Contracting under Incomplete Information and Social Preferences: An Experimental Study

Hoppe, Eva I. and Schmitz, Patrick W.

January 2013

Contracting under Incomplete Information and Social Preferences: An Experimental Study

EVA I. HOPPE

University of Cologne

and

PATRICK W. SCHMITZ*

University of Cologne and CEPR

Principal-agent models in which the agent has access to private information before a contract is signed are a cornerstone of contract theory. We have conducted an experiment with 720 participants to explore whether the theoretical insights are reflected by the behavior of subjects in the laboratory and to what extent deviations from standard theory can be explained by social preferences. Investigating settings with both exogenous and endogenous information structures, we find that agency theory is indeed useful to qualitatively predict how variations in the degree of uncertainty affect subjects' behavior. Regarding the quantitative deviations from standard predictions, our analysis based on several control treatments and quantal response estimations shows that agents' behavior can be explained by social preferences that are less pronounced than in conventional ultimatum games. Principals' own social preferences are not an important determinant of their behavior. However, when the principals make contract offers, they anticipate that social preferences affect agents' behavior.

Key words: Agency theory, Adverse selection, Information gathering, Ultimatum game, Social preferences, Experiment

JEL Codes: D82, D86, C72, C91

* Department of Economics, University of Cologne, Albertus-Magnus-Platz, 50923 Köln, Germany. E-mail: <patrick.schmitz@uni-koeln.de>.

1 Introduction

Principal-agent relationships play a central role in the theory of incentives and mechanism design. In standard principal-agent models, there are two parties. One party (the principal) designs a contract and makes a take-it-or-leave-it offer to the other party (the agent). Settings in which at the time the contract is signed the agent has access to private information are by now generally referred to as "adverse selection" problems.[1] While the theoretical literature on contracting under incomplete information has grown rapidly in the past three decades, empirical evidence is still scarce. In the present contribution, we report about a large-scale experiment designed to explore the behavior of decision makers confronted with adverse selection problems. We investigate to what extent the theoretical considerations are reflected by the behavior of subjects in the laboratory and assess the importance of social preferences and decision errors in this context.

Specifically, we consider a principal who can make a wage offer to an agent for the production of a good. The agent's production costs can be either low or high with equal probability. When the agent accepts the offer, he has to incur the production costs and the principal obtains a return. We consider a setting where the principal's return is larger than the production costs in both states of nature. Hence, ex post efficiency is achieved if the agent accepts the wage offer regardless of the state of nature.[2]

To explore how contracting responds to changes in uncertainty, we have conducted four main treatments, using a 2 x 2 design. In particular, we consider two different parameter constellations regarding the agent's production costs and two different information structures. One information structure is relatively simple (the agent always has private information about his production costs from the outset), while the other information structure is more

[1] In the contract-theoretic literature, it has become common to subdivide principal-agent models in the categories "adverse selection" and "moral hazard" (see Maskin and Riley, 1984; Hart and Holmström, 1987). In models of the latter kind, there is symmetric information when the contract is signed, but informational asymmetries can arise after the contract is signed, for instance because the agent's effort cannot be observed. See Laffont and Martimort (2002), Bolton and Dewatripont (2005), or Salanié (2005) for recent textbook expositions of principal-agent theory.

[2] We thus study a simple version of the canonical adverse selection problem (cf. Laffont and Martimort, ch. 2), which constitutes the central building block of the modern theory of procurement and regulation (Baron and Myerson, 1982; Laffont and Tirole, 1993) and monopolistic price discrimination (Maskin and Riley, 1984). For comprehensive discussions of theses and numerous further applications, see Bolton and Dewatripont (2005, ch. 2).

complex (before signing the contract, the agent endogenously decides whether to spend resources to privately learn his production costs).[3]

Suppose first that asymmetric information is exogenously given; i.e., the agent costlessly learns his production costs before he has to decide whether to accept the principal's wage offer. We consider two parameter constellations. In both constellations, the expected production costs are the same. Yet, in the first parameter constellation, the spread between the low and the high production costs is large, so that according to agency theory the principal would maximize her expected profit by giving up ex post efficiency in the bad state of nature, in favor of a small wage offer that is accepted in the good state of nature only. In contrast, in the second parameter constellation, the spread between the low and the high production costs is small, so that agency theory predicts a large wage offer that is accepted by both types of agents; i.e., ex post efficiency is always achieved.

Next, suppose that the information structure is endogenous, so that initially also the agent is uninformed about his production costs. After the principal has offered a wage, the agent can decide whether he wants to spend resources to learn his production costs before accepting or rejecting the offer. Note that from an efficiency perspective, information gathering is a wasteful activity in our setting, since it is commonly known that the principal's return is always larger than the production costs. Yet, if the spread between the low and the high production costs is large, according to agency theory the principal would make a wage offer which induces the agent to gather information and to accept the contract only if he learns to be of the low-cost type. In contrast, if the spread is small, the principal maximizes her expected profit when she makes a wage offer that is accepted by the agent without information gathering, so that ex post efficiency is achieved.

The two parameter constellations regarding the agent's production costs reflect a basic lesson of agency theory, according to which there is a rent extraction versus efficiency trade-off. This trade-off means that the principal may be willing to accept downward distortions away from the first-best trade

[3]Note that in traditional adverse selection theory it was typically assumed that the agent has private information from the outset, while more recent studies emphasize that in practice the agent may first have to spend resources to gather relevant information (see Crémer and Khalil, 1992, and the recent survey by Bergemann and Välimäki, 2006). For instance, before a drilling company agrees to drill oil at a given piece of land, it will gather information about the prevailing soil conditions and associated difficulties to undertake the drilling. Similarly, a supplier who is asked to develop specialized intermediate goods may spend resources to examine possible production techniques and associated costs before he signs the contract.

level in the bad state of nature, in order to make a larger profit in the good state of nature. Ex post efficiency is then achieved only when the agent has low production costs (i.e., there is "no distortion at the top"), while agents with high production costs are excluded. A comparison of the subjects' behavior between our two parameter constellations allows us to investigate whether the subjects take into account this trade-off that is at the heart of adverse selection theory.

We study this question both in the relatively simple setup in which asymmetric information is exogenously given and in the cognitively more demanding setup in which the information structure is endogenous. Note that the exogenous information structure is theoretically equivalent to an endogenous information structure with information gathering costs zero.[4] Thus, a comparison of the principals' behavior between the information structures allows us to explore if they react to variations of the information gathering costs as predicted by agency theory.

Overall, our experimental results show that agency theory is indeed very useful to qualitatively predict the differences in principals' and agents' behavior across treatments. The data largely corroborate the predicted reactions of the principals' offers and the agents' information gathering and acceptance decisions to the treatment variations. Thus, our experiment provides empirical evidence that agency models with exogenous as well as endogenous information structures capture important aspects that are taken into consideration by decision-makers confronted with adverse selection problems.

However, in each treatment we find deviations between our data and the quantitative predictions based on standard theory. In particular, compared to the standard theory predictions, principals' offers are generally too large and relatively small offers are rejected too often. These deviations are reminiscent of related findings in the literature on ultimatum games (see Güth, Schmittberger, and Schwarze, 1982).[5] Indeed, observe that a principal who makes a take-it-or-leave-it offer to an agent is in a similar position as a proposer in an ultimatum game, except that in standard ultimatum games the proposer knows the size of the cake to be divided and the responder does not have to incur production costs when he accepts. In the literature on ultimatum games, models of social preferences such as the prominent contribution by Fehr and

[4] We will show that indeed subjects' behavior in the treatments with exogenous information structures does not differ from behavior in respective control treatments with endogenous information structures in which information is freely available.

[5] See Camerer (2003, ch. 2) for a literature survey on ultimatum game experiments.

Schmidt (1999) have turned out to be useful to explain the observed deviations from standard theory. Fehr and Schmidt (1999) argue that in ultimatum games responders reject small offers because they dislike disadvantageous inequality, while proposers make relatively generous offers because they dislike advantageous inequality. To explore to what extent social preferences might play a role in our adverse selection setting, we have conducted several control treatments and we have estimated structural models.[6]

Specifically, to estimate models with and without social preferences, we apply the quantal response equilibrium (QRE) approach (see McKelvey and Palfrey, 1995) that accounts for noise in the data by allowing players to make mistakes. In contrast to standard theory, the model developed by Fehr and Schmidt (1999) is characterized by free parameters that measure a subject's degree of (advantageous and disadvantageous) inequity aversion. To give standard theory a fair chance, in a first step we tie our hands by considering the distribution of inequity parameters that was derived by Fehr and Schmidt (1999) from inspection of ultimatum game data. Taking this fixed distribution of inequity parameters, our QRE estimations show that when we allow players to make mistakes, then in three out of the four main treatments the data can be better explained if players have standard preferences.

To make further progress, we then take a closer look at agents' behavior. Using the quantal response approach, we estimate the agents' aversion to disadvantageous inequality and find that the agents' social preferences are less pronounced than postulated by Fehr and Schmidt (1999). We also have conducted a control treatment in which the offers were made by the computer, so that agents' social preferences could not play a role. It turns out that in this case observed behavior is closer to standard theory, which confirms the relevance of social preferences for the agents' behavior.

Finally, to better understand principals' behavior, we have conducted control treatments in which the agents' role was played by the computer. The computer was programmed to mimic the behavior of human agents in the main treatments, and this was known to the subjects. It turns out that there is no significant difference between the principals' behavior when playing with human agents or computer agents. This shows that their own social preferences

[6] In what follows, when we refer to "social preferences" without a qualifier, we have in mind the formulation provided by Fehr and Schmidt (1999). Their model has been successfully applied in the context of ultimatum games, which are related to our setting. For detailed reviews on the literature using Fehr-Schmidt preferences as well as other formulations of social preferences, see Fehr and Schmidt (2003, 2006).

cannot be an important determinant of principals' behavior. However, quantal response estimations of the principals' behavior indicate that when making their offers, the principals anticipate the relevance of social preferences for agents' behavior.

Note that if agents have private information about their degree of inequity aversion, then principals face an adverse selection problem even when there is symmetric information about the agents' production costs. We cannot vary the distribution of the agents' inequity parameters, so we cannot directly investigate how the principals respond to variations of the uncertainty about the agents' inequity aversion. Yet, comparing our main treatments with control treatments in which there is symmetric information about the production costs will allow us to demonstrate that when making their offers, principals take into account not only the (controlled) uncertainty about the agents' production costs, but also the (uncontrolled) uncertainty about the agents' inequity aversion.

In the light of the enormous attention that has been paid to adverse selection models in the theoretical literature, there is remarkably little empirical literature on this topic.[7] In particular, as far as laboratory experiments are concerned, Cabrales, Charness, and Villeval (2011) point out that experimental studies on contract theory have typically examined hidden action problems, while there is only little experimental work on adverse selection. Their study shows that in line with theoretical predictions, competition between privately informed agents enhances efficiency.[8] Moreover, several experimental studies confirm the theoretically predicted effects of adverse selection in insurance markets with competition between the lenders (see Asparouhova, 2006; Posey and Yavas, 2007; and Goswami, Grace, and Rebello, 2008).

In the literature on agency theory, it is a standard assumption that the principal makes a take-it-or-leave-it offer to the agent, which is akin to an ultimatum game in the experimental literature. While there is symmetric information about the monetary payoffs in conventional ultimatum games, some authors have also studied the case of asymmetric information. In most of these studies, it is assumed that it is the proposer (and not the responder) who is privately informed about the size of the pie to be divided (see Mitzkewitz

[7]For surveys of empirical tests of contract theory, see Prendergast (1999) and Chiappori and Salanié (2003).

[8]In a related paper, Cabrales and Charness (2011) experimentally examine optimal contracting with teams of privately informed agents. See also Charness and Dufwenberg (2011), who study the effects of communication in partnerships with asymmetric information.

and Nagel, 1993; Straub and Murnighan, 1995; Croson, 1996; Güth, Huck, and Ockenfels, 1996; Rapoport and Sundali, 1996; Güth and van Damme, 1998; and Huck, 1999). These experiments show that proposers make (and responders accept) lower offers when responders do not know the amount to be divided. Kagel, Kim, and Moser (1996) and Harstad and Nagel (2004) have conducted ultimatum game experiments in which the responder may be privately informed about the size of the cake. Yet, in these papers the responder has no costs, so that according to standard theory ex post efficiency would always be achieved, because the proposer would offer zero (or the smallest monetary unit) to the responder, who would accept the offer.[9]

To the best of our knowledge, there is not yet any experimental evidence on adverse selection problems in which the agent can gather private information. Following Crémer and Khalil (1992) and Crémer, Khalil, and Rochet (1998a), we consider a scenario in which costly information gathering can occur after the principal has offered the contract, but before the contract is signed.[10] It turns out that in our model the principal offers a contract with properties that are similar to those derived in Crémer, Khalil, and Rochet (1998a), even though in their model information gathering is a productive activity, while it is a pure rent-seeking activity in our framework, where ex post efficient behavior does not depend on the state of nature.[11]

The remainder of the paper is organized as follows. In the next section, we introduce the theoretical framework which serves as the basis for our experiment. The experimental design is presented in Section 3 and hypotheses are derived in Section 4. We present and analyze our experimental results in Section 5. Concluding remarks follow in Section 6.

---

[9] Forsythe, Kennan, and Sopher (1991) also have conducted an experiment with one-sided private information where the responder may be privately informed, but they study a bargaining game with free exchange of messages and a random dictator game. They find strong predictive power of the so-called strike condition. This condition is similar to the one under which ex post inefficiency in the bad state of nature occurs in our framework, provided that asymmetric information is exogenously given.

[10] See also Lewis and Sappington (1997). In contrast, Crémer and Khalil (1994), Crémer, Khalil, and Rochet (1998b), and Kessler (1998) analyze information gathering before the contract is offered.

[11] Note that in Crémer and Khalil (1992, 1994) and Crémer, Khalil, and Rochet (1998b), information gathering is also pure rent-seeking, but for a different reason (they assume that the agent costlessly learns his type after the contract is signed but before production takes place). In the incomplete contracting literature, Aghion and Tirole (1997) and Dewatripont and Tirole (1999) study productive information gathering, while Schmitz (2006) considers a setting where information gathering is a rent-seeking activity only.

2 The theoretical framework

In this section, to motivate our experimental study, we present the theoretical framework assuming standard preferences as a starting point. Consider a principal and an agent, both of whom are risk-neutral. At an initial date 0, nature draws the agent's type, i.e. his production costs $c \in \{c_l, c_h\}$, where $prob\{c = c_l\} = p$. At date 1, the principal who does not know the realization of the agent's production costs makes a wage offer w to the agent. At date 2, the agent can either accept or reject the offer. If he accepts the offer, he has to incur the production costs c in order to create the return R for the principal, so that at date 2 the agent's profit is $w - c$ and the principal's profit is $R - w$. If the agent rejects the offer, both parties' date-2 profits are zero. We assume that $R > c_h > c_l$, so that ex post efficiency is achieved if the return R is generated regardless of the state of nature. All parameters of the model are common knowledge, except for the agent's type c. We consider two scenarios that differ with regard to the information structure.

Asymmetric information. In the first scenario, the information structure is exogenously given. The agent privately learns the realization of his type c before he has to decide whether or not to accept the principal's wage offer.

Proposition 1 *In the asymmetric information scenario, when the principal has offered w, the agent will accept the offer whenever $w \geq c$. Thus, the principal's optimal wage offer is $w = c_l$ if $p(R - c_l) - (R - c_h) > 0$, and $w = c_h$ otherwise.*

Proof. See Appendix A.

According to standard theory, an agent accepts any wage offer that covers at least his production costs. Hence, if the principal offers $w = c_h$, then any type of agent will accept the offer, so that the principal's profit is $R - c_h$. In contrast, if the principal offers $w = c_l$, then only the low type accepts, such that the principal's expected profit is $p(R - c_l)$. This means that if the condition $p(R - c_l) - (R - c_h) > 0$ is satisfied, the principal gives up ex post efficiency in the bad state of nature in favor of a larger profit in the good state of nature by setting $w = c_l$. If the condition is not satisfied, the principal sets $w = c_h$, so that ex post efficiency is always achieved.

Information gathering. In the second scenario, the information structure is endogenous. At date 1.5 (i.e., after the principal has made her wage offer, but before the agent's decision to accept or reject the offer), the agent can decide whether he wants to spend information gathering costs $\gamma > 0$ in order to observe the state of nature.

Proposition 2 *In the information gathering scenario, the agent's optimal reaction to the principal's wage offer w is as follows.*

(i) Suppose that $\gamma \geq p(1-p)(c_h - c_l)$. Then the agent never gathers information. He accepts the offer whenever $w \geq E[c]$.

(ii) Suppose that $\gamma < p(1-p)(c_h - c_l)$. If $w < c_l + \frac{\gamma}{p}$, the agent rejects the offer without information gathering. If $c_l + \frac{\gamma}{p} \leq w < c_h - \frac{\gamma}{1-p}$, the agent gathers information and then accepts the offer whenever $c = c_l$. If $w \geq c_h - \frac{\gamma}{1-p}$, the agent accepts the offer without information gathering.

Proof. See Appendix A.

Of course, the agent will not gather information if the costs γ of doing so are prohibitively large (case i). In this case, the agent will accept any offer that at least covers his expected production costs $E[c]$.

Now consider the case in which the information gathering costs are relatively small (case ii). Obviously, the agent will reject offers smaller than c_l and accept offers larger than c_h without engaging in costly information gathering. Yet, in contrast to the asymmetric information scenario, also offers somewhat larger than c_l will always be rejected immediately. The reason is that the uninformed agent might have high production costs, and in order to be able to accept the offer only when his production costs are low he must gather information. But information gathering is costly and therefore the gain in the good state of nature must be large enough so that in expectation the agent can also recover his information gathering costs.

Similarly, also in contrast to the asymmetric information scenario, already offers somewhat smaller than c_h will always be accepted. If instead the agent gathered information, he could reject such an offer in the bad state of nature. Yet, if the offer is only slightly smaller than c_h, the expected gain from doing so is smaller than the information gathering costs γ.

