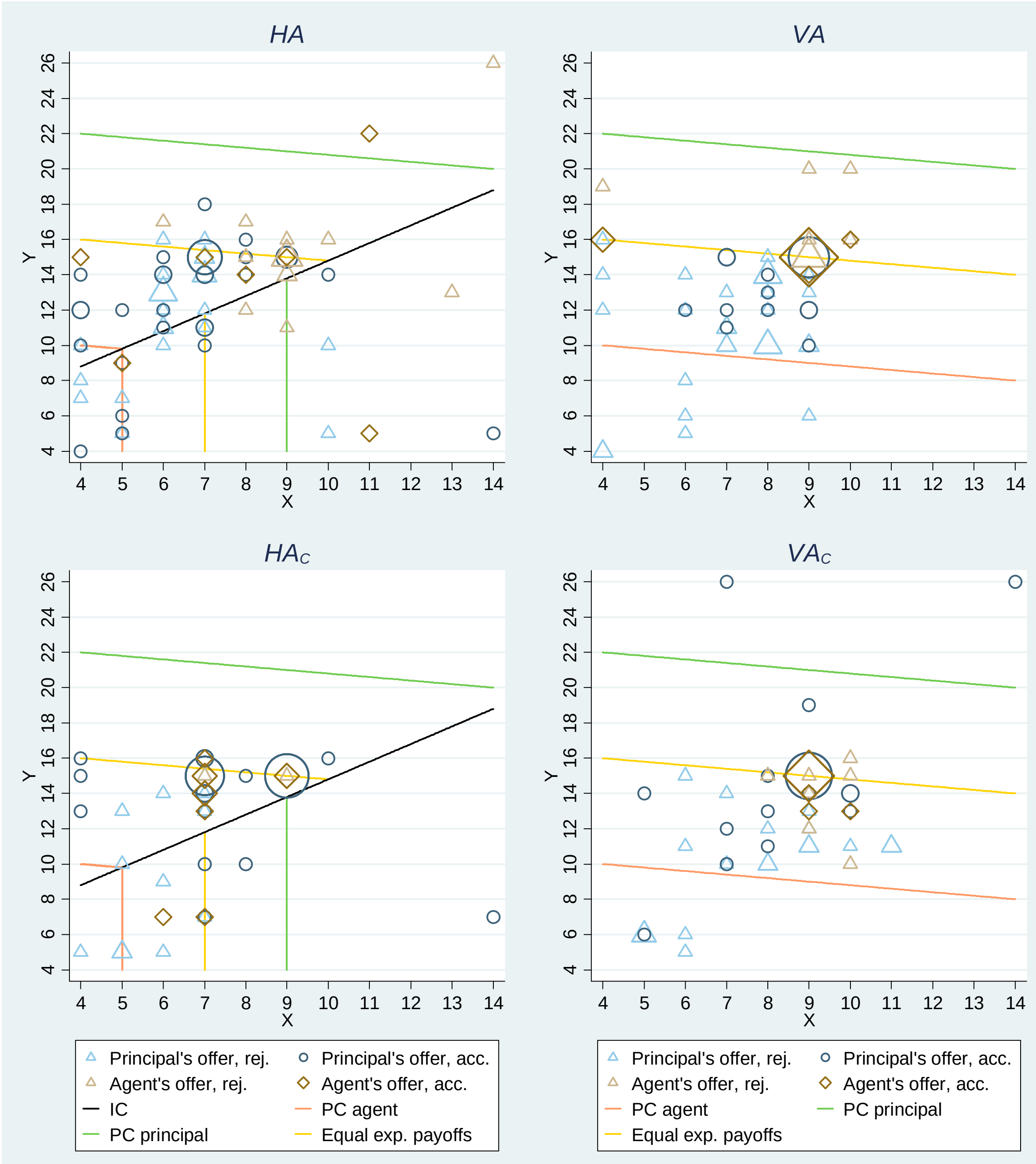

Figure A2. The figure depicts the distributions of the wage offers (X, Y) that were made in the contract negotiation stage in the treatments with contractible outcomes and indicates whether the respective offer was accepted or rejected by the other party. In each treatment, the size of the symbol is proportional to the relative frequency of the respective offer. Recall that in the hidden action treatments the effort level chosen by the agent when the contract was accepted is shown in Figure 1. Note that the panels of the treatments with verifiable effort show only the wages that were proposed in combination with high effort (see Figure A3 for the wages offered in combination with low effort).