Finally, for intermediate offers it is worthwhile for the agent to spend the information gathering costs γ. Such offers are too attractive for outright rejection and too unattractive for outright acceptance, so that costly information gathering and subsequent acceptance in the good state of nature only becomes the most profitable strategy for the agent.

Proposition 3 *In the information gathering scenario, the principal's optimal wage offer can be characterized as follows.*

(i) Suppose that $\gamma \geq p(1-p)(c_h - c_l)$. Then the principal sets $w = E[c]$.

(ii) Suppose that $\gamma < p(1-p)(c_h - c_l)$. Then the principal sets $w = c_l + \frac{\gamma}{p}$ if $p(R - c_l) - (R - c_h) > \frac{2-p}{1-p}\gamma$. Otherwise, she sets $w = c_h - \frac{\gamma}{1-p}$.

Proof. See Appendix A.

As we have seen in Proposition 2, if the information gathering costs γ are prohibitively large (case i), the agent will never gather information, regardless of the principal's offer. In this case, the principal offers $w = E[c]$, since this is the smallest offer that an uninformed agent is willing to accept.

Next, consider case ii, in which the information gathering costs are relatively small. Given the agent's behavior characterized in Proposition 2, the principal takes into consideration the wage offers $w = c_l + \frac{\gamma}{p}$ (so that the agent will gather information) and $w = c_h - \frac{\gamma}{1-p}$ (so that the agent will accept immediately). As one might expect, the principal prefers to induce the agent to gather costly information about his production costs only if also in the asymmetric information scenario (where the agent learns his type costlessly) the trade level would depend on the agent's type. However, now it is less attractive for the principal to trade only with an agent who has low production costs, because if she wants to do so she must also compensate the agent for his information gathering costs. Hence, the condition under which the principal induces costly information gathering is more restrictive than the corresponding condition in the asymmetric information scenario under which the principal prefers to trade in the good state of nature only.

3 Design

Our experiment consists of four main treatments and several control treatments. In total, 720 subjects participated in the experiment. All subjects were students of the University of Cologne from a wide variety of fields of study.[12] In this section, we describe the design of the four main treatments, while a detailed description of the control treatments is relegated to Appendix B.

Each of the four main treatments was run in three sessions. Each session had 32 participants. No subject was allowed to participate in more than one

[12] Subjects were recruited using ORSEE (Greiner, 2004) and the experiment was programmed and conducted with zTree (Fischbacher, 2007).

session. At the beginning of each session, written instructions were handed out to the subjects. We used the experimental currency unit ECU. At the end of each session, the players' payoffs were converted into euros (30 ECU = 1 €).[13] In each session, half of the participants were randomly assigned to the role of principals and the others to the role of agents. Participants kept their role throughout the whole session. Note that altogether we have 48 principals and 48 agents per main treatment.

In order to give the subjects the opportunity to gain experience, each session consisted of 15 rounds. At the beginning of each round, every principal was randomly matched with an agent. In each session, our matching algorithm split the subjects into two separate matching groups consisting of eight principals and eight agents, so that only principals and agents within a matching group could become trading partners. Hence, we have six independent matching groups per main treatment.[14] In each round and in each matching group, half of the agents had low production costs ($c = c_l$), while the other half of the agents had high production costs ($c = c_h$). All interactions were anonymous; i.e., no subject knew the identity of its trading partner.

In each round of the four main treatments, principals and agents interacted as follows.

Asymmetric information treatment AI 20-80. Each round consists of two stages. In the first stage, the principal makes a wage offer w to the agent (where w can be any integer between 0 and 100). The principal does not know the agent's production costs c; all she knows is that they can be either $c_l = 20$ or $c_h = 80$ with equal probability ($p = 1/2$). In the second stage, the agent learns his production costs and then he can decide whether or not to accept the principal's wage offer. If the agent accepts the offer, the principal's profit is $R - w = 100 - w$ and the agent's profit is $w - c$. If the agent rejects the offer, both parties make zero profits.

Asymmetric information treatment AI 40-60. This treatment is identical to the AI 20-80 treatment, except that now $c_l = 40$ and $c_h = 60$.

[13]Each subject started with a show-up fee of 250 ECU. Note that the agents could make losses, yet no player ever ran into a deficit (the smallest account balance ever encountered was 132 ECU).

[14]Throughout, when we report the results of Wilcoxon signed-ranks tests or Mann Whitney U tests, matching group averages are used as units of observations. The only exception are the computer treatments described in Appendix B, which are single-person decision problems, so that in each of these treatments we have 48 independent observations.

Information gathering treatment IG 20-80. Each round consists of two stages. The first stage is identical to the first stage in the AI 20-80 treatment. In the second stage, the agent can accept or reject the principal's wage offer immediately (without knowing his type c) or he can decide to incur information gathering costs $\gamma = 6$ to learn his type before accepting or rejecting the wage offer. The resulting profits are displayed in Table 1.

Information gathering treatment IG 40-60. This treatment is identical to the IG 20-80 treatment, except that now $c_l = 40$ and $c_h = 60$.

	accept	reject
no information gathering	$100 - w, w - c$	$0, 0$
information gathering	$100 - w, w - c - 6$	$0, -6$

Table 1. The profits (principal, agent) in the IG treatments.

4 Hypotheses

We now derive our main hypotheses on the subjects' behavior. Assuming that all subjects are rational and purely selfish, the predictions are very clear. We first hypothesize how the principals' wage offers, the occurrence of ex post inefficiencies, and the total surplus levels vary between the asymmetric information (AI) treatments.

Asymmetric information treatment AI 20-80. In line with Proposition 1, an agent will accept any offer that covers his costs, so that the principal will offer the wage $w = 20$, since $\frac{1}{2}(100-20) > 100-80$. The agent will accept this offer only if he is of the low type. Thus, ex post efficiency will be achieved in the good state of nature only and the expected total surplus is $\frac{1}{2}(100 - 20) = 40$.

Asymmetric information treatment AI 40-60. The standard theoretical prediction for this scenario is that the principal will offer the wage $w = 60$, since $\frac{1}{2}(100 - 40) < 100 - 60$. The agent will always accept the offer, so that ex post efficiency will always be achieved and the expected total surplus is $100 - \frac{1}{2}(40 + 60) = 50$.

While we did not expect that the subjects' behavior would strictly adhere to the selfish rational choice model, we hypothesized that agency theory would have predictive power to qualitatively capture the differences in behavior between the treatments.

Hypothesis 1.
(i) In AI 20-80, average wage offers are lower than in AI 40-60.
(ii) In AI 20-80, average rejections rates are larger than in AI 40-60.
(iii) In AI 20-80, average total surplus levels are lower than in AI 40-60.

Let us now consider the information gathering (IG) treatments.

Information gathering treatment IG 20-80. Given this parameter constellation, according to Proposition 3(ii), the wage offer $w = c_l + \frac{\gamma}{p} = 32$ is optimal for the principal. The agent will then gather information and accept the offer whenever he is of the low type, so that the expected total surplus is $\frac{1}{2}(100 - 20) - 6 = 34$.

Information gathering treatment IG 40-60. In this parameter constellation, the wage offer $w = E[c] = 50$ is optimal for the principal according to Proposition 3(i). In this case, the agent will accept the offer immediately without gathering information, so that the expected total surplus is $100 - 50 = 50$.

The preceding considerations lead us to make the following qualitative hypotheses regarding the IG treatments.

Hypothesis 2.
(i) In IG 20-80, average wage offers are lower than in IG 40-60.
(ii) In IG 20-80, average information gathering rates are larger than in IG 40-60.
(iii) In IG 20-80, average rejection rates are larger than in IG 40-60.
(iv) In IG 20-80, average total surplus levels are lower than in IG 40-60.

Observe that the IG treatments differ from the corresponding AI treatments only in that information is not costlessly available to the agent. The following hypotheses thus predict how the presence of information gathering costs affects the principals' wage offers, the occurrence of ex post inefficiencies, and the total surplus levels.

Hypothesis 3.
(i) In AI 20-80, average wage offers are lower than in IG 20-80.
(ii) In AI 40-60, average wage offers are larger than in IG 40-60.
(iii) In AI 20-80 and in IG 20-80, average rejection rates do not differ.
(iv) In AI 40-60 and in IG 40-60, average rejection rates do not differ.
(v) In AI 20-80, average total surplus levels are larger than in IG 20-80.
(vi) In AI 40-60 and in IG 40-60, average total surplus levels do not differ.

The quantitative predictions assuming standard preferences are summarized in Table 3. While we hypothesized that agency theory would successfully predict the qualitative differences between the treatments, we expected quantitative deviations. In particular, note that a principal who makes a take-it-or-leave-it offer to an agent is in a strong position, just as the proposer in an ultimatum game. While standard theory predicts a very unequal outcome in such situations, the vast literature on ultimatum games suggests that fairness considerations become relevant. Hence, it seems to be natural to also provide predictions assuming social preferences. Specifically, Fehr and Schmidt's (1999) prominent model in which players are inequity averse has turned out to be useful in several variants of the ultimatum game. They propose the utility function

$$U_i(x_i, x_j) = x_i - \alpha_i \max\{x_j - x_i, 0\} - \beta_i \max\{x_i - x_j, 0\},\ i \neq j,$$

where x_i denotes player i's monetary payoff and it is assumed that the parameters satisfy $\beta_i \leq \alpha_i$ and $0 \leq \beta_i < 1$. In the utility function, the second term measures player i's loss from disadvantageous inequality, while the third term measures the loss from advantageous inequality. Fehr and Schmidt (1999) allow players to be heterogeneous regarding their inequity parameters α and β.

Note that when the agent is privately informed about his preference parameters α and β, then the principal would face an adverse selection problem even if the agent's production cost parameter c was commonly known. Specifically, the larger an agent's preference parameter α, the larger is his acceptance threshold. Hence, in line with the rent extraction versus efficiency trade-off that forms the basis of adverse selection theory, the principal may prefer not to trade with large-α agents in order to make a better deal with low-α agents.

Thus, when the players have Fehr-Schmidt preferences, in our main treatments there are two different sources of uncertainty. First, an agent's production cost c may be low or high, which is unobservable by the principal, but controlled by the experimenter. Second, a player's degree of inequity aversion is his private information, which is unobservable also by the experimenter.

In contrast to the adverse selection model with standard preferences, a model with inequity aversion allows for a vast array of outcomes.[15] Hence,

[15] Even if we restricted the inequity parameters to be the same for all principals and agents, the model's predictions would crucially depend on these parameters. Specifically, when standard theory predicts ex post efficiency, inequity aversion may predict ex post

we consider the specific parameter distribution that has been derived by Fehr and Schmidt (1999) from inspection of ultimatum game data. Taking this fixed distribution of parameters (see Table 2), also Fehr and Schmidt's (1999) model leads to clear predictions, which are summarized in Table 3.[16]

α	β	rel. frequency
0	0	30%
0.5	0.25	30%
1	0.6	30%
4	0.6	10%

Table 2. The distribution of the preference parameters according to Fehr and Schmidt (1999).

	AI 20-80		AI 40-60		IG 20-80		IG 40-60	
	ST	FS	ST	FS	ST	FS	ST	FS
mean offer (ECU)	20	54.90	60	71.20	32	62.10	50	68.20
information gathering					100%	88%	0%	0%
rejections	50%	51.50%	0%	15.50%	50%	47%	0%	10%
rejections by (informed) high types	100%	100%	0%	31%	100%	100%		
rejections by (informed) low types	0%	3%	0%	0%	0%	0%		
rejections by uninformed agents						25%	0%	10%
mean surplus (ECU)	40	38.80	50	43.80	34	34.42	50	45
mean principal profit (ECU)	40	21.76	40	24.21	34	19.72	50	28.62
mean agent profit (ECU)	0	17.05	10	19.59	0	14.71	0	16.38

Table 3. The theoretical benchmarks with standard preferences (ST) and Fehr-Schmidt distributed preferences (FS).

Thus, in addition to standard theory, we have a second quantitative benchmark to which we can compare our data. Observe that our qualitative hypotheses derived from adverse selection theory with standard preferences are

inefficiency, and vice versa. Similarly, an agent may gather information given standard preferences while he would not do so under inequity aversion, and vice versa.

[16] See the supplementary material for a detailed derivation of the Fehr-Schmidt benchmark.

hardly affected if we assume that the players are inequity-averse and the preference parameters are distributed as postulated by Fehr and Schmidt (1999). In particular, Hypotheses 1 and 2, which compare the 20-80 and 40-60 parameter constellations, would also follow given Fehr-Schmidt distributed preferences. With regard to Hypothesis 3, which pertains to the effects of information gathering costs by comparing AI and IG, Hypotheses 3(iii), (iv), and (vi) would have to be changed. Specifically, given Fehr-Schmidt distributed preferences, rejection rates should be slightly larger in the AI treatments than in the corresponding IG treatments, and the average surplus level in AI 40-60 should be slightly lower than in IG 40-60.

5 Results

5.1 Overview: Descriptive statistics and hypotheses tests

In this section we present our main results. Table 4 summarizes the key findings for the main treatments. The table is separated into descriptive statistics for all rounds and for the last 10 rounds.

In what follows, we focus on rounds 6-15, where subjects have already gained some experience, such that their behavior tends to be more stable. In Table 4 we also indicate whether behavior between unexperienced and experienced players differs. As one might have expected, in particular in the somewhat more demanding IG treatments we observe statistically significant differences, although economically the effects are rather small.

Figure 1 depicts the distributions of the principals' wage offers and the agents' responses to these offers in the four main treatments.[17]

[17]In the figures as well as in the quantal response estimations reported below, we have grouped the offers into 21 categories (specifically, category 0 contains wages $w \leq 2$, categories $\tilde{w} \in \{5, 10, 15, ..., 95\}$ contain wages from $\tilde{w} - 2$ to $\tilde{w} + 2$, and category 100 contains wages $w \geq 98$).

	AI 20-80	AI 40-60	IG 20-80	IG 40-60
	rounds 1 - 15			
mean offer (ECU)	45.52	67.38	61.39	65.55
information gathering			51.81%	3.33%
rejections	51.53%	16.25%	41.53%	15.97%
rejections by (informed) high types	92.78%	27.5%	98.95%	100%
rejections by (informed) low types	10.28%	5.00%	1.10%	0.00%
rejections by uninformed agents			31.12%	14.94%
mean surplus (ECU)	36.61	43.00	33.84	41.80
mean principal profit (ECU)	23.88	26.12	19.38	27.61
mean agent profit (ECU)	12.74	16.88	14.45	14.19
	rounds 6 - 15			
mean offer (ECU)	45.38	68.07**	62.61**	66.25**
information gathering			51.25%	2.08%
rejections	50.83%	14.58%	39.58%**	12.92%**
rejections by (informed) high types	92.08%	28.33%	99.21%*	100% (4 obs)
rejections by (informed) low types	9.58%	0.83%**	0.00%	0.00% (6 obs)
rejections by uninformed agents			27.78%*	12.34%**
mean surplus (ECU)	36.96	44.08	35.26*	43.33**
mean principal profit (ECU)	24.58**	26.63	19.40	28.59**
mean agent profit (ECU)	12.38	17.46**	15.86*	14.74**

Table 4. Descriptive statistics. The stars indicate whether behavior in rounds 6-15 differs significantly (* at the 10% level, ** at the 5% level) from behavior in rounds 1-5 according to two-tailed Wilcoxon signed-ranks tests.

As can be seen in Table 4, the mean offers are ranked as predicted. In particular, it turns out that in the asymmetric information treatments as well as in the information gathering treatments, the average wage offers are lower in the 20-80 than in the 40-60 parameter constellation. In both cases, the difference is statistically significant, as shown in Table 5, which reports the p-values for pairwise comparisons between the treatments. Hence we find support for Hypotheses 1(i) and 2(i). Moreover, as predicted in Hypothesis 3(i) and 3(ii), the average wage offers in the AI 20-80 treatment are smaller than in the IG 20-80 treatment, while they are larger in the AI 40-60 than in the IG 40-60 treatment. The differences are again statistically significant.

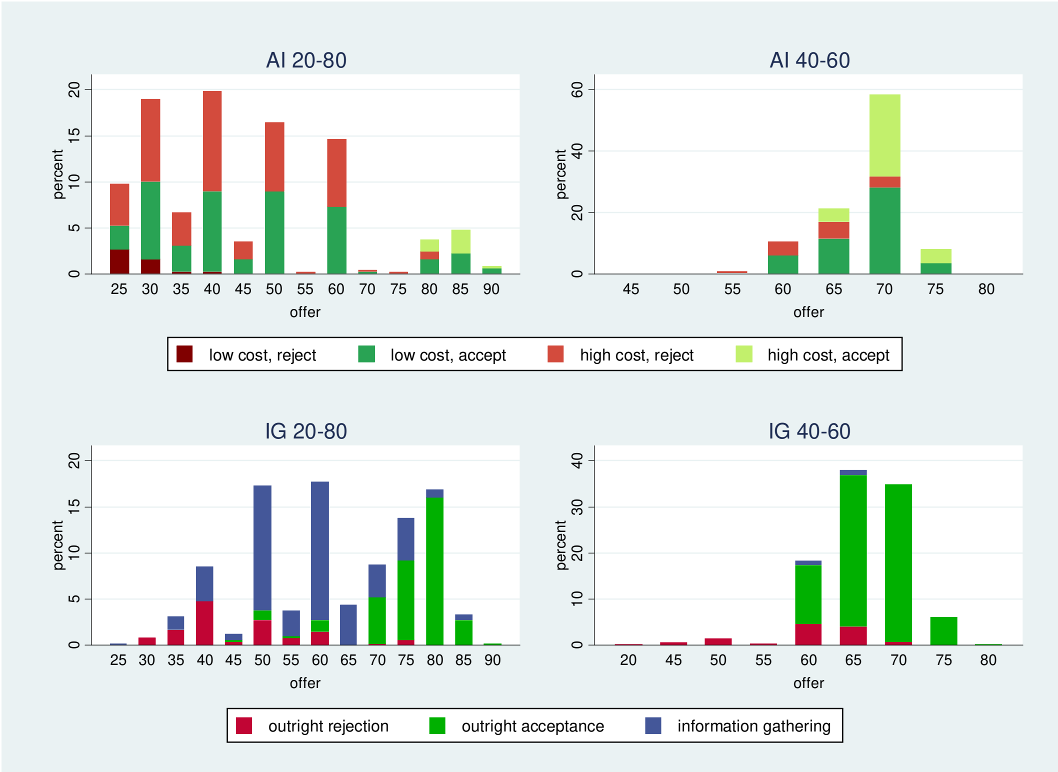

Figure 1. The principals' offers and the agents' responses to the offers in rounds 6-15. The total height of a bar shows the relative frequency with which the offer was made, while the different colors indicate how the agents reacted to this offer. In the IG treatments, when the agents gathered information, they always accepted the offer if they learned to have low costs and they almost always rejected the offer otherwise (cf. Table 4).

	AI 20-80 vs. AI 40-60	IG 20-80 vs. IG 40-60	AI 20-80 vs. IG 20-80	AI 40-60 vs. IG 40-60
offers	0.004	0.055	0.004	0.055
info. gath.		0.004		
rejections	0.004	0.004	0.045	0.374
surplus	0.005	0.004	0.423	0.810
principal profit	0.055	0.004	0.010	0.078
agent profit	0.004	0.873	0.337	0.004

Table 5. Significance levels for pairwise comparisons between the treatments in rounds 6-15. The reported p-values are obtained by two-tailed Mann Whitney U tests.

In line with Hypothesis 2(ii), information gathering occurs much more often in the IG 20-80 treatment than in the IG 40-60 treatment, which is highly significant.

With regard to rejection rates, Table 4 shows that in the asymmetric information treatments as well as in the information gathering treatments, rejections of wage offers occur considerably more often in the 20-80 than in the 40-60 parameter constellation, which is in support of Hypotheses 1(ii) and 2(iii). As can be seen in Table 5, these differences are highly significant.

However, in contrast to Hypothesis 3(iii), we find that rejection rates differ on the 5% level between the AI 20-80 and the IG 20-80 treatments. Specifically, as can be seen in Figure 1, in the IG 20-80 treatment there were considerably more offers between 70 and 80 than in the AI 20-80 treatment. The fact that in the former treatment most agents accepted such offers without information gathering has led to a lower rate of rejections in IG 20-80 than in AI 20-80. In line with Hypothesis 3(iv), we do not find a statistically significant difference in rejection rates between the AI 40-60 and the IG 40-60 treatments.

Moreover, Table 4 and Figure 1 also illustrate how the rejections in the different treatments are split among (informed) high types, (informed) low types, and uninformed agents. In particular, one can see that rejections occur only rarely when the agent knows or learns that he is of the low type, which is in line with the theoretical prediction that there should be "no distortion at the top."

Finally, we find strong evidence in favour of Hypotheses 1(iii) and 2(iv). In the AI treatments as well as in the IG treatments, the total surplus levels are significantly smaller in the 20-80 than in the 40-60 parameter constellations, which mainly results from the strong downward distortion of trade in the bad state of the world in the 20-80 parameter constellation. While the total surplus is on average larger in AI 20-80 than in IG 20-80 as predicted in Hypothesis 3(v), the difference is not statistically significant. In line with Hypothesis 3(vi), there is no significant difference between the surplus levels in AI 40-60 and IG 40-60.

Taken together, we have found clear support for 11 of our 13 qualitative predictions, which indicates that agency theory is indeed useful to predict the differences in principals' and agents' behavior across treatments. Specifically, we have found strong evidence for the trade-off between ex post efficiency in the bad state and a larger profit in the good state, which is central to adverse selection theory.

Recall that our Hypotheses 1, 2, and 3 were derived under the assumption of standard preferences. With regard to these hypotheses which qualitatively compare behavior across treatments, assuming Fehr-Schmidt distributed preferences would not lead to better predictions (recall that Hypotheses 3(iii), 3(iv), and 3(vi) would have to be changed given Fehr-Schmidt distributed preferences, but we found support for two of these three predictions). However, with regard to the quantitative deviations between data and theoretical benchmarks in each treatment, comparing Tables 3 and 4 immediately shows that the average offers, information gathering rates, rejection rates, and surplus levels observed in the experiment typically lie much closer to the Fehr-Schmidt benchmark.

In the following section, we will analyze the data more deeply in order to asses to what extent the deviations from standard theory can be attributed to social preferences. To do so, we will make use of several control treatments and we will estimate structural models, taking into account that players may be subject to bounded rationality.

5.2 A closer look at the data

We now have a closer look at the offers made and the responses to the offers. In order to clarify to what extent the subjects' behavior in our experiment can actually be attributed to social preferences, it is useful to estimate structural models. To do so, we have to account for noise in the data. Specifically, we apply the logit quantal response equilibrium (QRE) framework that was developed by McKelvey and Palfrey (1995). This approach models noise as mistakes, where a mistake is more likely to be made when the utility loss associated with the mistake is small. Specifically, let U_{ik} denote player i's expected utility if he makes a decision $k \in \{1, ..., n\}$. Then the probability that he makes the decision $k = \tilde{k}$ is given by

$$\frac{e^{\lambda U_{i\tilde{k}}}}{\sum_{k=1}^{n} e^{\lambda U_{ik}}}.$$

When a player computes his expected utility U_{ik}, he takes into account that all other decisions (including his own future decisions) are made in this probabilistic way.[18] Note that the parameter λ can be interpreted as a rationality parameter. If $\lambda = 0$, behavior is completely random (i.e., each decision is

[18] We thus use the agent QRE concept as devised by McKelvey and Palfrey (1998) for extensive form games.

made with the same probability), while behavior approaches rational choice if λ becomes large. We use maximum likelihood to estimate the parameter λ. Following Rogers, Palfrey, and Camerer (2009), we provide two benchmarks for the quality of fit (see Table 6). The "random" log likelihood results from a model where all decisions are taken with equal probabilities; it is thus a lower bound for the quality of fit. The "empirical" log likelihood is the best possible fit to the aggregate data; it results from a model that assigns to each decision its empirical relative frequency.

Table 6 shows the results of the QRE estimations assuming standard preferences as well as Fehr-Schmidt distributed social preferences. Inspection of Table 6 shows that when we allow players to make mistakes, in three out of the four treatments, the data can be better explained if players have standard preferences. Note that rejections of relatively small offers lead to small utility losses only and are hence to be expected in a QRE model with standard preferences, even in the absence of inequity aversion. Similarly, the fact that principals make relatively large offers can also be explained by QRE, since the principals know that small offers are more likely to be rejected.

	AI 20-80	AI 40-60	IG 20-80	IG 40-60
ST	$\lambda = 0.160$ (0.014) $\ln L = -1270.2$	$\lambda = 0.298$ (0.019) $\ln L = -924.7$	$\lambda = 0.180$ (0.014) $\ln L = -1562.0$	$\lambda = 0.204$ (0.007) $\ln L = -1140.1$
FS	$\lambda = 0.083$ (0.020) $\ln L = -1532.5$	$\lambda = 0.356$ (0.041) $\ln L = -825.0$	$\lambda = 0.166$ (0.007) $\ln L = -1716.4$	$\lambda = 0.221$ (0.014) $\ln L = -1236.9$
random	$\ln L = -1794.1$	$\ln L = -1794.1$	$\ln L = -2126.8$	$\ln L = -2126.8$
empirical	$\ln L = -1060.7$	$\ln L = -648.8$	$\ln L = -1327.7$	$\ln L = -820.9$

Table 6. Quantal response equilibrium with standard preferences (ST) and Fehr-Schmidt distributed preferences (FS), rounds 6-15. (Robust standard errors are in parentheses.)

So far, the evidence for the importance of social preferences in our experiment is rather mixed. On the one hand, average behavior is closer to the Fehr-Schmidt benchmark. On the other hand, taking into account that players make mistakes, in three out of four treatments the observed behavior can be better explained by QRE estimations assuming standard preferences instead of Fehr-Schmidt distributed preferences. To better understand the decisions made by the players, we now examine agents' and principals' behavior in more detail.

5.2.1 Agents' behavior

The agents' acceptance behavior is illustrated in Figure 2. The blue circles depict for each offer the relative frequency with which the offer was accepted (in each treatment, the size of a circle is proportional to the relative frequency with which an offer was made). Note that in most cases the actual acceptance frequency is smaller than in the standard benchmark, but larger than in the Fehr-Schmidt benchmark. Only a few observations lie outside of the corridor formed by the two benchmarks.

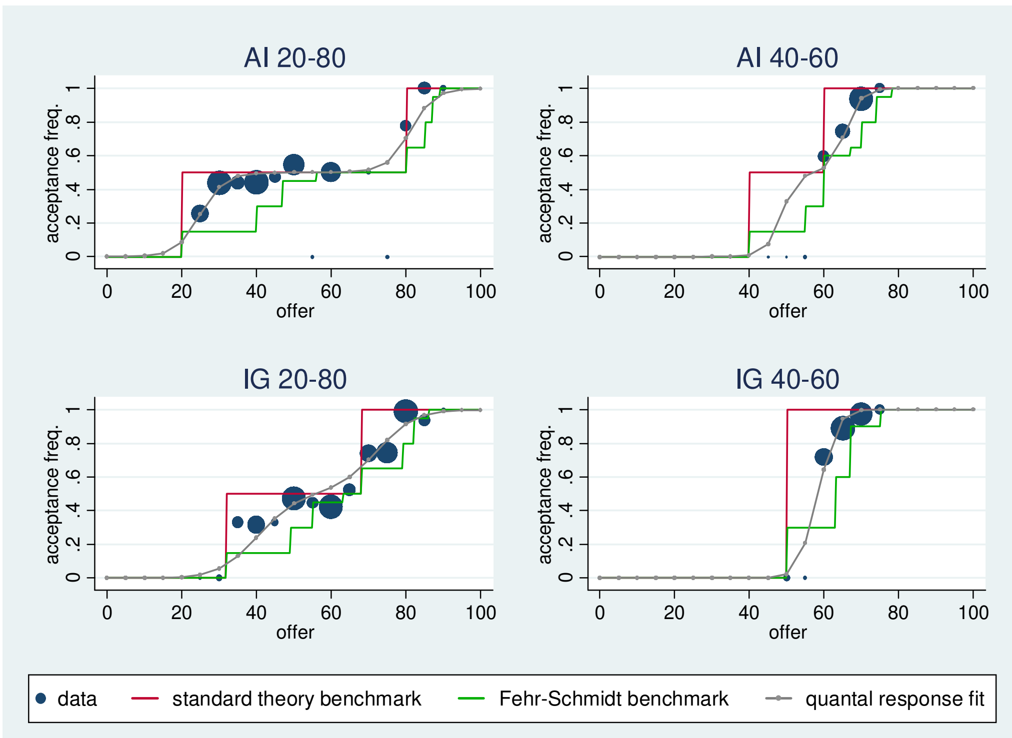

Figure 2. The blue circles show the relative frequencies with which the offers were accepted. In each treatment, the size of the circles is proportional to the relative frequency with which the offers were made (rounds 6-15). The red and green lines show the theoretical benchmarks with standard preferences and Fehr-Schmidt distributed preferences. The gray graphs are quantal response fits using the estimates reported in the row "inequity aversion" of Table 7.

While some of the rejections of relatively small offers may well be simple decision errors, most economists who have investigated ultimatum games seem to agree that at least part of the responders' behavior can be attributed to social preferences. Specifically, Fehr and Schmidt (1999) argue that rejections of relatively small offers occur when responders are averse to disadvantageous inequality. They have derived their distribution of α from inspection of responders' behavior in ultimatum games. Figure 2 suggests that in our case the agents' inequity aversion may be less pronounced than in the Fehr-Schmidt distribution.

	AI 20-80	AI 40-60	IG 20-80	IG 40-60
standard prefer.	$\lambda_A = 0.188$ (0.032) $\ln L_A = -63.5$	$\lambda_A = 0.190$ (0.017) $\ln L_A = -115.9$	$\lambda_A = 0.193$ (0.034) $\ln L_A = -336.5$	$\lambda_A = 0.257$ (0.034) $\ln L_A = -283.3$
inequity aversion	$\alpha_A = 0.071$ (0.013) $\lambda_A = 0.274$ (0.070) $\ln L_A = -58.9$	$\alpha_A = 0.201$ (0.028) $\lambda_A = 0.338$ (0.025) $\ln L_A = -92.6$	$\alpha_A = 0.153$ (0.056) $\lambda_A = 0.202$ (0.027) $\ln L_A = -309.4$	$\alpha_A = 0.252$ (0.058) $\lambda_A = 0.371$ (0.053) $\ln L_A = -229.0$
random	$\ln L_A = -332.7$	$\ln L_A = -332.7$	$\ln L_A = -665.4$	$\ln L_A = -665.4$
empirical	$\ln L_A = -54.1$	$\ln L_A = -88.8$	$\ln L_A = -267.6$	$\ln L_A = -169.3$

Table 7. Quantal response estimations of the agents' behavior, rounds 6-15. (Robust standard errors are in parentheses.)

Using the quantal response approach to account for noise in the data, in Table 7 we fit models of the agents' behavior assuming standard preferences ($U_i(x_i, x_j) = x_i$) and assuming disutility from disadvantageous inequality ($U_i(x_i, x_j) = x_i - \alpha_i \max\{x_j - x_i, 0\}$). In the latter case, it turns out that in every treatment the inequity aversion parameter α is significantly different from zero. Compared to the model with standard preferences, the fit improves and there is less reliance on noise (i.e., the rationality parameter λ_A is larger) if we allow for inequity aversion.[19] As can be seen by the gray curves in Figure 2, the inequity aversion estimates capture the data very well. Yet, the values for α that we obtain are smaller than those usually obtained in ultimatum games.[20]

[19]Note that since we estimate only one parameter α_A across all subjects, λ_A now captures both noise and the heterogeneity of social preferences. For further discussions, see also Goeree and Holt (2000), De Bruyn and Bolton (2008), and Blanco, Engelmann, and Normann (2011), who use similar approaches.

[20]Using the ultimatum game data of Roth et al. (1991), we have applied the same method to fit models with standard preferences and inequity aversion to their responders' behavior. The results are $\lambda_R = 0.299$, $\ln L_R = -715.2$ (standard preferences) and $\alpha_R = 0.608$, $\lambda_R = 0.400$, $\ln L_R = -665.1$ (inequity aversion). The benchmarks are $\ln L_R = -935.7$ (random) and $\ln L_R = -645.3$ (empirical). Note that the value obtained for α using the quantal response method is smaller than the average α of the Fehr-Schmidt distribution, which is 0.85. This is not surprising, as mistakes and inequity aversion are substitutes in explaining rejections. (The Fehr-Schmidt distribution was constructed by mere inspection of ultimatum game data, without any formal estimation techniques.)

Consider first the AI treatments, in which the agent's task is not much different from the responder's task in a standard ultimatum game. The agent knows his production costs and just has to decide whether or not to accept the principal's offer. Yet, there are subtle differences between our setting and usual ultimatum games, since we do not speak about dividing a pie (which might trigger subjects' fairness considerations) and the agent has strictly positive production costs when he accepts an offer. Thus, on the one hand, the fact that we find relatively small values of α compared to standard ultimatum games might be due to the different framing. On the other hand, the different findings may also be due to the fact that in our setting the principal does not know the agent's production costs.

To shed some light on this issue, we have conducted two further treatments which are identical to the AI treatments except that the principal knows the agent's production cost when she makes the offer.[21] In the 20-80 parameter constellation with symmetric information, the estimated $\alpha_A = 0.276$ is considerably larger than in the corresponding AI treatment, while in the 40-60 parameter constellation with symmetric information, the estimated $\alpha_A = 0.215$ is similar to the one in the corresponding AI treatment. Thus, even with symmetric information about the production costs we find relatively small levels of α compared to standard ultimatum games, which indicates that the different framing of the problem must play a role.[22] However, the fact that we found a particularly small value of α in the AI 20-80 treatment seems to be due to the presence of asymmetric information. In AI 20-80, agents apparently realize that they usually get offers smaller than 80. Hence, in the rare event that an agent with high production costs gets an offer that he can accept without making a loss, he does not expect a large markup. Moreover, when his production costs are low, he seems to realize that he would not have a chance to trade if his production costs were high, so he seizes the opportunity to trade even if the

[21] See Appendix B for more details on the symmetric information treatments SI 20-80 and SI 40-60.

[22] The potential importance of framing has also been stressed by Hoffman et al. (1994, p. 369), who argue that the relatively high rejection rates in Roth et al. (1991) may be due to the fact that the proposer is called buyer, while usually the seller is thought to be justified in naming a price. In our setting, one might similarly argue that we do not have high rejection rates because it is natural that the principal offers the wage. Note also that Croson (1996) finds that subjects care more about fairness when relative payoffs are made salient. Since the agent has to incur production costs in our setting, relative payoffs are less salient than in standard ultimatum games.

markup is small. Note also that if the agent rejected, the principal would not even know that she is being punished, since the principal could simply think that she met an agent with high production costs. As a result, agents are more reluctant to reject offers that are small (relative to the production costs) in the AI 20-80 treatment than in the AI 40-60 treatment or in the symmetric information benchmark.

Next, consider the information gathering treatments. As predicted, there was almost no information gathering in the IG 40-60 treatment.[23] The IG 20-80 treatment is more interesting, since we observed less information gathering than predicted. While we have already seen in Section 5.1 that principals often made larger offers than predicted, so that agents accepted without information gathering, we now analyze the agents' information gathering decisions conditional on the offers made.

The dark blue circles in Figure 3 indicate for each offer the relative frequency with which information was gathered. Note that most circles lie between the standard benchmark and the Fehr-Schmidt benchmark. In particular, for relatively small offers there was more information gathering than predicted by Fehr-Schmidt, but less than predicted by standard theory. The reason is that in contrast to the standard-theoretic analysis, outright rejections of relatively small offers occurred frequently (although less often than predicted by the Fehr-Schmidt benchmark). In contrast, for relatively large offers, information gathering occurred less often than predicted by the Fehr-Schmidt benchmark, but more often than predicted by the standard benchmark. This finding is due to the fact that in contrast to the Fehr-Schmidt prediction, outright acceptance of relatively large offers was frequently observed (although less often than standard theory predicts). Hence, the data are again well in line with our finding that social preferences play a role for the agents' behavior, but they are less pronounced than in the Fehr-Schmidt benchmark.