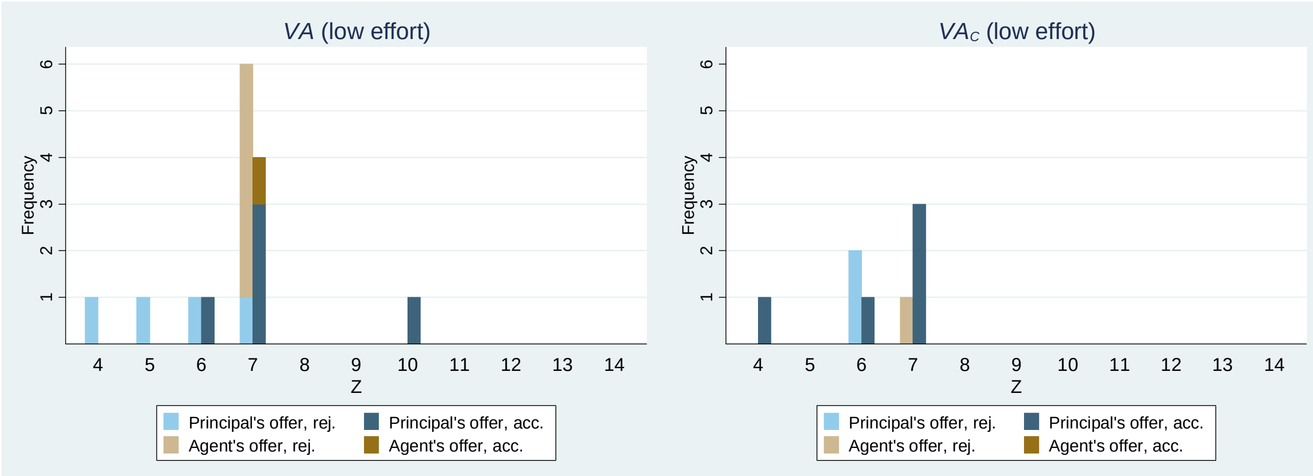

Figure A3. For the treatments with verifiable effort and contractible outcomes, the figure shows the distributions of the wage offers Z that were made when low effort was proposed in the contract negotiation stage. The figure also indicates whether the respective offer was accepted or rejected by the other party.

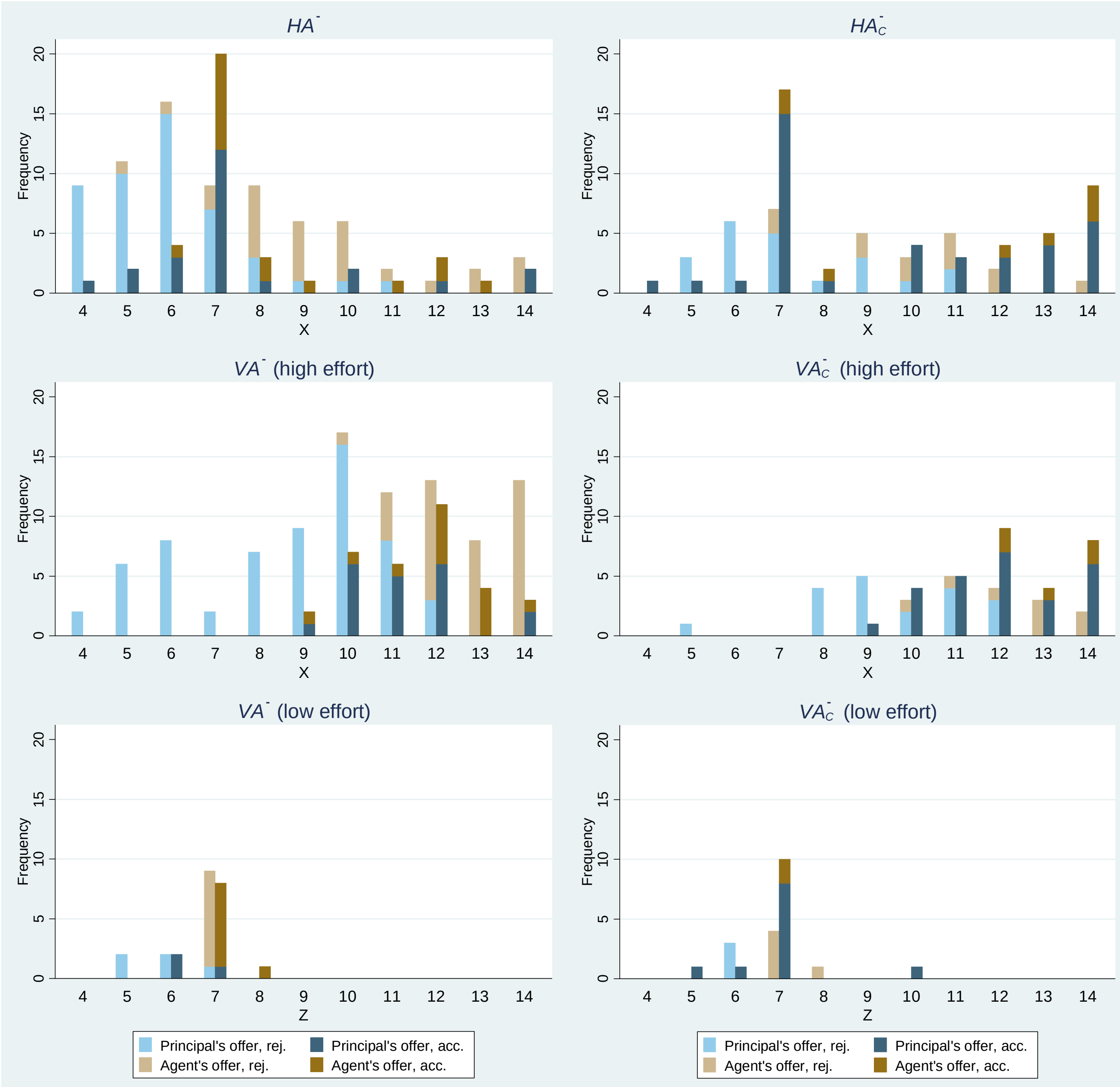

Figure A4. For the treatments with non-contractible outcomes, the figure displays the distributions of the wage offers that were made in the contract negotiation stage and shows whether the respective offer was accepted or rejected by the other party. Recall that in the hidden action treatments the contract consists only of a wage X (the effort level chosen by the agent when the contract was accepted is shown in Figure 2), while in the verifiable action treatments a contract offer either specifies high effort and a wage X or low effort and a wage Z.

B. Examples of free-form communication

We now provide illustrative examples of the contents of the free-form communication. Recall that in the experiment, we used a neutral framing (principals are called "player A," agents are called "player B," high effort is called "roll the die," and low effort is called "don't roll the die"). In each example, we report how the chat was classified by the two coders. Descriptions of the categories are provided in Table B1.

Friendliness	The tone (i.e., the atmosphere) of the conversation is friendly (e.g., use of greetings and smileys).
Clarification	A player explains something to another player (e.g., how the payoffs are calculated or why a specific behavior is in a player's interest).
Incentive comp.	A player points out that given specific payments, it is in player B's self-interest to roll the die (i.e., player B is better off by doing so).
Distrib. Fairness	A player mentions that a specific contracts leads to a fair distribution of the profits, or that it is impossible to achieve a fair distribution.
Reciprocity	A player mentions that if they agree on specific payments, fairness requires that subsequently player B will roll the die.
Promise	Player B makes a promise to roll the die (possibly conditional on an agreement on specific payments).
Threat	A player makes a threat (e.g., not to roll the die or to break off the negotiations).
Risk	A player mentions that specific behavior involves a risk or that it is impossible to divide the risk evenly between the players.

Table B1. Two coders independently classified the conversations according to the categories displayed in the table.

Hidden action treatment HA_C

- *Session 1, group 1.* The coders both marked "yes" in the categories Friendliness, Clarification, Promise, and "no" in the categories Reciprocity, Threat.

  Preplay communication:

  Player A: I choose $X = 7$, so we both obtain 7 if you choose "don't roll the die." And $Y = 15$, if you then choose "roll the die" (which is the best decision for both of us), there is a 5/6 probability that we both obtain 11 euro.

  Player B: Hello :-). I agree with Y, but not with X. I will definitely choose to roll the die. I expect that also for X you choose the amount which leads to the same result for both of us. So, $X = 9$ and $Y = 15$. For me it does not make much sense not to roll the die, because 5/6 is a pretty high probability... It would be good if we take the decision $Y = 15$ and $X = 9$ immediately in the first round.

Player A: Though I cannot trust you! Because here one can trust nobody, but if you really think economically in your own interest, you should then choose to roll the die, because then you have the good ! chance to get 11 euro. I choose $X = 9$ and $Y = 15$.

Player A proposes $X = 9$, $Y = 15$ *in the first round of the negotiations and adds the message:* Let's then hope for a 2, 3, 4, 5, or 6.

Player B immediately accepts the offer and chooses "roll."

- *Session 1, group 8.* The coders both marked "yes" in the categories Friendliness, Clarification, Incentive Comp., and "no" in the categories Promise, Threat.

  Preplay communication:

  Player A: Hello. I would propose a contract $X = 6$ and $Y = 15$. When rolling the die the probability is quite high so a profit of 11 for EACH of us should be great and we would make the same profits!

  Player B: Hi, I think your offer is quite good already, but I would choose $X = 9$, because if I then decide to roll the die so that hopefully each of us obtains 11 ECU, both of us would obtain 5 ECU in case the die after all comes up 1.

  Player A: Hi! If you don't roll the die, you get $X = 9$ and I get 5 ECU... That makes no sense! Because then your incentive to roll the die is quite low. My offer: $Y = 15$, as before, $X = 7$! You can roll the die, then the probability is high that both of us get 11 ECU, or both of us get 7 ECU. Given a probability of 1/6, I expect that this scenario will not occur!

  Player B: You have to trust in your fellow humans a little more ;-), but it is okay, we will do it this way! $X = 7$ and $Y = 15$.

  Player A proposes $X = 7$, $Y = 15$ *in the first round of the negotiations and adds the message:* Oh well, with trust I have never had a good experience in experiments :-), but okay, we agree on $X = 7$ and $Y = 15$. I have entered it now :-).

  Player B immediately accepts the offer and chooses "roll."

Verifiable action treatment VA_C

- *Session 1, group 7.* The coders both marked "yes" in the categories Friendliness, Clarification, and "no" in the categories Threat, Risk.

  Preplay communication:

  Player B: Well. No contract negotiated means 5 ECU -> bad. Not rolling the die given a value of 7 means 7 for both of us -> better, but still bad. We should roll the die, with values $X = 9$ and $Y = 15$. There is the little probability that both of us then get only 5 ECU each, but the probability is higher that both of us get 11 ECU and that would be the best result. Agreed?

  Player A: Yes, of course, sounds good, so we roll the die with the values that you have proposed.

  Player B: Exactly. $X = 9$ and $Y = 15$. Good luck for us! ;-) Let us begin the contract negotiations.

Player A proposes $X = 9$*,* $Y = 15$ *and the action "roll the die" in the first round of the negotiations and adds the message:* Everything okay given this contract? :-)

Player B immediately accepts the offer.

- *Session 2, group 2.* The coders both marked "yes" in the categories Friendliness, Clarification, and "no" in the categories Threat, Risk.

  Preplay communication:

  Player A: Well, my proposal is: Action roll the die, $X = 9$ (then both of us obtain only 5 ECUs, but the probability of this is only 1/6), and $Y = 15$, (then both of us get 11 ECU with the probability 5/6. If we did not roll the die we could at most get 7 if I take $Z = 7$). Hence, I think the first proposal is much better :P What do you say :) ?

  Player B: O.k., we can do this.

  Player A proposes $X = 9$*,* $Y = 15$ *and the action "roll the die" in the first round of the negotiations and adds the message:* Perfect. Then keep your fingers crossed that the die comes up correctly.

  Player B immediately accepts the offer.

Hidden action with non-contractible outcome treatment HA_C^-

- *Session 1, group 10.* The coders both marked "yes" in the categories Friendliness, Clarification, Reciprocity, Promise, and "no" in the categories Threat, Risk.