[23] Observe that the estimate for α_A is larger in IG 40-60 than in the other three main treatments. This treatment comes closest to a standard ultimatum game, because since there is almost no information gathering, there is symmetric (non-)information. Note also that the rejection rate in IG 40-60 is quite similar to the rejection rates in our symmetric information treatments (see Appendix B).

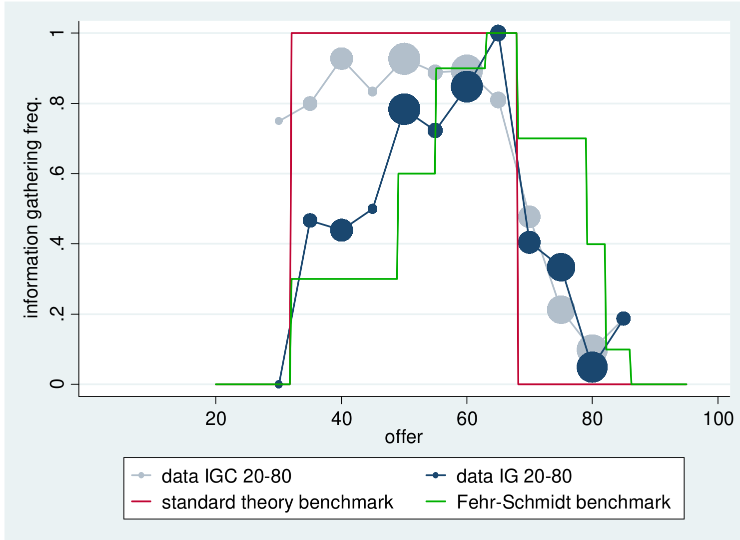

Figure 3. The dark blue circles show the relative frequencies with which the agents gathered information in the IG 20-80 treatment. The gray circles show the information gathering frequencies in the control treatment IGC 20-80, in which the same offers were made by the computer. The size of the circles is proportional to the relative frequency with which the offers were made. The figure shows the agents' behavior for offers that were made at least two times in rounds 6-15. The red and green lines show the theoretical benchmarks with standard preferences and Fehr-Schmidt distributed preferences.

To further clarify the role of social preferences for the agents' decisions to gather information, we conducted another control treatment. In this treatment, agents were confronted with one-person decision problems that differed from the problems faced by the agents in the original IG 20-80 treatment only in that the offers were made by the computer (the offers were identical to the offers in IG 20-80).[24] Since the agents knew that there were no human principals, social preferences could not play a role in the computer treatment.[25] The relative frequencies with which the agents gathered information in the computer treatment are depicted by the gray circles in Figure 3.

Observe that the agents' behavior in the computer treatment was closer to the standard theory benchmark. Overall, in the computer treatment information gathering occurred in 60.21% of the cases in rounds 6-15. If we consider

[24] See Appendix B for further details on the computer treatment IGC 20-80.

[25] On computer treatments as a way to eliminate social preferences, see also Houser and Kurzban (2002) and the recent work by Huck, Seltzer, and Wallace (2011).

offers between 32 and 68, for which information gathering should occur according to standard theory, then in the last ten rounds information gathering was observed in 73.70% of the cases in the IG 20-80 treatment, while it was observed in 89.63% of the cases in the computer treatment. The difference is highly significant (p-value<0.001 according to a two-tailed Mann Whitney U test). The fact that in the absence of inequity considerations there was more information gathering is due to the fact that for relatively small offers, there were much fewer outright rejections than in the IG 20-80 treatment.[26]

5.2.2 Principals' behavior

The principals' behavior is illustrated in Figure 4. In each treatment, the blue dots depict the cumulative distribution of the offers. Observe that most offers lie in the corridor formed by the benchmarks assuming standard preferences and Fehr-Schmidt distributed preferences. In other words, the offers were larger than predicted by standard theory, but they often were smaller than in the Fehr-Schmidt benchmark.

While in the literature on standard ultimatum games, responders' rejections are often attributed mainly to social preferences, there is less consensus about the driving forces behind proposers' offers. For instance, Roth et al. (1991) have pointed out that given responders' rejection behavior, proposers' behavior is roughly consistent with income-maximization. In contrast, Fehr and Schmidt (1999) argue that proposers' behavior in ultimatum games is driven by disutility from advantageous inequality, so that they derive their distribution of β from inspecting ultimatum game data. In order to find out to what extent in our setting principals' behavior is driven by social preferences, we have conducted two further control treatments, which can be compared directly to the AI 20-80 and AI 40-60 treatments. These control treatments are one-person decision problems, in which the subjects had to make offers to the computer, and they were told that the computer will accept or reject the offers with the same probabilities that were observed in analogous experiments with human agents. Hence, all subjects were in the role of principals and they knew that they were not playing with human agents, so principals' social preferences could not be relevant. In the computer treatments, the average offers in the last ten rounds were 46.80 in the 20-80 parameter constellation and 67.03

[26]The rejection rate of uninformed agents was only 3.66% in the computer treatment, as opposed to 27.78% in the IG 20-80 treatment. The difference is highly significant (p-value<0.001 according to a two-tailed Mann Whitney U test).

in the 40-60 constellation.[27] According to two-tailed Mann Whitney U tests, there was no significant difference in the principals' behavior between the AI treatments and the corresponding computer treatments (the p-values are 0.956 in the 20-80 constellation and 0.782 in the 40-60 constellation). Thus, we conclude that in our setting principals' social preferences cannot be an important determinant of their behavior.[28]

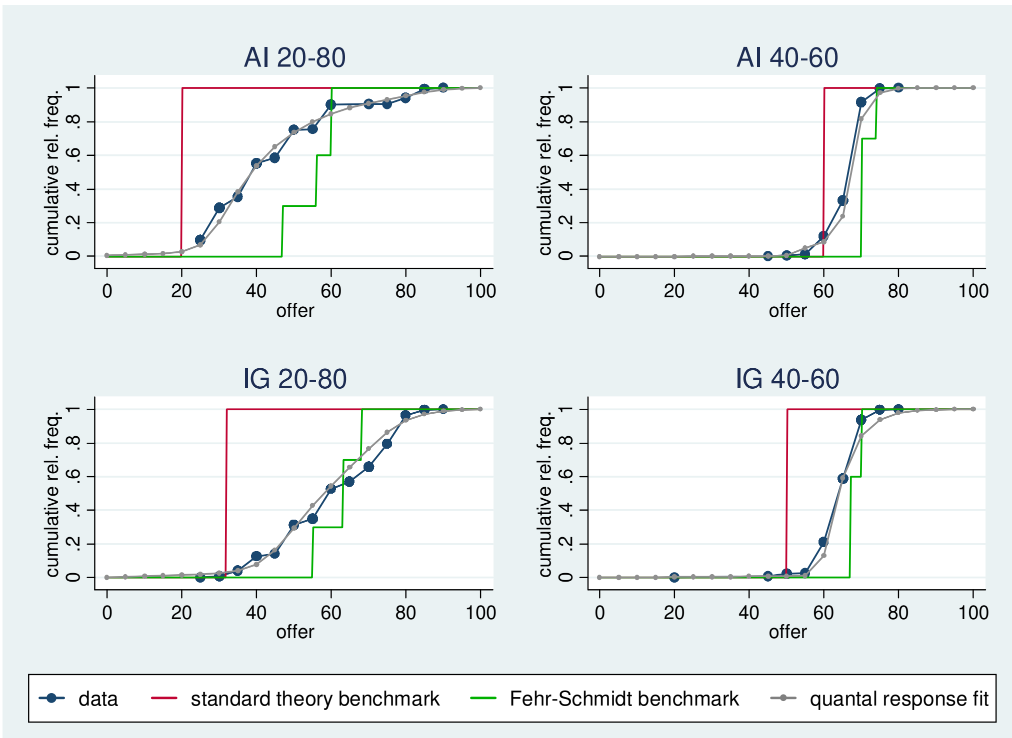

Figure 4. The blue dots show the cumulative distributions of the offers made by the principals (rounds 6-15), while the red and green lines show the theoretical benchmarks with standard preferences and Fehr-Schmidt distributed preferences. The gray graphs are quantal response fits using the estimates in the "inequity-averse agent" row of Table 8.

[27] For further details on the computer treatments AIC 20-80 and AIC 40-60, see Appendix B. The cumulative distributions of the principals' offers in the computer treatments are illustrated in Figure 5.

[28] Our finding is in line with Güth, Huck, and Ockenfels (1996) and Güth and van Damme (1998), who have conducted experiments on ultimatum games in which the proposer has private information. They also find that proposers do not have a strong intrinsic motivation for fairness. See also Huck, Müller, and Normann (2001) who study duopoly markets and find that Stackelberg leaders are not averse to advantageous inequality.

	AI 20-80	AI 40-60	IG 20-80	IG 40-60
standard agent	$\lambda_P = 0.140$ (0.019) $\ln L_P = -1203.1$	$\lambda_P = 0.318$ (0.048) $\ln L_P = -846.8$	$\lambda_P = 0.156$ (0.021) $\ln L_P = -1221.0$	$\lambda_P = 0.173$ (0.007) $\ln L_P = -871.3$
inequity-av. agent	$\lambda_P = 0.121$ (0.012) $\ln L_P = -1199.3$	$\lambda_P = 0.387$ (0.040) $\ln L_P = -621.7$	$\lambda_P = 0.166$ (0.017) $\ln L_P = -1190.1$	$\lambda_P = 0.191$ (0.014) $\ln L_P = -720.8$
random	$\ln L_P = -1461.4$	$\ln L_P = -1461.4$	$\ln L_P = -1461.4$	$\ln L_P = -1461.4$
empirical	$\ln L_P = -1006.6$	$\ln L_P = -560.0$	$\ln L_P = -1060.1$	$\ln L_P = -651.6$

Table 8. Quantal response estimations of the principals' behavior, rounds 6-15. In the row "standard agent," it is assumed that the principals believe the agents behave as estimated in the row "standard preferences" of Table 7, while in the row "inequity-averse agent," it is assumed that the principals believe the agents behave as estimated in the row "inequity aversion" of Table 7. (Robust standard errors are in parentheses.)

However, the principals seem to understand that social preferences play a role in agents' behavior. In Table 8, we report quantal response estimations of the principals' behavior. The observed behavior of the principals can be better explained if we assume that when making their offers, the principals correctly anticipate that the agents' behavior will be influenced by social preferences as estimated in Table 7. As can be seen in Figure 4, the estimates assuming equilibrium beliefs about the agents' social preferences capture the data quite well.

In order to explore to what extent the principals take the uncertainty about the agents' social preferences into account, it is instructive to compare the principals' behavior in the AI treatments with the control treatments that were identical to AI except that there was symmetric information about the agents' production costs. According to standard theory, the offers in AI 20-80 should not be different from the offers that the principals make when they know that the agents' production costs are 20. Similarly, according to standard theory in AI 40-60 the offers should not differ from those made when the principals know that the agents' production costs are 60.

In the 20-80 control treatment with symmetric information, when the production costs were known to be 20, the average offer in the last ten rounds was 45.70; the offers were not statistically different from the offers in AI 20-80 (p-value$= 0.749$, two-tailed Mann Whitney U test). In contrast, in the 40-60 control treatment, when the production costs were known to be 60, the offers were significantly larger than in AI 40-60 (p-value= 0.004, two-tailed Mann Whitney U test); the average offer in the last ten rounds was 73.78.

These findings can be explained if the principals anticipate that conditional on a production cost type, the agents still differ with respect to their degree of inequity aversion.[29] Specifically, consider the AI 20-80 treatment, in which the principals typically decide to trade only with agents whose production costs are 20. When the principals deliberate whether to make more or less generous offers (i.e., whether or not to also trade with particularly inequity-averse agents who have production costs 20), they behave in the same way as if they knew for sure that the agents' production costs are 20.[30] Now consider the AI 40-60 treatment, in which the principals generally make offers that may be acceptable for agents with production costs 60, so that the offers will clearly be accepted by agents with production costs 40. When deliberating whether or not to make very generous offers in order to also trade with particularly inequity-averse agents with production costs 60, the principals tend not to do so, since in case the agent has production costs 40, such a very generous offer would only reduce the profit. In contrast, when the principal knows for sure that the agent has production costs 60, she will be more willing to make a very generous offer, so that also particularly inequity-averse agents will accept the offer. Hence, since the principals are uncertain about the agents' degree of inequity aversion, in AI 40-60 the principals make offers somewhat smaller than they would make if they knew for sure that the production costs are 60 (cf. Figure 5).

[29] Note that if the agents were averse to disadvantageous inequality, but there was no uncertainty about their social preferences, the discrepancy between the offers in AI 40-60 and in the control treatment in which the production costs are known to be 60 could not be explained. In general, if there was no uncertainty about the agents' degree of inequity aversion, then depending on the parameter constellation the optimal offer in an AI treatment in which the production costs are c_l or c_h would either be equal the optimal offer in a symmetric information treatment with costs c_l, or it would be equal to the optimal offer in a symmetric information treatment with costs c_h.

[30] More precisely, as can be seen in Figure 5, in AI 20-80 the principals make small offers slightly more often (which is in accord with our observation that in AI 20-80 agents are less inclined to reject small offers), while they also make a few very large offers, trying to trade with agents who have production costs 80.

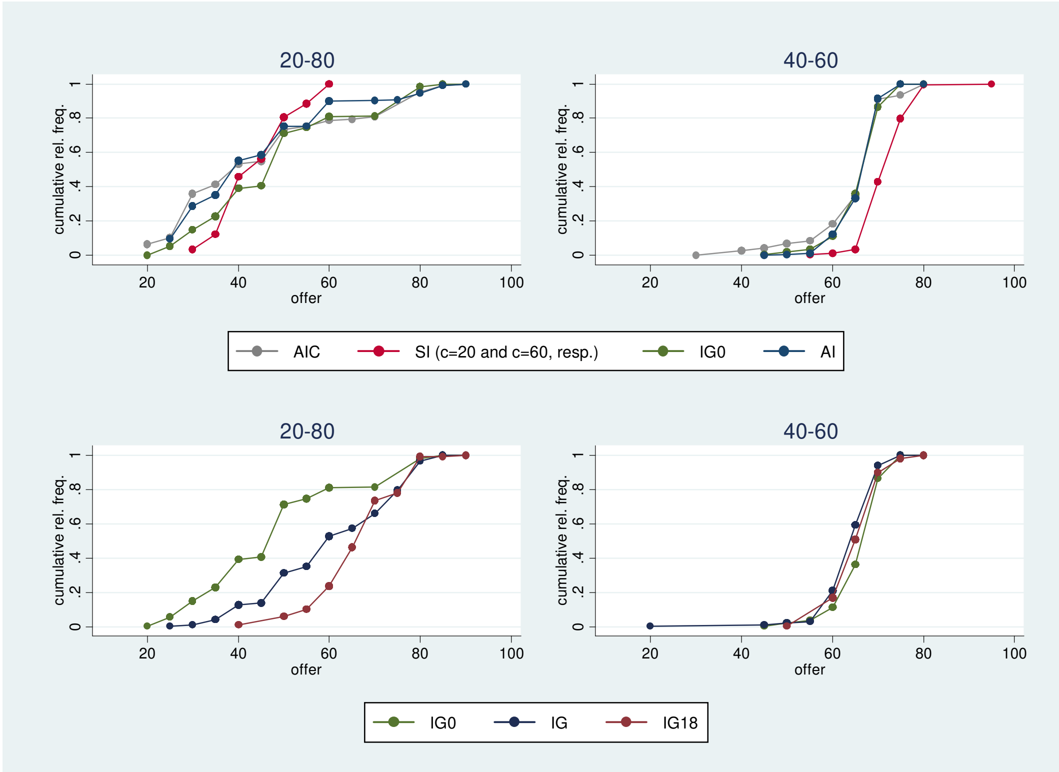

Figure 5. Cumulative distributions of the principals' offers (rounds 6-15). In the upper half of the panel, the principals' behavior in AI 20-80 and AI 40-60 is compared with (i) the AIC treatments in which the computer decided whether or not to accept the offer, (ii) the symmetric information (SI) treatments (for $c = 20$ in the 20-80 constellation and $c = 60$ in the 40-60 constellation), and (iii) the IG0 treatments in which the information acquisition costs were zero. The lower half of the panel compares the principals' behavior in IG 20-80 and IG 40-60 with the IG0 and IG18 treatments in which the information acquisition costs were $\gamma = 0$ and $\gamma = 18$, respectively.

Taken together, the principals' behavior reflects the basic considerations that are at the heart of adverse selection theory. The principals ponder whether to set a relatively low wage, foregoing opportunities to trade with agents whose acceptance threshold is high in order to make a larger profit with agents whose acceptance threshold is low, or to set a larger wage so that trade occurs more often. In the AI treatments, an agent's acceptance threshold depends on both his production costs and the strength of his aversion to disadvantageous inequity. Note that in the symmetric information treatments (and in standard ultimatum games) there is only uncertainty about the agents' degree of inequity aversion, which however cannot be controlled by the experimenter. Hence, in such treatments we cannot vary the distribution of the uncertain parameter. In contrast, in our AI treatments this uncontrolled uncertainty is combined with the controlled uncertainty about the agents' production costs. The comparison of the AI treatments and the symmetric information treatments allowed us to demonstrate that the principals' offers indeed take into account not only the uncertainty about the production costs, but also the uncertainty about the agent's social preferences.

Finally, recall that the asymmetric information treatments can be seen as a special case of information gathering in which the costs of information gathering are zero. In order to test whether the experimental subjects indeed view these situations as equivalent and to explore whether larger information gathering costs have the predicted effects, we have conducted four additional treatments. Following each IG treatment, two treatments were conducted which were identical to the original IG treatment, except that the information gathering costs now were 0 and 18.