  Preplay communication:

  Player B: Good morning, teammate :) Just to clarify, so that it doesn't take us unnecessarily many negotiation rounds (in case you want to negotiate at all). Below 10 ECU a contract makes no sense. Then I can take 5 ECUs which one gets without a contract. Starting with 12 ECU in the contract I would roll the die, then both of us profit from this (except in case of a 1, but a 1 is not very likely). Kind regards

  Player A: If you really roll the die, I will even start with 13 ECU. Agreed?

  Player B: Agreed, it's a deal!

  Player A proposes $X = 13$ *in the first round of the negotiations and adds the message:* Great ;-)

  Player B immediately accepts the offer and chooses "roll."

- *Session 1, group 13.* The coders both marked "yes" in the categories Friendliness, Clarification, Reciprocity, Risk, and "no" in the categories Promise, Threat.

  Preplay communication:

  Player A: I suppose that you understand the experiment. I propose that we agree on a number and then choose to roll the die and hope that the 5/6 probability materializes. For the largest profit, 14 is optimal. But I propose 12, so I still get something in case the 1/6 probability materializes. You would then get 8 plus 5. :)

  Player B: It's all clear to me ;) I don't fully agree with 12. What about 13? Then you would still get something if the 1/6 probability materializes. After all, I rather prefer not to roll the die, because then I would get more anyway ;)

  Player A: Then we agree on 7 and don't roll the die. Then both of us get 7.

Player B: Hmm. Then 12 would be better, of course ;)

Player A: I prefer 7 ;), just to make sure. And we are through quickly.

Player B: 10?

Player A: 7 or 5. Your call.

Player B: O.k., then 7.

Player A proposes $X = 7$ *in the first round of the negotiations and adds the message:* Good :)

Player B immediately accepts the offer and chooses "don't roll."

Verifiable action with non-contractible outcome treatment VA_C^-

- *Session 2, group 15.* The coders both marked "yes" in the categories Clarification, Distrib. Fairness, and "no" in the categories Friendliness, Threat.

  Preplay communication:

  Player A: I would prefer the action "roll the die" with the number $X = 10$, since for you the profits are always the same, my payoff however depends on the number the die shows and it would thus be either 4 ECU or 16 ECU.

  Player B: The probability 5/6 is higher. Hence I would like to choose $X = 12$. Thus I would obtain more and it is relatively unlikely that the die comes up 1. In the end the payoffs would be fairer.

  Player A proposes $X = 12$ *and the action "roll the die" in the first round of the negotiations.*

  Player B immediately accepts the offer.

- *Session 3, group 1.* The coders both marked "yes" in the categories Friendliness, Clarification, Distrib. Fairness, Risk, and "no" in the category Threat.

  Preplay communication:

  Player A: The chance to get more money in case of the contract "roll the die" is definitely higher. Do you agree to chose this contract variant so that both of us have the chance to get more money?

  Player B: Yes, absolutely!!!

  Player A: Perfect!! So far, we agree. Since the number of rounds reduces the amount of money, we should sign the contract immediately in round 1. To make it fair, I would choose X such that ideally both of us obtain more money than in case of not rolling the die. Do you also agree with this?

  Player B: Yes, I would have proposed the same. Which X do you propose?

  Player A: Since in the bad scenario when the die comes up 1 we obtain the same payoffs and since it is relatively fair I would propose $X = 9$ as a compromise. Do you agree?

  Player B: Given your proposal, we would better choose not to roll the die and $Z = 7$. Rolling the die makes sense only if we take a larger X. I would have proposed $X = 12$ or $X = 13$.

  Player A: Yes, but in case of $X = 12$ or $X = 13$, I lose much more when the die comes up 1 than when we choose the fair case not to roll the die, $Z = 7$. Then I would not get 7, but only 1 or 2 ECU! I have to bear this risk. Hence, I'm willing to agree on $X = 11$ at most, so that it pays off.

Player B: O.k.

Player A proposes $X = 11$ *and the action "roll the die" in the first round of the negotiations.*

Player B immediately accepts the offer.

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Supplementary Material for

Hidden Action and Outcome Contractibility: An Experimental Test of Moral Hazard Theory

Eva I. Hoppe and Patrick W. Schmitz

The Supplementary Material contains the experimental instructions for all of our eight treatments. The following table illustrates how the treatments differ from each other.

Table S1. The eight treatments.

Instructions for the treatment *HA*

Experimental Instructions

In this experiment always two participants interact with each other. You will be randomly assigned either to the role of player A or to the role of player B.

The currency in the experiment is called ECU ("Experimental Currency Unit").

First stage: Contract negotiation

In the first stage, the two players can agree on a contract.

A **contract** consists of two numbers **X and Y.**

First, player A proposes a contract. The negotiation then proceeds as follows:

Round 1:

Player B learns which contract player A has proposed. Player B then takes one of the following decisions:

- Player B accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player B rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player B rejects the contract and proposes a different contract. The negotiation then proceeds with the next round.

Round 2:

Player A learns which contract player B has proposed. Player A then takes one of the following decisions:

- Player A accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player A rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU

- Player A rejects the contract and proposes a different contract. The negotiation then proceeds with the next round.

If **round 3 (resp., 5, 7, 9, ...)** takes place, this round proceeds in analogy to round 1.

If **round 4 (resp., 6, 8, 10, ...)** takes place, this round proceeds in analogy to round 2.

Second stage: Roll or don't roll a die

If in the first stage a proposed contract has been accepted, the two numbers X and Y are fixed. The experiment then proceeds as follows:

Player B takes one of the actions "roll the die" or "don't roll the die."

Player A does not learn whether player B chooses "roll the die" or "don't roll the die."

- If player B chooses ***"don't roll the die,"*** the profits are as follows:
  Player A: 14 - X ECU
  Player B: X ECU

- If player B chooses ***"roll the die,"*** the profits depend on the outcome of the roll of a die that is simulated by the computer:

  With probability 1/6, the die comes up 1. Then the profits are:
  Player A: 14 - X ECU
  Player B: X - 4 ECU

  With probability 5/6, the die comes up 2, 3, 4, 5, or 6. Then the profits are:
  Player A: 26 - Y ECU
  Player B: Y - 4 ECU

Please note:

- The experiment takes place only once, there are no repetitions. Please take your time to think carefully about what you want to do.
- Only such contracts where X and Y are integers and that do not lead to a negative profit for a player in any case can be proposed.

Your payoff:
The profit made in the experiment will be paid out to you in cash. The exchange rate is as follows: One ECU corresponds to $0{,}99^R$ Euro, where R is the number of rounds that have taken place in the first stage. Thus, the fewer rounds have taken place in the first stage, the more favorable is the exchange rate for you: 1 ECU = 0,99 Euro in case of one round, 1 ECU ≈ 0,98 Euro in case of two rounds, 1 ECU ≈ 0,97 Euro in case of three rounds, 1 ECU ≈ 0,96 Euro in case of four rounds, and so on.

Additionally, you obtain 5 Euro for your participation. At the end of the experiment, we kindly ask you to answer a questionnaire.

Please note:
During the whole experiment communication is not allowed. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

Instructions for the treatment *VA*

Experimental Instructions

In this experiment always two participants interact with each other. You will be randomly assigned either to the role of player A or to the role of player B.

The currency in the experiment is called ECU ("Experimental Currency Unit").

First stage: Contract negotiation

In the first stage, the two players can agree on a contract.

A **contract** consists of
• either the action "***roll the die***" and two numbers **X and Y**
• or the action ***"don't roll the die"*** and a number **Z**.

First, player A proposes a contract. The negotiation then proceeds as follows:

Round 1:

Player B learns which contract player A has proposed. Player B then takes one of the following decisions:

- Player B accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player B rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player B rejects the contract and proposes a different contract. The negotiation then proceeds with the next round.

Round 2:

Player A learns which contract player B has proposed. Player A then takes one of the following decisions:

- Player A accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player A rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:

Player A: 5 ECU
Player B: 5 ECU

- Player A rejects the contract and proposes a different contract. The negotiation then proceeds with the next round.

If **round 3 (resp., 5, 7, 9, ...)** takes place, this round proceeds in analogy to round 1.

If **round 4 (resp., 6, 8, 10, ...)** takes place, this round proceeds in analogy to round 2.

Second stage: Roll or don't roll a die

If in the first stage a proposed contract has been accepted, the experiment proceeds as follows:

- If the contract prescribes the action **"*don't roll the die,*"** the profits are as follows:
  Player A: 14 - Z ECU
  Player B: Z ECU

- If the contract prescribes the action **"*roll the die,*"** the profits depend on the outcome of the roll of a die that is simulated by the computer:

  With probability 1/6, the die comes up 1. Then the profits are:
  Player A: 14 - X ECU
  Player B: X - 4 ECU

  With probability 5/6, the die comes up 2, 3, 4, 5, or 6. Then the profits are:
  Player A: 26 - Y ECU
  Player B: Y - 4 ECU

Please note:
- The experiment takes place only once, there are no repetitions. Please take your time to think carefully about what you want to do.
- Only such contracts where X and Y, resp. Z, are integers and that do not lead to a negative profit for a player in any case can be proposed.

Your payoff:
The profit made in the experiment will be paid out to you in cash. The exchange rate is as follows: One ECU corresponds to $0{,}99^R$ Euro, where R is the number of rounds that have taken place in the first stage. Thus, the fewer rounds have taken place in the first stage, the more favorable is the exchange rate for you: 1 ECU = 0,99 Euro in case of one round, 1 ECU ≈ 0,98 Euro in case of two rounds, 1 ECU ≈ 0,97 Euro in case of three rounds, 1 ECU ≈ 0,96 Euro in case of four rounds, and so on.

Additionally, you obtain 5 Euro for your participation. At the end of the experiment, we kindly ask you to answer a questionnaire.

Please note:
During the whole experiment communication is not allowed. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

Instructions for the treatment HA_C

Experimental Instructions

In this experiment always two participants interact with each other. You will be randomly assigned either to the role of player A or to the role of player B.

The currency in the experiment is called ECU ("Experimental Currency Unit").

To begin with, player A and player B who are assigned to one another can alternatingly send each other text messages via the computer. Hereafter, the first stage of the experiment starts.

First stage: Contract negotiation

In the first stage, the two players can agree on a contract.

A **contract** consists of two numbers **X and Y.**

First, player A proposes a contract. A text message can be added to the contract offer. The negotiation then proceeds as follows:

Round 1:

Player B learns which contract player A has proposed. Player B then takes one of the following decisions:

- Player B accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player B rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player B rejects the contract and proposes a different contract (a text message can be added to the contract offer). The negotiation then proceeds with the next round.

Round 2:

Player A learns which contract player B has proposed. Player A then takes one of the following decisions:

- Player A accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.

- Player A rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player A rejects the contract and proposes a different contract (a text message can be added to the contract offer). The negotiation then proceeds with the next round.

If **round 3 (resp., 5, 7, 9, ...)** takes place, this round proceeds in analogy to round 1.

If **round 4 (resp., 6, 8, 10, ...)** takes place, this round proceeds in analogy to round 2.

Second stage: Roll or don't roll a die

If in the first stage a proposed contract has been accepted, the two numbers X and Y are fixed. The experiment then proceeds as follows:

Player B takes one of the actions "roll the die" or "don't roll the die."

Player A does not learn whether player B chooses "roll the die" or "don't roll the die."