As expected, neither the principals' offers nor the agents' rejection behavior differed significantly between AI and the corresponding treatment in which the information gathering costs were 0 (see the upper panels of Figure 5 and Table B5 in Appendix B). When the information gathering costs are 18, according to Proposition 3(i), information gathering should occur neither in the 20-80 nor in the 40-60 parameter constellation. The offers in the 20-80 constellation should thus be larger than in the original IG 20-80 treatment, while there should be no difference between the 40-60 treatment with information gathering costs 18 and the original IG 40-60 treatment. Indeed, with information gathering costs 18, in the last ten rounds the average offers were 68.07 in the 20-80 constellation and 67.22 in the 40-60 constellation. In the 20-80 constellation, the offers were significantly larger than in the original IG 20-80 treatment (p-value= 0.028, two-tailed Wilcoxon signed-ranks test), while there was no significant difference in the 40-60 parameter constellation. Hence, increasing the information gathering costs affects the principals' offers as predicted.

6 Conclusion

Agency problems in which the agent has access to private information before the contract is signed are ubiquitous in the real world. This fact explains why the number of theoretical models on contracting under adverse selection has grown so rapidly in the past three decades. A central insight of these models is the fact that a principal who offers a contract to an agent whose type she does not know trades off ex post efficiency in the bad state of nature against a larger profit in the good state of nature. However, due to the inherent availability problem regarding data on private information, empirical tests of this basic trade-off are scarce. As a first step in this direction, we have conducted a large-scale experiment to investigate whether the theoretical trade-off is intuitively taken into account by decision-makers facing agency problems with both exogenous and endogenous information structures.

Our experimental findings regarding the subjects' reactions to the treatment variations are in good accord with the predictions based on agency theory and thus lend support for the empirical relevance of the postulated trade-off. Moreover, our analysis shows that agents' social preferences are helpful to explain the quantitative deviations of our data from standard theory, although we find that social preferences seem to be less pronounced in our framework than in standard ultimatum games. Finally, we find that while principals' own social preferences are not an important determinant of their behavior, when making their offers the principals anticipate that agents' behavior is affected by social preferences.

Conducting further experiments on agency problems with incomplete information seems to be a promising path for future research. In particular, we plan to supplement the present study by performing experiments in which the agent can gather information before the principal offers the contract. Moreover, we plan to experimentally study adverse selection problems where in the bad state of nature the theoretically predicted trade level is still positive but smaller than in the good state. In such a setting it would be interesting to see whether the principals will then offer two different contracts and thereby succeed in separating the agents. To further explore the role of social preferences, it may also be promising to conduct experiments in which the agent's costs are commonly known, but the principal's return is initially known only by herself, while the agent can gather information about it.[31]

[31] Note that according to standard theory, this information would be useless for the agent. Yet, if information gathering can take place before the agent's acceptance decision, an inequity-averse agent could have an incentive to gather information. Moreover, treatments in which the agent can gather information only after the acceptance decision might then be useful to isolate the agent's pure desire to know the truth and the principal's pure fear of being found out to be greedy.

Appendix A: Proofs

Proof of Proposition 1

The agent will accept the wage offer whenever $c \leq w$. Note that if $c_l < w < c_h$, then the principal would be better off by setting $w = c_l$. If $w > c_h$, then the principal would be better off by setting $w = c_h$. If $w < c_l$, then the principal would make zero profit, which is less than $R - c_h$, the profit that she could make by setting $w = c_h$. Hence, the principal will take into consideration wage offers $w \in \{c_l, c_h\}$ only. If the principal sets $w = c_l$, so that only an agent of type c_l accepts, then her expected profit is $p(R - c_l)$. If she sets $w = c_h$, then the offer is always accepted, so that the principal's profit is $R - c_h$. The proposition thus follows immediately. ■

Proof of Proposition 2

Suppose that the principal has offered the wage w. The agent can react in three different ways. The agent's expected profit if he accepts the offer without information gathering is $w - E[c]$. The agent's expected profit if he gathers information is $E[\max\{w - c, 0\}] - \gamma$ (because when informed, the agent accepts the wage offer whenever $w - c \geq 0$). Finally, the agent makes zero profit if he rejects the offer without gathering information.

If the principal has set $w < c_l$, then the agent rejects the offer without information gathering. If the principal has set $w \geq c_h$, then the agent accepts the offer without information gathering.

In the remainder of the proof, we consider offers $c_l \leq w < c_h$. If the agent gathers information, he accepts such an offer whenever $c = c_l$, and his expected profit is $E[\max\{w - c, 0\}] - \gamma = p(w - c_l) - \gamma$.

The agent's expected profit when he immediately accepts, $w - E[c] = w - (pc_l + (1 - p)c_h)$, is larger than his expected profit when he gathers information whenever $w \geq c_h - \frac{\gamma}{1-p}$. The agent's expected profit when he gathers information is larger than zero (his expected profit when he immediately rejects) whenever $w \geq c_l + \frac{\gamma}{p}$. The agent's profit when he immediately accepts is larger than his profit when he immediately rejects whenever $w \geq E[c]$.

(i) If $\gamma \geq p(1 - p)(c_h - c_l)$, then $c_l + \frac{\gamma}{p} \geq c_h - \frac{\gamma}{1-p}$ must hold. Hence, for every wage offer outright acceptance and/or outright rejection must be better for the agent than information gathering. Part (i) of Proposition 2 then follows immediately.

(ii) If $\gamma < p(1 - p)(c_h - c_l)$, then $c_l + \frac{\gamma}{p} < c_h - \frac{\gamma}{1-p}$ must hold. Hence, for every wage offer information gathering must be better for the agent than at least one of the two alternatives (outright acceptance and outright rejection). Part (ii) of Proposition 2 thus follows immediately. ■

Proof of Proposition 3

(i) Consider the case $\gamma \geq p(1-p)(c_h - c_l)$. If the principal sets $w < E[c]$, the agent rejects, so the principal's profit is zero. If she sets $w \geq E[c]$, the agent accepts, so the principal's profit is $R - w$. Hence, the best the principal can do is to set $w = E[c]$.

(ii) Consider the case $\gamma < p(1-p)(c_h - c_l)$. If the principal sets $w < c_l + \frac{\gamma}{p}$, the agent will reject and hence the principal's profit is zero. If the principal sets $w \in [c_l + \frac{\gamma}{p}, c_h - \frac{\gamma}{1-p})$, the agent gathers information and then accepts the offer whenever $c = c_l$. Thus, the most profitable offer for the principal in this interval is $w = c_l + \frac{\gamma}{p}$, in which case the principal's profit is $p(R - c_l - \frac{\gamma}{p})$. If the principal wants to set $w \geq c_h - \frac{\gamma}{1-p}$, so that the agent immediately accepts, the best the principal can do is to set $w = c_h - \frac{\gamma}{1-p}$, yielding the profit $R - c_h + \frac{\gamma}{1-p}$. Part (ii) of Proposition 3 then follows immediately. ■

Appendix B: Control treatments

In addition to the four main treatments, we conducted nine control treatments. These treatments follow the design of the corresponding main treatments as closely as possible.

The symmetric information treatments

The symmetric information treatments are similar to the AI treatments, except that the principal knows the agent's production costs when making her offer. Just as in the main treatments, in each of the two symmetric information treatments, we altogether have 48 principals and 48 agents, and there are again six independent matching groups. Due to recruitment problems, we conducted the SI 20-80 treatment in six sessions (so that a matching group is identical to a session), while the SI 40-60 treatment was conducted in three sessions. Subjects who participated in the main treatments were not allowed to participate in the symmetric information treatments.

Symmetric information treatment SI 20-80. Each round consists of two stages. In the first stage, the principal and the agent learn the agent's production costs c, which are $c_l = 20$ or $c_h = 80$ with equal probability. The principal then makes a wage offer w to the agent (where w can be any integer between 0 and 100). In the second stage, the agent can decide whether or not to accept the principal's wage offer. If the agent accepts the offer, the principal's profit is $R - w = 100 - w$ and the agent's profit is $w - c$. If the agent rejects the offer, both parties make zero profits.

Symmetric information treatment SI 40-60. This treatment is identical to the SI 20-80 treatment, except that now $c_l = 40$ and $c_h = 60$.

The results of the two treatments are summarized in Table B1. Moreover, Table B2 presents quantal response estimations of the agents' behavior in analogy to Table 7.

	SI 20-80		SI 40-60	
	rounds 1 - 15			
production costs (ECU)	20	80	40	60
mean offer (ECU)	46.06	88.00	58.48	73.59
rejections	12.78%	15.28%	12.50%	16.11%
mean surplus (ECU)	69.78	16.94	52.50	33.56
mean principal profit (ECU)	45.98	9.35	35.43	21.39
mean agent profit (ECU)	23.79	7.60	17.07	12.17
	rounds 6 - 15			
production costs (ECU)	20	80	40	60
mean offer (ECU)	45.70	88.40	58.50	73.78
rejections	10.42%	11.67%**	12.08%	15.00%
mean surplus (ECU)	71.67	17.67**	52.75	34.00
mean principal profit (ECU)	47.74	9.78**	35.84	21.56
mean agent profit (ECU)	23.93	7.88	16.91	12.44

Table B1. The symmetric information treatments. The stars indicate whether behavior in rounds 6-15 differs significantly (* at the 10% level, ** at the 5% level) from behavior in rounds 1-5 according to two-tailed Wilcoxon signed-ranks tests.

	SI 20-80	SI 40-60
standard preferences	$\lambda_A = 0.153$ (0.009) $\ln L_A = -155.2$	$\lambda_A = 0.141$ (0.022) $\ln L_A = -158.8$
inequity aversion	$\alpha_A = 0.276$ (0.053) $\lambda_A = 0.274$ (0.040) $\ln L_A = -125.7$	$\alpha_A = 0.215$ (0.030) $\lambda_A = 0.211$ (0.034) $\ln L_A = -146.9$
random	$\ln L_A = -332.7$	$\ln L_A = -332.7$
empirical	$\ln L_A = -111.2$	$\ln L_A = -142.4$

Table B2. Quantal response estimations of the agents' behavior in the symmetric information treatments, rounds 6-15. (Robust standard errors are in parentheses.)

The computer treatments

The computer treatments are one-person decision problems. In each of the two computer treatments that correspond to AI 20-80 and AI 40-60, we have 48 principals. In order to eliminate the effects that principals' social preferences might play, there were no agents; their role was played by the computer. The computer accepted or rejected offers according to our estimation of the agents' behavior in the corresponding AI treatment. In AIC 20-80, we conducted one session with 30 participants and a second session with 18 participants. In AIC 40-60, we conducted two sessions with 31 and 17 participants, respectively.

In the computer treatment that corresponds to IG 20-80, we have 48 agents. To rule out that agents' social preferences might play a role, there were no principals. The computer made exactly the same offers to the agents that were made by the principals in IG 20-80.[32] We conducted two sessions with 32 and 16 participants, respectively.

Subjects who participated in the main treatments or in the symmetric information treatments were not allowed to participate in the computer treatments.

Asymmetric information computer treatment AIC 20-80. In each round, the principal makes a wage offer w (where w can be any integer between 0 and 100). When the principal makes her offer she knows that the computer simulates the behavior of real experimental participants in the role of agents in an earlier experiment. She also knows that in each round the computer simulates with equal probability either the behavior of an agent with production costs $c_l = 20$ or $c_h = 80$. If the computer accepts the offer, the principal's profit is $R - w = 100 - w$. If the computer rejects the offer, the principal makes zero profit.

Asymmetric information computer treatment AIC 40-60. This treatment is identical to the AIC 20-80 treatment, except that now $c_l = 40$ and $c_h = 60$.

Information gathering computer treatment IGC 20-80. In each round, the computer makes an offer to the agent. The agent can accept or reject the wage offer immediately (without knowing his production costs c, which are either $c_l = 20$ or $c_h = 80$ with equal probability) or he can decide to incur information gathering costs $\gamma = 6$ to learn his type before accepting or rejecting the wage offer. When the agent gathers information, his profit is $w - c - 6$ if he accepts

[32] Note that since the computer randomized between high and low production costs in the same way as in IG 20-80, this also means that the same offers were made to each production cost type as in IG 20-80.

and -6 if he rejects. When the agent does not gather information, his profit is $w - c$ if he accepts and 0 if he rejects.

The results of the computer treatments are summarized in Table B3.[33]

	AIC 20-80	AIC 40-60		IGC 20-80
	rounds 1 - 15			
mean offer (ECU)	46.36	66.21		(61.39)
information gathering				59.44%
rejections	(51.94%)	(25.69%)		33.47%
rejections by (informed) high types	(88.61%)	(43.58%)		98.10%
rejections by (informed) low types	(15.28%)	(8.01%)		0.46%
rejections by uninformed agents				11.30%
mean principal profit (ECU)	21.39	22.59		
mean agent profit (ECU)				15.81
	rounds 6 - 15			
mean offer (ECU)	46.80	67.03**		(62.61)
information gathering				60.21%
rejections	(50.63%)	(21.67%)		30.21%**
rejections by (informed) high types	(87.50%)	(38.08%)		97.87%
rejections by (informed) low types	(13.75%)	(5.39%)		0.00%
rejections by uninformed agents				3.66%*
mean principal profit (ECU)	22.34	23.86**		
mean agent profit (ECU)				16.58

Table B3. The computer treatments. Note that the numbers in parentheses result from choices by the computer. The stars indicate whether the subjects' behavior in rounds 6-15 differs significantly (* at the 10% level, ** at the 5% level) from behavior in rounds 1-5 according to two-tailed Wilcoxon signed-ranks tests.

[33] We also tried to learn more about the noise that remains once social preferences are eliminated. Specifically, subjects' heterogeneity regarding their risk attitudes might play a role. Therefore, after the final round of each computer treatment session, we conducted Holt and Laury's (2002) test consisting of ten lottery choices. We classify subjects as risk-tolerant if they make at most five safe Holt/Laury-choices. Using two-tailed Mann Whitney U tests, we do not find significant differences between risk-tolerant and risk-avoiding subjects, neither with regard to the principals' offers nor with regard to the agents' information gathering behavior. Although tentative, these findings suggest that risk-aversion might not be a major determinant of subjects' behavior in our experiment.

The additional information gathering treatments

After the final rounds of the IG 20-80 and IG 40-60 treatments, in each session we told the subjects that two further experiments will take place. Specifically, we conducted the following four treatments.

Information gathering treatment with costless information IG0 20-80. This treatment is identical to the IG 20-80 treatment, except that now the information gathering costs are $\gamma = 0$.

Information gathering treatment with costless information IG0 40-60. This treatment is identical to the IG 40-60 treatment, except that now the information gathering costs are $\gamma = 0$.

Information gathering treatment with expensive information IG18 20-80. This treatment is identical to the IG 20-80 treatment, except that now the information gathering costs are $\gamma = 18$.

Information gathering treatment with expensive information IG18 40-60. This treatment is identical to the IG 40-60 treatment, except that now the information gathering costs are $\gamma = 18$.

Following the IG 20-80 (IG 40-60) treatment, we conducted first the IG18 20-80 (IG18 40-60) and then the IG0 20-80 (IG0 40-60) treatment.[34] Written instructions were handed out at the beginning of each treatment. The results of the additional information gathering treatments are summarized in Table B4, while Table B5 reports p-values of comparisons between AI and IG0, and Table B6 reports p-values of comparisons between IG0 and IG as well as IG and IG18.

[34] Due to a limited subject pool, we could not recruit different subjects for the additional information gathering treatments, so that these treatments should be taken with some care, since IG18 (IG0) may be influenced by the players' experience in IG (and IG18). Yet, we wanted to be sure that the additional treatments could have no effect on the main IG treatments, so we decided not to change the order in which the treatments were played in the sessions.

	IG0 20-80	IG0 40-60	IG18 20-80	IG18 40-60
	rounds 1 - 15			
mean offer (ECU)	50.71	67.98	67.55	67.07
information gathering	86.39%	47.50%	11.67%	0.14%
rejections	45.69%	13.33%	25.42%	11.81%
rejections by (informed) high types	93.97%	53.01%	93.18%	100.00% (1 obs)
rejections by (informed) low types	3.91%	1.14%	0.00%	(0 obs)
rejections by uninformed agents	21.43%	1.59%	22.33%	11.68%
mean surplus (ECU)	38.94	44.50	36.15	44.09
mean principal profit (ECU)	23.44	27.13	21.76	28.49
mean agent profit (ECU)	15.50	17.37	14.39	15.59
	rounds 6 - 15			
mean offer (ECU)	50.54	68.16	68.07	67.22
information gathering	86.04%	46.04%**	8.96%**	0.21%
rejections	45.63%	12.29%	23.54%**	10.63%*
rejections by (informed) high types	94.31%	51.92%	90.91%	100% (1 obs)
rejections by (informed) low types	2.97%	1.71%	0.00%	(0 obs)
rejections by uninformed agents	20.90%	1.16%	21.28%	10.44%*
mean surplus (ECU)	39.13	44.88	36.93	44.67
mean principal profit (ECU)	23.83	27.32	22.39*	28.92*
mean agent profit (ECU)	15.30	17.56	14.54	15.75

Table B4. The additional information gathering treatments. The stars indicate whether behavior in rounds 6-15 differs significantly (* at the 10% level, ** at the 5% level) from behavior in rounds 1-5 according to two-tailed Wilcoxon signed-ranks tests.

	IG0 20-80 vs. AI 20-80	IG0 40-60 vs. AI 40-60
offers	0.262	0.873
rejections	0.335	0.221
surplus	0.337	0.258
principal profit	0.423	0.423
agent profit	0.262	0.873

Table B5. Significance levels for pairwise comparisons between the treatments in rounds 6-15. The reported p-values are obtained by two-tailed Mann Whitney U tests.

	IG0 20-80 vs. IG 20-80	IG 20-80 vs. IG18 20-80	IG0 40-60 vs. IG 40-60	IG 40-60 vs. IG18 40-60
offers	0.028	0.028	0.028	0.116
info. gath.	0.028	0.028	0.028	0.052
rejections	0.059	0.028	0.398	0.035
surplus	0.075	0.345	0.075	0.046
principal profit	0.028	0.028	0.028	0.345
agent profit	0.600	0.600	0.028	0.173

Table B6. Significance levels for pairwise comparisons between the treatments in rounds 6-15. The reported p-values are obtained by two-tailed Wilcoxon signed-ranks tests.