- If player B chooses ***"don't roll the die,"*** the profits are as follows:
  Player A: 14 - X ECU
  Player B: X ECU

- If player B chooses ***"roll the die,"*** the profits depend on the outcome of the roll of a die that is simulated by the computer:

  With probability 1/6, the die comes up 1. Then the profits are:
  Player A: 14 - X ECU
  Player B: X - 4 ECU

  With probability 5/6, the die comes up 2, 3, 4, 5, or 6. Then the profits are:
  Player A: 26 - Y ECU
  Player B: Y - 4 ECU

Please note:

- The experiment takes place only once, there are no repetitions. Please take your time to think carefully about what you want to do.
- Only such contracts where X and Y are integers and that do not lead to a negative profit for a player in any case can be proposed.
- Each **text message** can contain a free-form text with up to 500 characters. Any hints regarding your identity (e.g., name, cabin number, cloths, etc.) are not allowed.

Your payoff:
The profit made in the experiment will be paid out to you in cash. The exchange rate is as follows: One ECU corresponds to $0,99^R$ Euro, where R is the number of rounds that have taken place in the first stage. Thus, the fewer rounds have taken place in the first stage, the more favorable is the exchange rate for you: 1 ECU = 0,99 Euro in case of one round, 1 ECU ≈ 0,98 Euro in case of two rounds, 1 ECU ≈ 0,97 Euro in case of three rounds, 1 ECU ≈ 0,96 Euro in case of four rounds, and so on.

Additionally, you obtain 5 Euro for your participation. At the end of the experiment, we kindly ask you to answer a questionnaire.

Please note:
During the whole experiment communication is not allowed except through the experimental software. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

Instructions for the treatment VA_C

Experimental Instructions

In this experiment always two participants interact with each other. You will be randomly assigned either to the role of player A or to the role of player B.

The currency in the experiment is called ECU ("Experimental Currency Unit").

To begin with, player A and player B who are assigned to one another can alternatingly send each other text messages via the computer. Hereafter, the first stage of the experiment starts.

First stage: Contract negotiation

In the first stage, the two players can agree on a contract.

A **contract** consists of
- either the action ***"roll the die"*** and two numbers **X and Y**
- or the action ***"don't roll the die"*** and a number **Z**.

First, player A proposes a contract. A text message can be added to the contract offer. The negotiation then proceeds as follows:

Round 1:

Player B learns which contract player A has proposed. Player B then takes one of the following decisions:

- Player B accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player B rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player B rejects the contract and proposes a different contract (a text message can be added to the contract offer). The negotiation then proceeds with the next round.

Round 2:

Player A learns which contract player B has proposed. Player A then takes one of the following decisions:

- Player A accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player A rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player A rejects the contract and proposes a different contract (a text message can be added to the contract offer). The negotiation then proceeds with the next round.

If **round 3 (resp., 5, 7, 9, ...)** takes place, this round proceeds in analogy to round 1.

If **round 4 (resp., 6, 8, 10, ...)** takes place, this round proceeds in analogy to round 2.

Second stage: Roll or don't roll a die

If in the first stage a proposed contract has been accepted, the experiment proceeds as follows:

- If the contract prescribes the action **"*don't roll the die,*"** the profits are as follows:
  Player A: 14 - Z ECU
  Player B: Z ECU

- If the contract prescribes the action **"*roll the die,*"** the profits depend on the outcome of the roll of a die that is simulated by the computer:

  With probability 1/6, the die comes up 1. Then the profits are:
  Player A: 14 - X ECU
  Player B: X - 4 ECU

  With probability 5/6, the die comes up 2, 3, 4, 5, or 6. Then the profits are:
  Player A: 26 - Y ECU
  Player B: Y - 4 ECU

Please note:

- The experiment takes place only once, there are no repetitions. Please take your time to think carefully about what you want to do.
- Only such contracts where X and Y, resp. Z, are integers and that do not lead to a negative profit for a player in any case can be proposed.
- Each **text message** can contain a free-form text with up to 500 characters. Any hints regarding your identity (e.g., name, cabin number, cloths, etc.) are not allowed.

Your payoff:
The profit made in the experiment will be paid out to you in cash. The exchange rate is as follows: One ECU corresponds to $0{,}99^R$ Euro, where R is the number of rounds that have taken place in the first stage. Thus, the fewer rounds have taken place in the first stage, the more favorable is the exchange rate for you: 1 ECU = 0,99 Euro in case of one round, 1 ECU ≈ 0,98 Euro in case of two rounds, 1 ECU ≈ 0,97 Euro in case of three rounds, 1 ECU ≈ 0,96 Euro in case of four rounds, and so on.

Additionally, you obtain 5 Euro for your participation. At the end of the experiment, we kindly ask you to answer a questionnaire.

Please note:
During the whole experiment communication is not allowed except through the experimental software. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

Instructions for the treatment HA^-

Experimental Instructions

In this experiment always two participants interact with each other. You will be randomly assigned either to the role of player A or to the role of player B.

The currency in the experiment is called ECU ("Experimental Currency Unit").

First stage: Contract negotiation

In the first stage, the two players can agree on a contract.

A **contract** consists of a number **X.**

First, player A proposes a contract. The negotiation then proceeds as follows:

Round 1:

Player B learns which contract player A has proposed. Player B then takes one of the following decisions:

- Player B accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player B rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player B rejects the contract and proposes a different contract. The negotiation then proceeds with the next round.

Round 2:

Player A learns which contract player B has proposed. Player A then takes one of the following decisions:

- Player A accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player A rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU

- Player A rejects the contract and proposes a different contract. The negotiation then proceeds with the next round.

If **round 3 (resp., 5, 7, 9, ...)** takes place, this round proceeds in analogy to round 1.

If **round 4 (resp., 6, 8, 10, ...)** takes place, this round proceeds in analogy to round 2.

Second stage: Roll or don't roll a die

If in the first stage a proposed contract has been accepted, the number X is fixed. The experiment then proceeds as follows:

Player B takes one of the actions "roll the die" or "don't roll the die."

Player A does not learn whether player B chooses "roll the die" or "don't roll the die."

- If player B chooses ***"don't roll the die,"*** the profits are as follows:
  Player A: 14 - X ECU
  Player B: X ECU

- If player B chooses ***"roll the die,"*** the profits depend on the outcome of the roll of a die that is simulated by the computer:

  With probability 1/6, the die comes up 1. Then the profits are:
  Player A: 14 - X ECU
  Player B: X - 4 ECU

  With probability 5/6, the die comes up 2, 3, 4, 5, or 6. Then the profits are:
  Player A: 26 - X ECU
  Player B: X - 4 ECU

Please note:

- The experiment takes place only once, there are no repetitions. Please take your time to think carefully about what you want to do.
- Only such contracts where X is an integer and that do not lead to a negative profit for a player in any case can be proposed.

Your payoff:
The profit made in the experiment will be paid out to you in cash. The exchange rate is as follows: One ECU corresponds to $0{,}99^R$ Euro, where R is the number of rounds that have taken place in the first stage. Thus, the fewer rounds have taken place in the first stage, the more favorable is the exchange rate for you: 1 ECU = 0,99 Euro in case of one round, 1 ECU ≈ 0,98 Euro in case of two rounds, 1 ECU ≈ 0,97 Euro in case of three rounds, 1 ECU ≈ 0,96 Euro in case of four rounds, and so on.

Additionally, you obtain 5 Euro for your participation. At the end of the experiment, we kindly ask you to answer a questionnaire.

Please note:
During the whole experiment communication is not allowed. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

Instructions for the treatment VA^-

Experimental Instructions

In this experiment always two participants interact with each other. You will be randomly assigned either to the role of player A or to the role of player B.

The currency in the experiment is called ECU ("Experimental Currency Unit").

First stage: Contract negotiation

In the first stage, the two players can agree on a contract.

A **contract** consists of
• either the action ***"roll the die"*** and a number **X**
• or the action ***"don't roll the die"*** and a number **Z**.

First, player A proposes a contract. The negotiation then proceeds as follows:

Round 1:

Player B learns which contract player A has proposed. Player B then takes one of the following decisions:

- Player B accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player B rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player B rejects the contract and proposes a different contract. The negotiation then proceeds with the next round.

Round 2:

Player A learns which contract player B has proposed. Player A then takes one of the following decisions:

- Player A accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player A rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:

Player A: 5 ECU
Player B: 5 ECU

- Player A rejects the contract and proposes a different contract. The negotiation then proceeds with the next round.

If **round 3 (resp., 5, 7, 9, ...)** takes place, this round proceeds in analogy to round 1.

If **round 4 (resp., 6, 8, 10, ...)** takes place, this round proceeds in analogy to round 2.

Second stage: Roll or don't roll a die

If in the first stage a proposed contract has been accepted, the experiment proceeds as follows:

- If the contract prescribes the action **"*don't roll the die,*"** the profits are as follows:
  Player A: 14 - Z ECU
  Player B: Z ECU

- If the contract prescribes the action **"*roll the die,*"** the profits depend on the outcome of the roll of a die that is simulated by the computer:

  With probability 1/6, the die comes up 1. Then the profits are:
  Player A: 14 - X ECU
  Player B: X - 4 ECU

  With probability 5/6, the die comes up 2, 3, 4, 5, or 6. Then the profits are:
  Player A: 26 - X ECU
  Player B: X - 4 ECU

Please note:

- The experiment takes place only once, there are no repetitions. Please take your time to think carefully about what you want to do.
- Only such contracts where X and Z are integers and that do not lead to a negative profit for a player in any case can be proposed.

Your payoff:
The profit made in the experiment will be paid out to you in cash. The exchange rate is as follows: One ECU corresponds to $0{,}99^R$ Euro, where R is the number of rounds that have taken place in the first stage. Thus, the fewer rounds have taken place in the first stage, the more favorable is the exchange rate for you: 1 ECU = 0,99 Euro in case of one round, 1 ECU ≈ 0,98 Euro in case of two rounds, 1 ECU ≈ 0,97 Euro in case of three rounds, 1 ECU ≈ 0,96 Euro in case of four rounds, and so on.

Additionally, you obtain 5 Euro for your participation. At the end of the experiment, we kindly ask you to answer a questionnaire.

Please note:
During the whole experiment communication is not allowed. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

Instructions for the treatment HA_C^-

Experimental Instructions

In this experiment always two participants interact with each other. You will be randomly assigned either to the role of player A or to the role of player B.

The currency in the experiment is called ECU ("Experimental Currency Unit").

To begin with, player A and player B who are assigned to one another can alternatingly send each other text messages via the computer. Hereafter, the first stage of the experiment starts.

First stage: Contract negotiation

In the first stage, the two players can agree on a contract.

A **contract** consists of a number **X.**

First, player A proposes a contract. A text message can be added to the contract offer. The negotiation then proceeds as follows:

Round 1:

Player B learns which contract player A has proposed. Player B then takes one of the following decisions:

- Player B accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player B rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player B rejects the contract and proposes a different contract (a text message can be added to the contract offer). The negotiation then proceeds with the next round.

Round 2:

Player A learns which contract player B has proposed. Player A then takes one of the following decisions:

- Player A accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.