Acknowledgment

We are grateful to Bruno Biais, Imran Rasul, and anonymous referees for making very useful comments and suggestions that have helped us to substantially improve our paper. Moreover, we would like to thank Al Roth for providing us with the ultimatum game data from Roth et al. (1991). We have benefitted from helpful discussions with Gary Bolton, Stefano DellaVigna, Philippe Jehiel, Ulrike Malmendier, David Martimort, as well as participants of the WEAI conference 2010 in Portland, the ISNIE conference 2011 in Stanford, and the Roy-Adres Seminar at the Paris School of Economics in April 2012. The experiments were conducted in the Cologne Laboratory of Economic Research, which is partially funded by the DFG, FOR 1371. Furthermore, we thank Felix Meickmann for providing excellent research assistance in programming and conducting the experiment.

References

AGHION, P. and TIROLE, J. (1997), "Formal and Real Authority in Organizations", *Journal of Political Economy*, **105**, 1–29.

ASPAROUHOVA, E. (2006), "Competition in Lending: Theory and Experiments", *Review of Finance*, **10**, 189–219.

BARON, D.P. and MYERSON, R.B. (1982), "Regulating a Monopolist with Unknown Costs", *Econometrica*, **50**, 911–930.

BERGEMANN, D. and VÄLIMÄKI, J. (2006), "Information in Mechanism Design", in Blundell, R., Newey, W. and Persson, T. (eds) *Advances in Economics and Econometrics,* Econometric Society Monographs, Ninth World Congress, Vol. 1 (Cambridge: Cambridge University Press) 186–221.

BLANCO, M., ENGELMANN, D. and NORMANN, H.T. (2011), "A Within-Subject Analysis of Other-Regarding Preferences", *Games and Economic Behavior*, **72**, 321–338.

BOLTON, P. and DEWATRIPONT, M. (2005), *Contract Theory* (Cambridge: MIT Press).

CABRALES, A. and CHARNESS, G. (2011), "Optimal Contracts with Team Production and Hidden Information: An Experiment", *Journal of Economic Behavior and Organization*, **77**, 163–176.

CABRALES, A., CHARNESS, G. and VILLEVAL, M.-C. (2011), "Hidden Information, Bargaining Power, and Efficiency: An Experiment", *Experimental Economics*, **14**, 133–159.

CAMERER, C.F. (2003), *Behavioral Game Theory: Experiments in Strategic Interaction* (Princeton: Princeton University Press).

CHARNESS, G. and DUFWENBERG, M. (2011), "Participation", *American Economic Review*, **101**, 1213–1239.

CHIAPPORI, P.A. and SALANIÉ, B. (2003), "Testing Contract Theory: A Survey of Some Recent Work", in Dewatripont, M., Hansen, L.P. and Turnovsky, S.J. (eds) *Advances in Economics and Econometrics,* Econometric Society Monographs, Eighth World Congress, Vol. 1 (Cambridge: Cambridge University Press) 115–149.

CRÉMER, J. and KHALIL, F. (1992), "Gathering Information before Signing a Contract", *American Economic Review*, **82**, 566–578.

CRÉMER, J. and KHALIL, F. (1994), "Gathering Information before the Contract is Offered: The Case with Two States of Nature", *European Economic Review*, **38**, 675–682.

CRÉMER, J., KHALIL, F. and ROCHET, J.-C. (1998a), "Contracts and Productive Information Gathering", *Games and Economic Behavior*, **25**, 174–193.

CRÉMER, J., KHALIL, F. and ROCHET, J.-C. (1998b), "Strategic Information Gathering before a Contract is Offered", *Journal of Economic Theory*, **81**, 163–200.

CROSON, R.T.A. (1996), "Information in Ultimatum Games: An Experimental Study", *Journal of Economic Behavior and Organization*, **30**, 197–212.

DE BRUYN, A. and BOLTON, G.E. (2008), "Estimating the Influence of Fairness on Bargaining Behavior", *Management Science*, **54**, 1774–1791.

DEWATRIPONT, M. and TIROLE, J. (1999), "Advocates", *Journal of Political Economy*, **107**, 1–39.

FEHR, E. and SCHMIDT, K.M. (1999), "A Theory of Fairness, Competition, and Cooperation", *Quarterly Journal of Economics*, **114**, 817–868.

FEHR, E. and SCHMIDT, K.M. (2003), "Theories of Fairness and Reciprocity – Evidence and Economic Applications", in Dewatripont, M., Hansen, L.P. and Turnovsky, S.J. (eds) *Advances in Economics and Econometrics,* Econometric Society Monographs, Eighth World Congress, Vol. 1 (Cambridge: Cambridge University Press) 208–257.

FEHR, E. and SCHMIDT, K.M. (2006), "The Economics of Fairness, Reciprocity and Altruism - Experimental Evidence and New Theories", in Kolm, S.-C. and Ythier, J.M. (eds) *Handbook on the Economics of Giving, Reciprocity and Altruism,* Vol. 1 (Amsterdam: Elsevier) 615–691.

FISCHBACHER, U. (2007), "z-Tree: Zurich Toolbox for Ready-Made Economic Experiments", *Experimental Economics*, **10**, 171–178.

FORSYTHE, R., KENNAN, J. and SOPHER, B. (1991), "An Experimental Analysis of Strikes in Bargaining Games with One-Sided Private Information", *American Economic Review*, **81**, 253–278.

GOEREE, J.K. and HOLT, C.A. (2000), "Asymmetric Inequality Aversion and Noisy Behavior in Alternating-Offer Bargaining Games", *European Economic Review*, **44**, 1079–1089.

GOSWAMI, G., GRACE, M.F. and REBELLO, M.J. (2008), "Experimental Evidence on Coverage Choices and Contract Prices in the Market for Corporate Insurance", *Experimental Economics*, **11**, 67–95.

GREINER, B. (2004), "An Online Recruiting System for Economic Experiments", in Kremer, K. and Macho, V. (eds) *Forschung und wissenschaftliches Rechnen 2003. GWDG Bericht 63* (Göttingen: Ges. für Wiss. Datenverarbeitung) 79–93.

GÜTH, W., HUCK, S. and OCKENFELS, P. (1996), "Two-Level Ultimatum Bargaining with Incomplete Information: An Experimental Study", *Economic Journal*, **106**, 593–604.

GÜTH, W., SCHMITTBERGER, R. and SCHWARZE, B. (1982), "An Experimental Analysis of Ultimatum Bargaining", *Journal of Economic Behavior and Organization*, **3**, 367–388.

GÜTH, W. and VAN DAMME, E. (1998), "Information, Strategic Behavior, and Fairness in Ultimatum Bargaining: An Experimental Study", *Journal of Mathematical Psychology*, **42**, 227–247.

HARSTAD, R. and NAGEL, R. (2004), "Ultimatum Games with Incomplete Information on the Side of the Proposer: An Experimental Study", *Cuadernos de Economía*, **27**, 37–74.

HART, O. and HOLMSTRÖM, B. (1987), "The Theory of Contracts", in Bewley, T. (eds) *Advances in Economics and Econometrics,* Econometric Society Monographs, Fifth World Congress (Cambridge: Cambridge University Press) 71–155.

HOFFMAN, E., MCCABE, K., SHACHAT, K. and SMITH, V. (1994), "Preferences, Property Rights, and Anonymity in Bargaining Games", *Games and Economic Behavior*, **7**, 346–380.

HOLT, C.A. and LAURY, S.K. (2002), "Risk Aversion and Incentive Effects", *American Economic Review*, **92**, 1644–1655.

HOUSER, D. and KURZBAN, R. (2002), "Revisiting Kindness and Confusion in Public Goods Experiments", *American Economic Review*, **92**, 1062–1069.

HUCK, S. (1999), "Responder Behavior in Ultimatum Offer Games with Incomplete Information", *Journal of Economic Psychology*, **20**, 183–206.

HUCK, S., MÜLLER, W. and NORMANN, H.-T. (2001), "Stackelberg Beats Cournot: On Collusion and Efficiency in Experimental Markets", *Economic Journal,* **111**, 1–17.

HUCK, S., SELTZER, A.J. and WALLACE, B. (2011), "Deferred Compensation in Multiperiod Labor Contracts: An Experimental Test of Lazear's Model", *American Economic Review*, **101**, 819–843.

KAGEL, J.H., KIM, C. and MOSER, D. (1996), "Fairness in Ultimatum Games with Asymmetric Information and Asymmetric Payoffs", *Games and Economic Behavior*, **13**, 100–110.

KESSLER, A.S. (1998), "The Value of Ignorance", *Rand Journal of Economics*, **29**, 339–354.

LAFFONT, J.-J. and MARTIMORT, D. (2002), *The Theory of Incentives: The Principal-Agent Model* (Princeton: Princeton University Press).

LAFFONT, J.-J. and TIROLE, J. (1993), *A Theory of Incentives in Procurement and Regulation* (Cambridge: MIT Press).

LEWIS, T.R. and SAPPINGTON, D.E.M. (1997), "Information Management in Incentive Problems", *Journal of Political Economy*, **105**, 796–821.

MASKIN, E. and RILEY, J. (1984), "Monopoly with Incomplete Information", *Rand Journal of Economics*, **15**, 171–196.

MCKELVEY, R.D. and PALFREY, T.R. (1995), "Quantal Response Equilibria in Normal Form Games", *Games and Economic Behavior*, **10**, 6–38.

MCKELVEY, R.D. and PALFREY, T.R. (1998), "Quantal Response Equilibria in Extensive Form Games", *Experimental Economics*, **1**, 9–41.

MITZKEWITZ, M. and NAGEL, R. (1993), "Experimental Results on Ultimatum Games with Incomplete Information", *International Journal of Game Theory*, **22**, 171–198.

POSEY, L.L. and YAVAS, A. (2007), "Screening Equilibria in Experimental Markets", *Geneva Risk and Insurance Review*, **32**, 147–167.

PRENDERGAST, C. (1999), "The Provision of Incentives in Firms", *Journal of Economic Literature*, **37**, 7–63.

RAPOPORT, A. and SUNDALI, J.A. (1996), "Ultimatums in Two-Person Bargaining with One-Sided Uncertainty: Offer Games", *International Journal of Game Theory*, **25**, 475–494.

ROGERS, B.W., PALFREY, T.R. and CAMERER, C.F. (2009), "Heterogeneous Quantal Response Equilibrium and Cognitive Hierarchies", *Journal of Economic Theory*, **144**, 1440–1467.

ROTH, A.E., PRANSIKAR, V., OKUNO-FUJIWARA, M. and ZAMIR, S. (1991), "Bargaining and Market Behavior in Jerusalem, Ljubljana, Pittsburgh, and Tokyo: An Experimental Study", *American Economic Review*, **81**, 1068–1095.

SALANIÉ, B. (2005), *The Economics of Contracts* (Cambridge: MIT Press).

SCHMITZ, P.W. (2006), "Information Gathering, Transaction Costs, and the Property Rights Approach", *American Economic Review*, **96**, 422–434.

STRAUB, P.G. and MURNIGHAN, J.K. (1995), "An Experimental Investigation of Ultimatum Games: Information, Fairness, Expectations, and Lowest Acceptable Offers", *Journal of Economic Behavior and Organization*, **27**, 345–364.

Supplementary Material for
"Contracting under Incomplete Information
and Social Preferences: An Experimental Study"

Eva I. Hoppe and Patrick W. Schmitz
University of Cologne

Derivation of the Fehr-Schmidt benchmark in Table 3

In the AI treatments, the agent's utility is $w - c - \alpha_A \max\{100 - 2w + c, 0\} - \beta_A \max\{2w - 100 - c, 0\}$ if the offer w is accepted, and 0 otherwise. Hence, the agent accepts whenever $w \geq \hat{w}(\alpha_A, c) = \frac{\alpha_A(100+c)+c}{1+2\alpha_A}$.[1] The acceptance threshold levels $\hat{w}$ for the Fehr-Schmidt distribution are shown in Table S1.

	rel. freq.	c=20	c=80	c=40	c=60
$\alpha_A = 0$	30%	20	80	40	60
$\alpha_A = 0.5$	30%	40	85	55	70
$\alpha_A = 1$	30%	47	87	60	74
$\alpha_A = 4$	10%	56	89	67	78

Table S1. The agent's acceptance thresholds in the AI treatments.

Denote the agent's acceptance decision by $d(w, c, \alpha_A) = 1$ if $w \geq \hat{w}(\alpha_A, c)$ and $d(w, c, \alpha_A) = 0$ otherwise. Given that the agents are Fehr-Schmidt distributed, from the principal's point of view the probability that the agent accepts offer w is thus $z(w, c) = 0.3d(w, c, 0) + 0.3d(w, c, 0.5) + 0.3d(w, c, 1) + 0.1d(w, c, 4)$.

The principal's expected utility EU_P is

$$\begin{aligned}
&0.5(100 - w - \alpha_P \max\{2w - 100 - c_l, 0\} \\
&-\beta_P \max\{100 + c_l - 2w, 0\})z(w, c_l) \\
&+0.5(100 - w - \alpha_P \max\{2w - 100 - c_h, 0\} \\
&-\beta_P \max\{100 + c_h - 2w, 0\})z(w, c_h).
\end{aligned}$$

[1] It is straightforward to show that the agent always accepts if $w > (100 + c)/2$ (so that aversion to advantageous inequality becomes relevant) and that $\hat{w}(\alpha_A, c) < (100 + c)/2$.

Inspection of Figures S1 and S2 shows that the principal's utility-maximizing offers are as shown in Table S2. The numbers reported in Table 3 in the paper then follow immediately.

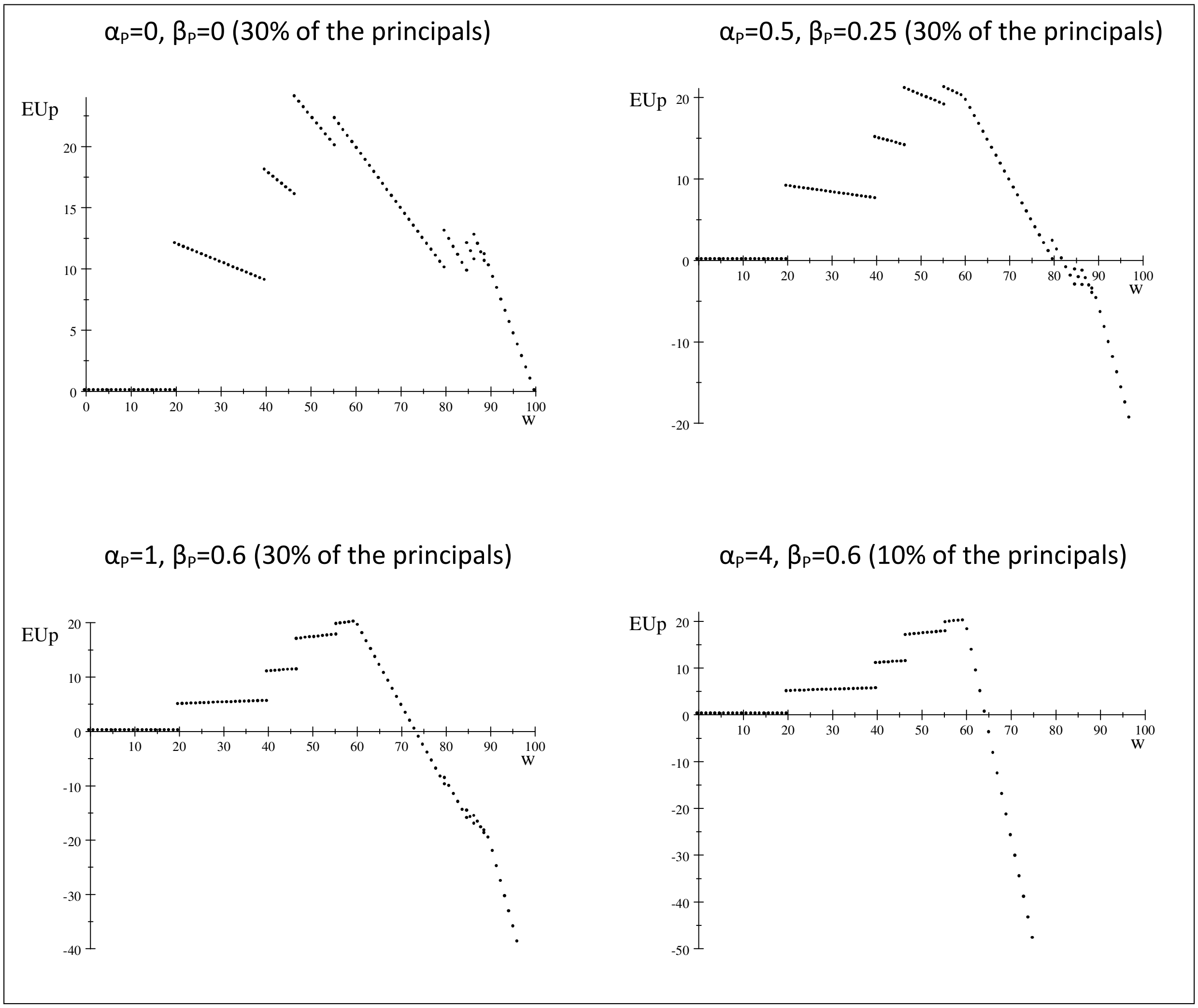

Figure S1. The principal's expected utility in the treatment AI 20-80.