- Player A rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player A rejects the contract and proposes a different contract (a text message can be added to the contract offer). The negotiation then proceeds with the next round.

If **round 3 (resp., 5, 7, 9, ...)** takes place, this round proceeds in analogy to round 1.

If **round 4 (resp., 6, 8, 10, ...)** takes place, this round proceeds in analogy to round 2.

Second stage: Roll or don’t roll a die

If in the first stage a proposed contract has been accepted, the number X is fixed. The experiment then proceeds as follows:

Player B takes one of the actions “roll the die” or “don’t roll the die.”

Player A does not learn whether player B chooses “roll the die” or “don’t roll the die.”

- If player B chooses ***“don’t roll the die,”*** the profits are as follows:
  Player A: 14 - X ECU
  Player B: X ECU

- If player B chooses ***“roll the die,”*** the profits depend on the outcome of the roll of a die that is simulated by the computer:

  With probability 1/6, the die comes up 1. Then the profits are:
  Player A: 14 - X ECU
  Player B: X - 4 ECU

  With probability 5/6, the die comes up 2, 3, 4, 5, or 6. Then the profits are:
  Player A: 26 - X ECU
  Player B: X - 4 ECU

Please note:

- The experiment takes place only once, there are no repetitions. Please take your time to think carefully about what you want to do.
- Only such contracts where X is an integer and that do not lead to a negative profit for a player in any case can be proposed.
- Each **text message** can contain a free-form text with up to 500 characters. Any hints regarding your identity (e.g., name, cabin number, cloths, etc.) are not allowed.

Your payoff:
The profit made in the experiment will be paid out to you in cash. The exchange rate is as follows: One ECU corresponds to $0{,}99^R$ Euro, where R is the number of rounds that have taken place in the first stage. Thus, the fewer rounds have taken place in the first stage, the more favorable is the exchange rate for you: 1 ECU = 0,99 Euro in case of one round, 1 ECU ≈ 0,98 Euro in case of two rounds, 1 ECU ≈ 0,97 Euro in case of three rounds, 1 ECU ≈ 0,96 Euro in case of four rounds, and so on.

Additionally, you obtain 5 Euro for your participation. At the end of the experiment, we kindly ask you to answer a questionnaire.

Please note:
During the whole experiment communication is not allowed except through the experimental software. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

Instructions for the treatment VA_C^-

Experimental Instructions

In this experiment always two participants interact with each other. You will be randomly assigned either to the role of player A or to the role of player B.

The currency in the experiment is called ECU (“Experimental Currency Unit”).

To begin with, player A and player B who are assigned to one another can alternatingly send each other text messages via the computer. Hereafter, the first stage of the experiment starts.

First stage: Contract negotiation

In the first stage, the two players can agree on a contract.

A **contract** consists of
• either the action ***“roll the die”*** and a number **X**
• or the action ***“don’t roll the die”*** and a number **Z**.

First, player A proposes a contract. A text message can be added to the contract offer. The negotiation then proceeds as follows:

Round 1:

Player B learns which contract player A has proposed. Player B then takes one of the following decisions:

- Player B accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.
- Player B rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU
- Player B rejects the contract and proposes a different contract (a text message can be added to the contract offer). The negotiation then proceeds with the next round.

Round 2:

Player A learns which contract player B has proposed. Player A then takes one of the following decisions:

- Player A accepts the contract. The contract negotiation then is finished and the second stage of the experiment is reached.

- Player A rejects the contract and does not propose a different contract. The experiment is terminated, i.e. the second stage is not reached. In this case, the profits are:
  Player A: 5 ECU
  Player B: 5 ECU

- Player A rejects the contract and proposes a different contract (a text message can be added to the contract offer). The negotiation then proceeds with the next round.

If **round 3 (resp., 5, 7, 9, ...)** takes place, this round proceeds in analogy to round 1.

If **round 4 (resp., 6, 8, 10, ...)** takes place, this round proceeds in analogy to round 2.

Second stage: Roll or don't roll a die

If in the first stage a proposed contract has been accepted, the experiment proceeds as follows:

- If the contract prescribes the action **"*don't roll the die,*"** the profits are as follows:
  Player A: 14 - Z ECU
  Player B: Z ECU

- If the contract prescribes the action **"*roll the die,*"** the profits depend on the outcome of the roll of a die that is simulated by the computer:

  With probability 1/6, the die comes up 1. Then the profits are:
  Player A: 14 - X ECU
  Player B: X - 4 ECU

  With probability 5/6, the die comes up 2, 3, 4, 5, or 6. Then the profits are:
  Player A: 26 - X ECU
  Player B: X - 4 ECU

Please note:
- The experiment takes place only once, there are no repetitions. Please take your time to think carefully about what you want to do.
- Only such contracts where X and Z are integers and that do not lead to a negative profit for a player in any case can be proposed.
- Each **text message** can contain a free-form text with up to 500 characters. Any hints regarding your identity (e.g., name, cabin number, cloths, etc.) are not allowed.

Your payoff:
The profit made in the experiment will be paid out to you in cash. The exchange rate is as follows: One ECU corresponds to $0{,}99^{R}$ Euro, where R is the number of rounds that have taken

place in the first stage. Thus, the fewer rounds have taken place in the first stage, the more favorable is the exchange rate for you: 1 ECU = 0,99 Euro in case of one round, 1 ECU ≈ 0,98 Euro in case of two rounds, 1 ECU ≈ 0,97 Euro in case of three rounds, 1 ECU ≈ 0,96 Euro in case of four rounds, and so on.

Additionally, you obtain 5 Euro for your participation. At the end of the experiment, we kindly ask you to answer a questionnaire.

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During the whole experiment communication is not allowed except through the experimental software. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.