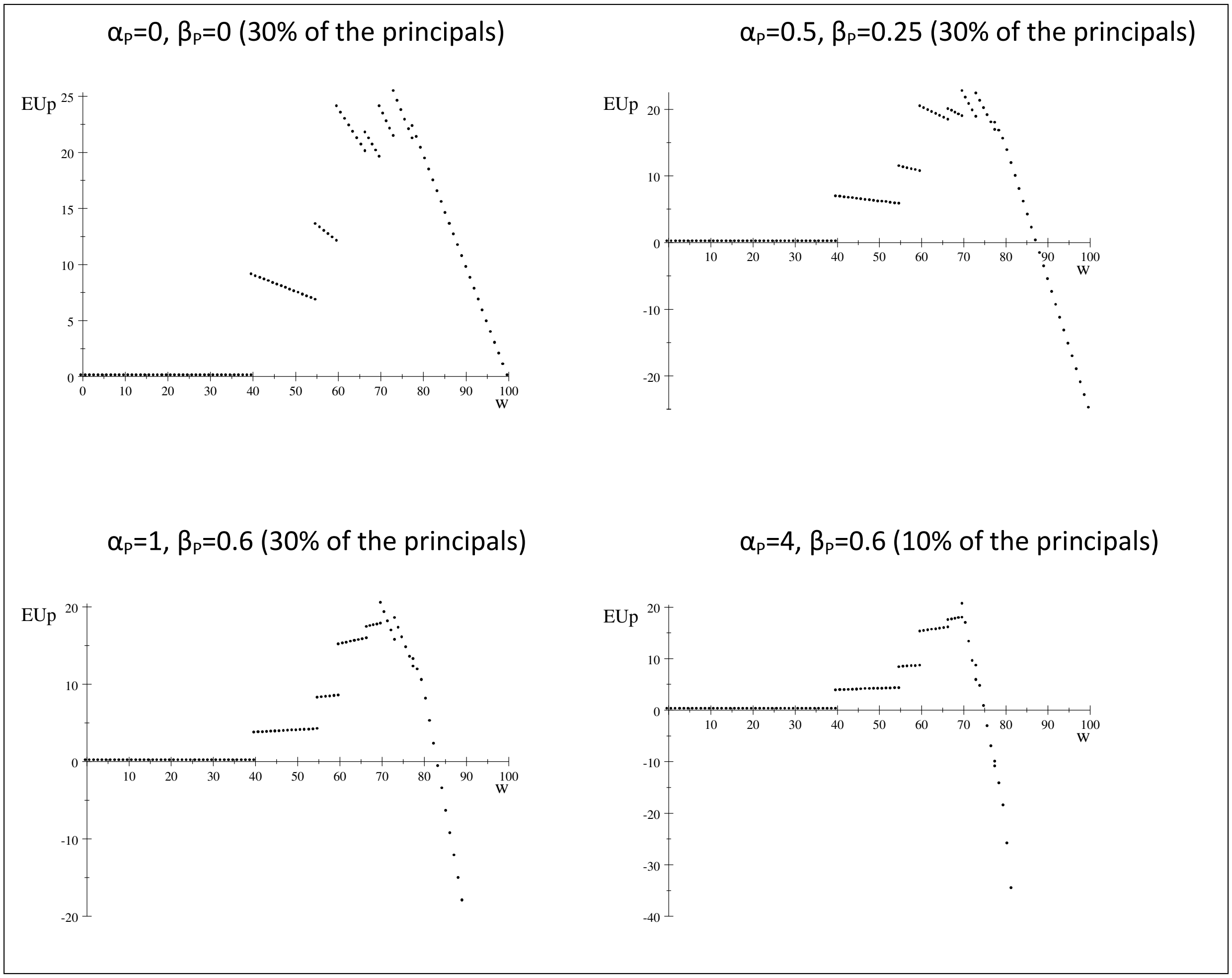

Figure S2. The principal's expected utility in the treatment AI 40-60.

	rel. freq.	AI 20-80	AI 40-60
$\alpha_P = 0,\ \beta_P = 0$	30%	47	74
$\alpha_P = 0.5,\ \beta_P = 0.25$	30%	56	70
$\alpha_P = 1,\ \beta_P = 0.6$	30%	60	70
$\alpha_P = 4,\ \beta_P = 0.6$	10%	60	70

Table S2. The principal's utility-maximizing wage offers in the AI treatments.

In the IG treatments, the agent's expected utility EU_A is given by 0 if he rejects without information gathering, by

$$0.5(w - c_l - \alpha_A \max\{100 + c_l - 2w, 0\} - \beta_A \max\{2w - 100 - c_l, 0\})$$
$$+0.5(w - c_h - \alpha_A \max\{100 + c_h - 2w, 0\} - \beta_A \max\{2w - 100 - c_h, 0\})$$

if he accepts without information gathering, and by

$$0.5(w - c_l - \gamma - \alpha_A \max\{100 + c_l + \gamma - 2w, 0\}$$
$$-\beta_A \max\{2w - 100 - c_l - \gamma, 0\}) + 0.5(-\gamma - \alpha_A \gamma)$$

if he gathers information and subsequently accepts whenever his type is low.[2]

From the principal's point of view, let $g(w)$ denote the probability that the agent gathers information and let $z(w)$ denote the probability that he accepts the offer without information gathering. Then the principal's expected utility EU_P is given by

$$g(w)[0.5(100 - w - \alpha_P \max\{2w - 100 - c_l - \gamma, 0\}$$
$$-\beta_P \max\{100 + c_l + \gamma - 2w, 0\}) - 0.5\beta_P \gamma]$$
$$+z(w)[0.5(100 - w - \alpha_P \max\{2w - 100 - c_l, 0\}$$
$$-\beta_P \max\{100 + c_l - 2w, 0\}) + 0.5(100 - w - \alpha_P \max\{2w - 100 - c_h, 0\}$$
$$-\beta_P \max\{100 + c_h - 2w, 0\})].$$

In the IG 20-80 treatment, inspection of Figure S3 shows that

$$g(w) = \begin{cases} 0 & if \quad 0 \leq w < 32 \\ 0.3 & if \quad 32 \leq w < 49 \\ 0.6 & if \quad 49 \leq w < 55 \\ 0.9 & if \quad 55 \leq w < 63 \\ 1 & if \quad 63 \leq w < 68 \\ 0.7 & if \quad 68 \leq w < 79 \\ 0.4 & if \quad 79 \leq w < 82 \\ 0.1 & if \quad 82 \leq w < 86 \\ 0 & if \quad 86 \leq w \leq 100 \end{cases}$$

[2] It is straightforward to show that when the agent has gathered information, he will never accept if his production costs are high and he will never reject if his production costs are low.

$$\text{and } z(w) = \begin{cases} 0 & if \quad 0 \le w < 68 \\ 0.3 & if \quad 68 \le w < 79 \\ 0.6 & if \quad 79 \le w < 82 \\ 0.9 & if \quad 82 \le w < 86 \\ 1 & if \quad 86 \le w \le 100. \end{cases}$$

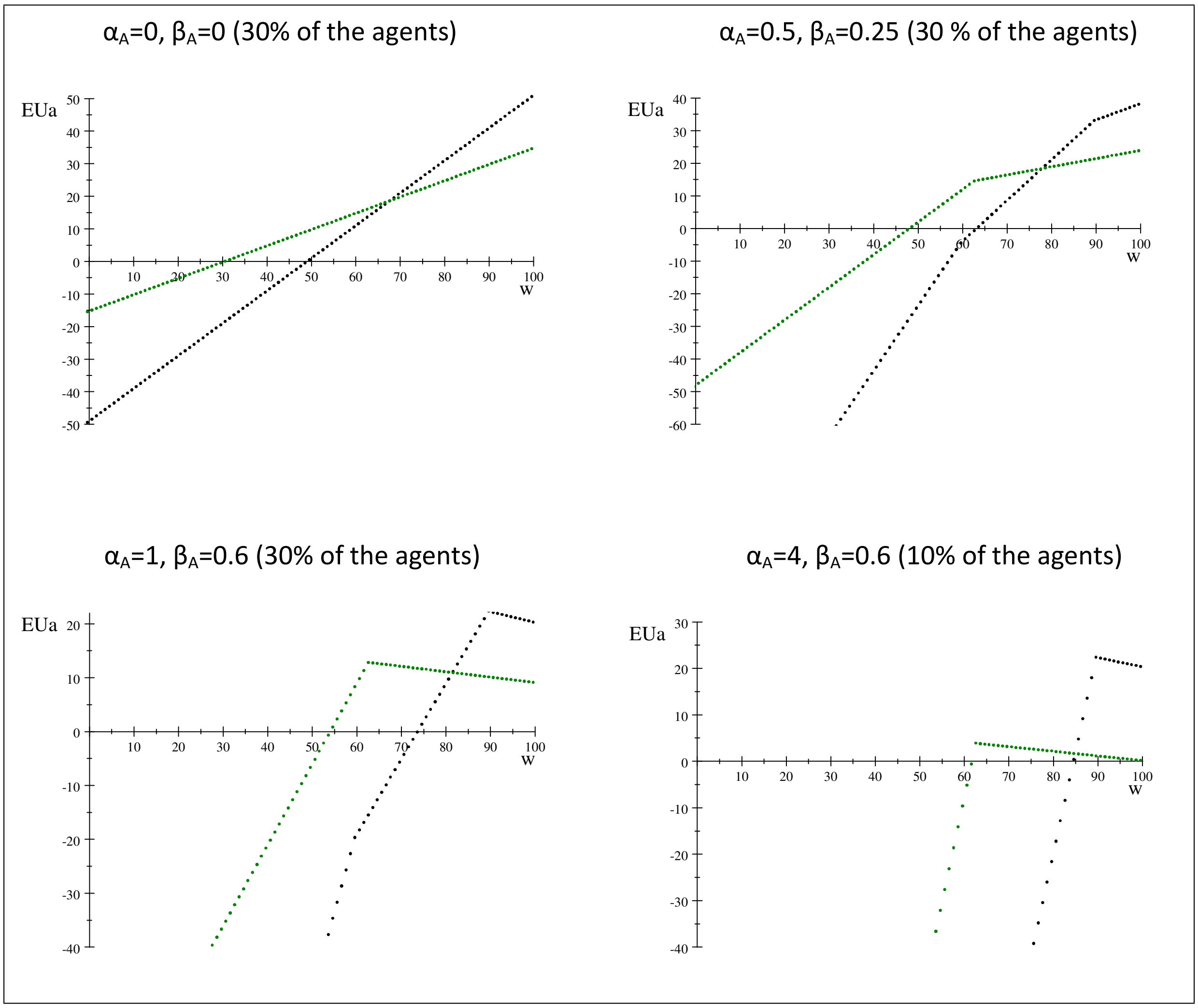

Figure S3. The agent's expected utility in the IG 20-80 treatment. The green dots show the case in which the agent gathers information (and then accepts whenever his costs are low), while the black dots show the case in which the agent accepts the offer without gathering information.

Thus, in the IG 20-80 treatment the principal's expected utility as a function of her wage offer is as depicted in Figure S4.

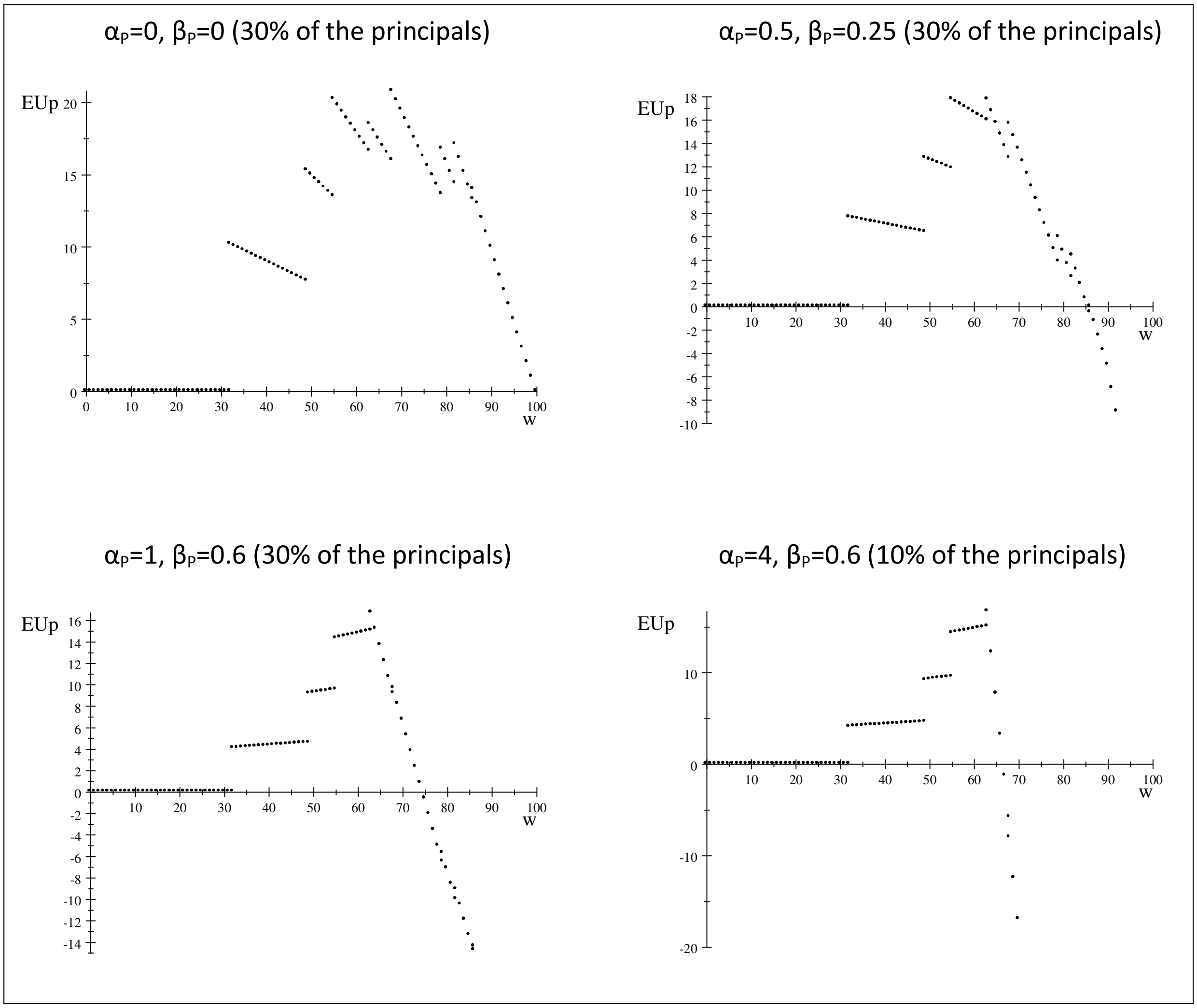

Figure S4. The principal's expected utility in the IG 20-80 treatment.

In the IG 40-60 treatment, Figure S5 shows that $g(w) = 0$ and

$$z(w) = \begin{cases} 0 & if \quad 0 \leq w < 50 \\ 0.3 & if \quad 50 \leq w < 63 \\ 0.6 & if \quad 63 \leq w < 67 \\ 0.9 & if \quad 67 \leq w < 75 \\ 1 & if \quad 75 \leq w \leq 100. \end{cases}$$

The principal's expected utility in the IG 40-60 treatment is shown in Figure S6. Thus, as can be seen in Figures S4 and S6, the principal's utility-maximizing wage offers in the IG treatments are as given in Table S3. Again, the numbers in Table 3 in the paper follow immediately.

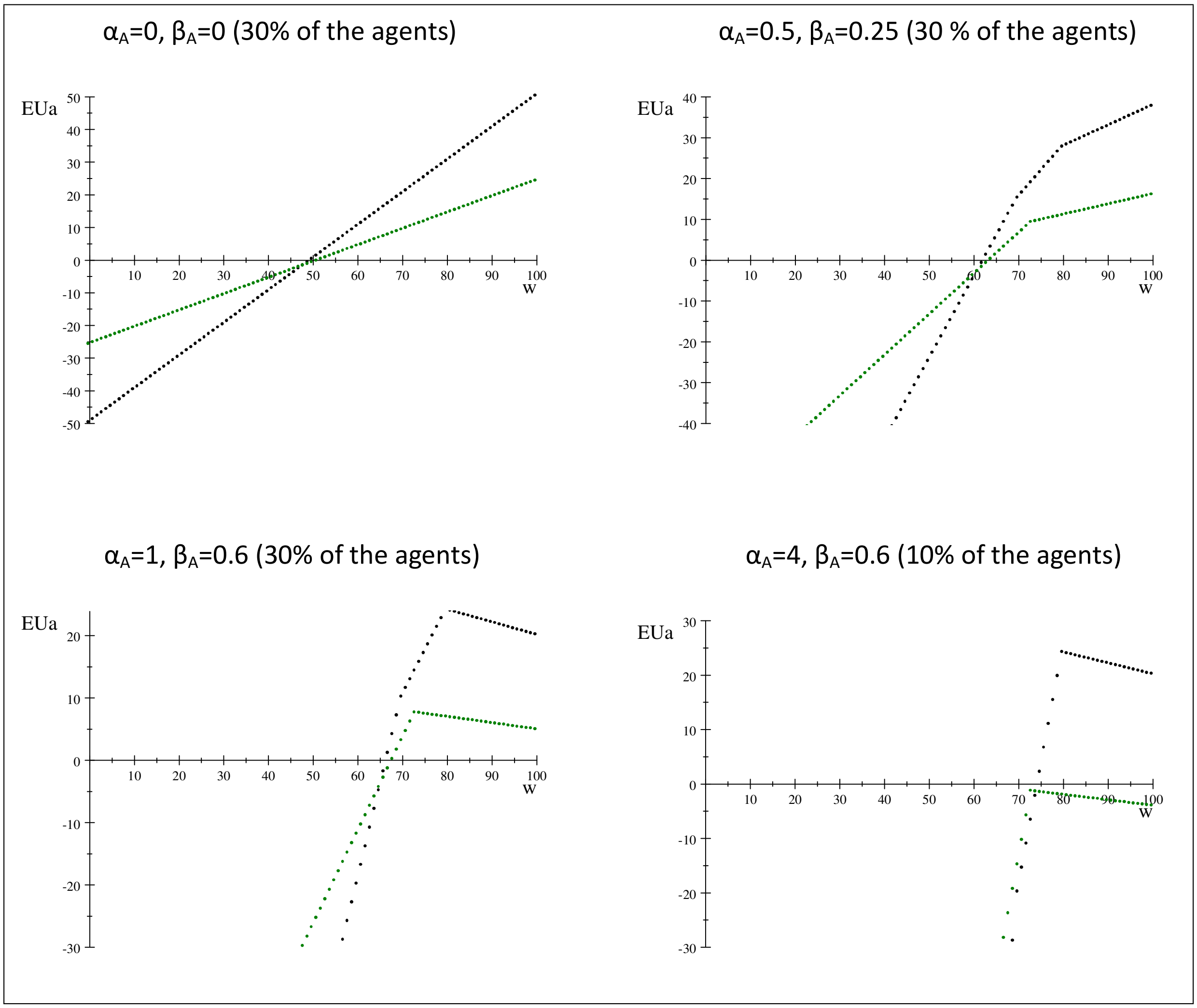

Figure S5. The agent's expected utility in the IG 40-60 treatment. The green dots show the case in which the agent gathers information (and then accepts whenever his costs are low), while the black dots show the case in which the agent accepts the offer without gathering information.

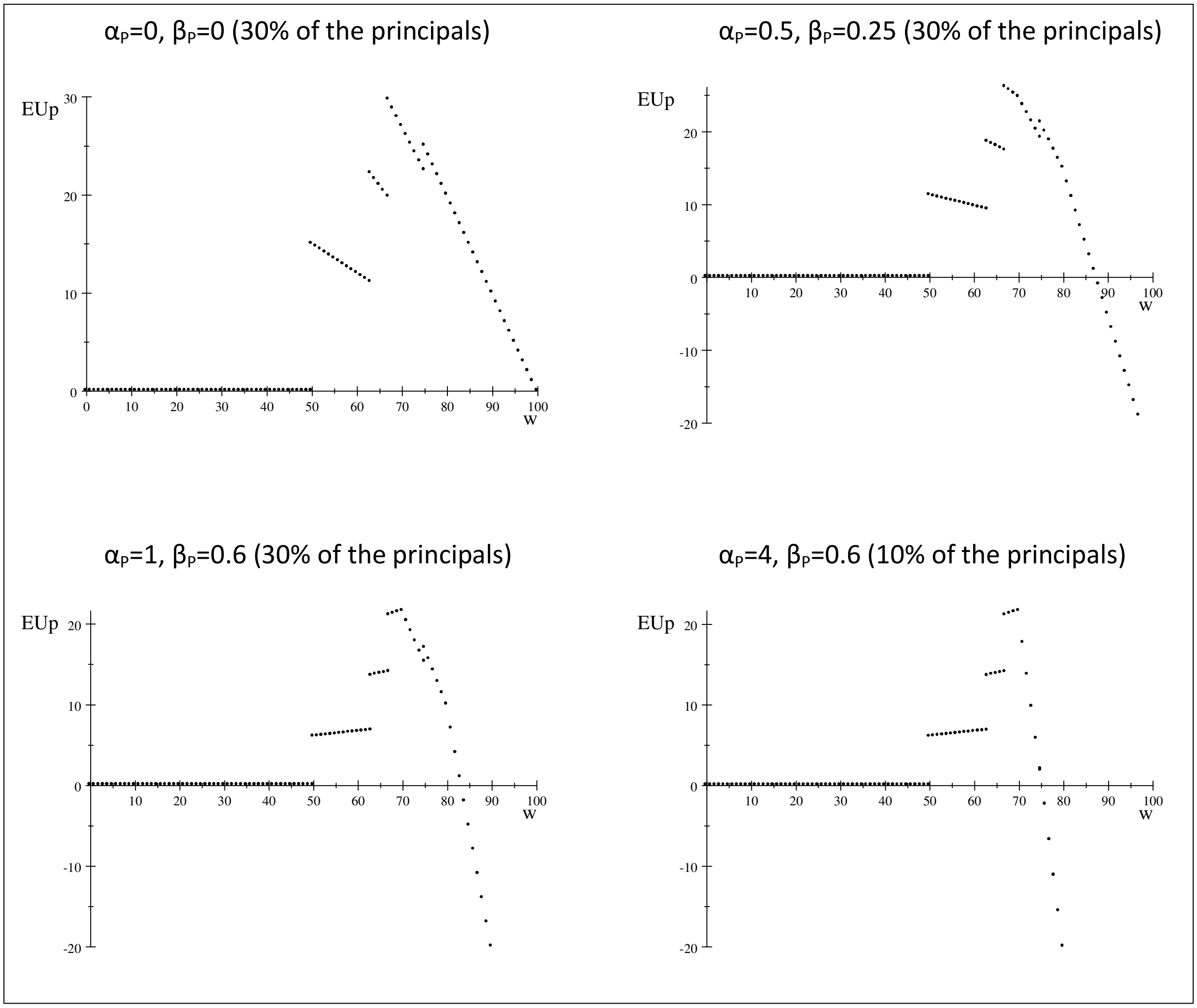

Figure S6. The principal's expected utility in the IG 40-60 treatment.

	rel. freq.	IG 20-80	IG 40-60
$\alpha_P = 0,\ \beta_P = 0$	30%	68	67
$\alpha_P = 0.5,\ \beta_P = 0.25$	30%	55	67
$\alpha_P = 1,\ \beta_P = 0.6$	30%	63	70
$\alpha_P = 4,\ \beta_P = 0.6$	10%	63	70

Table S3. The principal's utility-maximizing wage offers in the IG treatments.

Instructions for the AI 20-80 treatment

Experimental Instructions

In this experiment there is always one principal (employer) who interacts with one agent (employee).

At first you see on the screen whether you have been randomly assigned to the role of a principal or to the role of an agent.

The experiment consists of 15 rounds.

You will keep your role (principal or agent) for all 15 rounds.

At the beginning of each round, it is randomly determined which principal interacts with which agent in this round.

The currency in the experiment is called ECU (Experimental Currency Unit).
Your initial endowment is 250 ECU.
Throughout the whole experiment your current balance is displayed on your screen.

Each round consists of two stages:

Stage 1:
The principal can make a wage offer w to the agent.
(The wage has to be an integer between 0 ECU and 100 ECU.)

If the agent accepts the wage offer in stage 2, the principal obtains a return of 100 ECU and the agent incurs costs c.

The principal only knows that the agent's costs c are either c = 20 ECU or c = 80 ECU with equal probability.

Stage 2:
The agent learns the principal's wage offer and his costs c (in each round each agent's costs which are with equal probability either c = 20 ECU or c = 80 ECU are randomly drawn anew).

Then the agent can decide whether to accept or reject the wage offer.

The profits in this round are as follows:

If the agent accepts the wage offer:
Principal's profit: 100 ECU - w
Agent's profit: w - c

If the agent rejects the wage offer:
Principal's profit: 0 ECU
Agent's profit: 0 ECU

Your payoff:
After the last round your final balance will be paid out to you in cash (30 ECU = 1 Euro).

Instructions for the AI 40-60 treatment

The instructions for the AI 40-60 treatment were identical to those of the AI 20-80 treatment, except that throughout c = 20 ECU was replaced by c = 40 ECU and c = 80 ECU was replaced by c = 60 ECU.

Instructions for the IG 20-80 treatment

Experimental Instructions

In this experiment there is always one principal (employer) who interacts with one agent (employee).

At first you see on the screen whether you have been randomly assigned to the role of a principal or to the role of an agent.

The experiment consists of 15 rounds.

You will keep your role (principal or agent) for all 15 rounds.

At the beginning of each round, it is randomly determined which principal interacts with which agent in this round.

The currency in the experiment is called ECU (Experimental Currency Unit).
Your initial endowment is 250 ECU.
Throughout the whole experiment your current balance is displayed on your screen.

Each round consists of two stages:

Stage 1:
The principal can make a wage offer w to the agent.
(The wage has to be an integer between 0 ECU and 100 ECU.)

If the agent accepts the wage offer in stage 2, the principal obtains a return of 100 ECU and the agent incurs costs c.

At this stage both parties only know that the agent's costs c are either c = 20 ECU or c = 80 ECU with equal probability (in each round each agent's costs which are with equal probability either c = 20 ECU or c = 80 ECU are randomly drawn anew).

Stage 2:
The agent learns the principal's wage offer.

Before accepting or rejecting the principal's wage offer, the agent can decide if he wants to gather information to learn the exact level of his costs c. Information gathering means that the agent has to incur additional costs of 6 ECU.

- If the agent does not gather information, the profits in this round are as follows:

  If the agent accepts the wage offer:
  Principal's profit: 100 ECU - w
  Agent's profit: w - c

  If the agent rejects the wage offer:
  Principal's profit: 0 ECU
  Agent's profit: 0 ECU

  Observe that in this case the agent does not yet know the actual level of his costs c when he decides whether to accept or reject the wage offer.

- If the agent gathers information, the profits are as follows:

  If the agent accepts the wage offer:
  Principal's profit: 100 ECU - w
  Agent's profit: w - c - 6 ECU

  If the agent rejects the wage offer:
  Principal's profit: 0 ECU
  Agent's profit: -6 ECU

  Observe that in this case the agent knows whether his costs are c = 20 ECU or c = 80 ECU when he decides whether to accept or reject the wage offer.

Your payoff:
After the last round your final balance will be paid out to you in cash (30 ECU = 1 Euro).

Instructions for the IG 40-60 treatment

The instructions for the IG 40-60 treatment were identical to those of the IG 20-80 treatment, except that throughout c = 20 ECU was replaced by c = 40 ECU and c = 80 ECU was replaced by c = 60 ECU.

<u>Instructions for the SI 20-80 treatment</u>

Experimental Instructions

In this experiment there is always one principal (employer) who interacts with one agent (employee).

At first you see on the screen whether you have been randomly assigned to the role of a principal or to the role of an agent.

The experiment consists of 15 rounds.

You will keep your role (principal or agent) for all 15 rounds.

At the beginning of each round, it is randomly determined which principal interacts with which agent in this round.

The currency in the experiment is called ECU (Experimental Currency Unit).
Your initial endowment is 250 ECU.
Throughout the whole experiment your current balance is displayed on your screen.

Each round consists of two stages:

Stage 1:
The principal can make a wage offer w to the agent.
(The wage has to be an integer between 0 ECU and 100 ECU.)

If the agent accepts the wage offer in stage 2, the principal obtains a return of 100 ECU and the agent incurs costs c. Both the principal and the agent know the agent's costs c (in each round each agent's costs which are with equal probability either c = 20 ECU or c = 80 ECU are randomly drawn anew).

Stage 2:
The agent learns the principal's wage offer.

Then the agent can decide whether to accept or reject the wage offer.

The profits in this round are as follows:

If the agent accepts the wage offer:
Principal's profit: 100 ECU - w
Agent's profit: w - c

If the agent rejects the wage offer:
Principal's profit: 0 ECU
Agent's profit: 0 ECU

Your payoff:
After the last round your final balance will be paid out to you in cash (30 ECU = 1 Euro).

<u>Instructions for the SI 40-60 treatment</u>

The instructions for the SI 40-60 treatment were identical to those of the SI 20-80 treatment, except that throughout c = 20 ECU was replaced by c = 40 ECU and c = 80 ECU was replaced by c = 60 ECU.

Instructions for the AIC 20-80 treatment

Experimental Instructions

In this experiment every participant is assigned to the role of a principal (employer). You do not interact with any other participant of the experiment. Instead you interact only with a computer that simulates the behaviour of an agent (employee).

The experiment consists of 15 rounds.

The currency in the experiment is called ECU (Experimental Currency Unit).
Your initial endowment is 250 ECU.
Throughout the whole experiment your current balance is displayed on your screen.

Each round proceeds as follows:

You make a wage offer w.
(The wage has to be an integer between 0 ECU and 100 ECU.)

If the computer accepts the wage offer, your profit is: 100 ECU - w
If the computer rejects the wage offer, your profit is: 0 ECU

The computer simulates the behaviour of real experimental participants in the role of an agent in an earlier experiment. In this experiment half of the agents had to incur costs c = 20 ECU if they decided to accept the offer. The other half of the agents had to incur costs c = 80 ECU if they decided to accept the offer. In case of accepting the offer an agent's profit was w – c, while an agent's profit was 0 ECU in case of rejecting the offer.

When you make your wage offer you only know that the computer simulates with equal probability either the behaviour of an agent with costs c = 20 ECU or the behaviour of an agent with costs c=80 ECU. In other words, the computer accepts a certain wage offer with the probability with which this offer was accepted on average by real agents with respective costs in the earlier experiment.

In each round it is randomly determined anew whether the computer simulates the behaviour of an agent with costs c = 20 ECU or c = 80 ECU.

Your payoff:
After the last round your final balance will be paid out to you in cash (30 ECU = 1 Euro).

Instructions for the AIC 40-60 treatment

The instructions for the AIC 40-60 treatment were identical to those of the AIC 20-80 treatment, except that throughout c = 20 ECU was replaced by c = 40 ECU and c = 80 ECU was replaced by c = 60 ECU.

<u>Instructions for the IGC 20-80 treatment</u>

Experimental Instructions

In this experiment every participant is assigned to the role of an agent (employee). You do not interact with any other participant of the experiment. Instead you interact only with a computer.

The experiment consists of 15 rounds.

The currency in the experiment is called ECU (Experimental Currency Unit).
Your initial endowment is 250 ECU.
Throughout the whole experiment your current balance is displayed on your screen.

Each round proceeds as follows:

The computer makes a wage offer w.

If you accept the wage offer you have to incur costs c. At this stage you only know that your costs c are either c = 20 ECU or c = 80 ECU with equal probability.

Before accepting or rejecting the wage offer, you can decide if you want to gather information to learn the exact level of your costs c. Information gathering means that you have to incur additional costs of 6 ECU.

- If you do not gather information, your profit in this round is as follows:

  If you accept the wage offer: w - c

  If you reject the wage offer: 0 ECU

  Observe that in this case you do not yet know the actual level of your costs c when you decide whether to accept or reject the wage offer.

- If you gather information, your profit in this round is as follows:

  If you accept the wage offer: w - c - 6 ECU
  If you reject the wage offer: - 6 ECU

  Observe that in this case you know whether your costs are c = 20 ECU or c = 80 ECU when you decide whether to accept or reject the wage offer.

In each round your costs which are either c = 20 ECU or c = 80 ECU with equal probability are randomly determined anew.

Your payoff:
After the last round your final balance will be paid out to you in cash (30 ECU = 1 Euro).

Instructions for the IG18 20-80 treatment

The instructions were handed out to the subjects right after they had participated in the IG 20-80 treatment.

Experimental Instructions

The experiment again consists of 15 rounds.

You keep the role (principal or agent) you were assigned to in the previous experiment.

At the beginning of each round, it is again randomly determined which principal interacts with which agent in this round.

Your initial endowment again is 250 ECU (Experimental Currency Unit).
Throughout the whole experiment your current balance is displayed on your screen.

Each round consists of two stages:

Stage 1:
The principal can make a wage offer w to the agent.
(The wage has to be an integer between 0 ECU and 100 ECU.)

If the agent accepts the wage offer in stage 2, the principal obtains a return of 100 ECU and the agent incurs costs c.

At this stage both parties only know that the agent's costs c are either c = 20 ECU or c = 80 ECU with equal probability (in each round each agent's costs which are with equal probability either c = 20 ECU or c = 80 ECU are randomly drawn anew).

Stage 2:
The agent learns the principal's wage offer.

Before accepting or rejecting the principal's wage offer, the agent can decide if he wants to gather information to learn the exact level of his costs c. Information gathering means that the agent has to incur additional costs of 18 ECU.

- If the agent does not gather information, the profits in this round are as follows:

  If the agent accepts the wage offer:
  Principal's profit: 100 ECU - w
  Agent's profit: w - c

  If the agent rejects the wage offer:
  Principal's profit: 0 ECU
  Agent's profit: 0 ECU

  Observe that in this case the agent does not yet know the actual level of his costs c when he decides whether to accept or reject the wage offer.

- If the agent gathers information, the profits are as follows:

  If the agent accepts the wage offer:
  Principal's profit: 100 ECU - w
  Agent's profit: w - c - 18 ECU

If the agent rejects the wage offer:
Principal’s profit: 0 ECU
Agent’s profit: -18 ECU

Observe that in this case the agent knows whether his costs are c = 20 ECU or c = 80 ECU when he decides whether to accept or reject the wage offer.

Your payoff:
After the last round your final balance will be paid out to you in cash (30 ECU = 1 Euro).

Instructions for the IG18 40-60 treatment

The instructions for the IG18 40-60 treatment were identical to those of the IG18 20-80 treatment, except that throughout c = 20 ECU was replaced by c = 40 ECU and c = 80 ECU was replaced by c = 60 ECU.

Instructions for the IG0 20-80 treatment

The instructions were handed out to the subjects right after they had participated in the IG18 20-80 treatment.

Experimental Instructions

The experiment again consists of 15 rounds.

You keep the role (principal or agent) you were assigned to in the previous two experiments.

At the beginning of each round, it is again randomly determined which principal interacts with which agent in this round.

Your initial endowment again is 250 ECU.
Throughout the whole experiment your current balance is displayed on your screen.

Each round consists of two stages:

Stage 1:
The principal can make a wage offer w to the agent.
(The wage has to be an integer between 0 ECU and 100 ECU.)

If the agent accepts the wage offer in stage 2, the principal obtains a return of 100 ECU and the agent incurs costs c.

At this stage both parties only know that the agent's costs c are either c = 20 ECU or c = 80 ECU with equal probability (in each round each agent's costs which are with equal probability either c = 20 ECU or c = 80 ECU are randomly drawn anew).

Stage 2:
The agent learns the principal's wage offer.

Before accepting or rejecting the principal's wage offer, the agent can decide if he wants to gather information to learn the exact level of his costs c. Information gathering is costless for the agent.

The profits in this round are as follows:

If the agent accepts the wage offer:
Principal's profit: 100 ECU - w
Agent's profit: w - c

If the agent rejects the wage offer:
Principal's profit: 0 ECU
Agent's profit: 0 ECU

Please note: If the agent does not gather information, he does not know the actual level of his costs c when he decides whether to accept or reject the wage offer.
If the agent gathers information, then the agent knows whether his costs are c = 20 ECU or c = 80 ECU when he decides whether to accept or reject the wage offer.

Your payoff:
After the last round your final balance will be paid out to you in cash (30 ECU = 1 Euro).

Instructions for the IG0 40-60 treatment

The instructions for the IG0 40-60 treatment were identical to those of the IG0 20-80 treatment, except that throughout c = 20 ECU was replaced by c = 40 ECU and c = 80 ECU was replaced by c = 60 ECU.

Furthermore, at the end of all instructions, the following information was provided:

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.