Ultimatum Offers and the Role of Transparency: An Experimental Study of Information Acquisition

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This paper analyses individual information acquisition in an ultimatum game with a-priori unknown outside options. We find that while individual play seems to accord reasonably well with the distribution of empirical behavior, contestants seem to grossly overweigh the value of information. While information acquisition seems to be excessive in all of our scenarios we identify a significant difference in behavior related to market transparency. In transparent markets, when respondents can observe whether bidders have acquired information, acceptance rates are higher. Accordingly, information is more valuable in transparent markets, both individually and socially.

1. INTRODUCTION

How does information affect individual strategic decisions? How do individuals assess the role of information and how do they exploit it? Do individuals tend to exploit informational advantages or do they act according to fairness norms that do not (necessarily) rely on information? Do they purchase the right amount of information, or do they invest excessively or insufficiently in relevant information? Does it matter whether other players observe whether information is acquired or not?

The answers to those questions are particularly important to assess the performance of markets where informational asymmetries may be viewed as constituting properties such as financial markets. Is a venture financier likely to overinvest or underinvest in information before striking a financing deal?[1] Do banks invest efficiently into screening credit applications?[2] Do investors and fund managers engage in the efficient amount of information acquisition prior to buying stocks? If they behave inefficiently, how will the cost of information acquisition affect the degree of inefficiency? Do cost reductions ultimately improve investment or purchase decisions?

Naturally the answer will depend on how information is used by individual decision makers. This complicates the economic analysis of these issues since typically optimal (or rational) behavior does depend very sensitively on the economic environment and the equilibrium concept used.[3] Moreover, the required degree of rationality assumes an almost unrealistically high degree of complexity of individual behavior. Therefore, it is important to understand well the motivations of individual agents in strategic situations as well as the variables on which they tend to condition their decisions.

While the literature largely concentrates on the strategic motivations of agents with pre-specified information, in this paper we want to understand how individual agents acquire information and how they use this information. Our analysis is cast in the most basic setting of strategic interaction. We consider a variant of the well-known ultimatum game[4] with conflict payoffs only known to the responder. Another novelty is that the proposer may choose to purchase information about the responder's type prior to his take it or leave it-offer. Rational choice allows to determine straightforward solutions to this simple game. Moreover the value of information can be easily computed as a function of agents' risk characteristics.

In our class-room experiments participants decide about information acquisition before playing the resulting ultimatum with (non-) informed proposers. Contrasting the predictions of rational choice models with experimental behavior reveals that the value of information is grossly overstated by a vast majority of respondents. This is true both in terms of Nash equilibrium values of information as well as for players who would anticipate the empirical distributions of respondents.

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[1] see, e.g., Gehrig, Stenbacka (2002)

[2] see, e.g., Gehrig (1998)

[3] For example, when equilibrium prices are sufficient statistics of information variables only observed by a few privileged traders (insiders), sophisticated but uninformed agents could condition their behavior on equilibrium prices. In such a situation the information of few insiders will be completely revealed to uninformed agents (Radner, 1972). In this world incentives to acquire information are nil. This framework corresponds to a complete markets setting. As soon as another dimension of economic uncertainty (noise) is added to the economic framework (incomplete markets), prices will no longer be sufficient statistics and private information is only partially revealed. In that world incentives to acquire information are strictly positive.

[4] Although previous experiments of ultimatum games with incomplete information had proposers (and not responders as in our study) better informed, the idea is not to perform another ultimatum experiment but to shed light in the basic research questions discussed above. The ultimatum game is only our workhorse in that it is easily understood by participants and simple enough to assume that participants can concentrate on whether to acquire and, if so, how to use structural information.

We highlight this point, since observed behavior does not support equilibrium behavior – only about a quarter of respondents behave that way. Instead we find that on average observed behavior performed remarkably well against the empirical distribution of play within the population of respondents. Observed behavior certainly seems smart in this sense. Hence, in our setting we observe extremely high, and thus excessive investment in private information, both in terms of the equilibrium-benchmark as well as relative to the actually observed characteristics.

Surprisingly, we also find that the inefficiencies are enhanced, when agents cannot observe whether their counterpart has acquired information. Transparency about the informational endowment of the counterpart seems to affect individual payoffs more than information privately acquired by the respondents.[5]

This finding is independent of the actual value of the respondent's conflict payoffs. In particular, even, when the outside opportunity is less than an equal split of the surplus and when individuals could split the surplus without any informational investments only 20 percent of our subjects would select the fair and cost efficient solution. Overall, we find very little evidence for fairness concerns in our population of participants.[6] Given the dominance of the rational choice solution among our participants the excessive investment result is all the more surprising.

Our analysis proceeds as follows. Section 2 provides the details of the experimental set-up. Section 3 discusses the results on bidding behavior and section 4 on information acquisition. Section 5 concludes.

2. THE EXPERIMENTAL FRAMEWORK

Our analysis concentrates on the most basic negotiation procedure in order to distil most visibly the crucial behavioral determinants. Specifically, we consider an ultimatum game with proposer X and responder Y , who may share a common surplus of 10 units. The proposer offers y units, which Y can accept or reject (y is an integer with $1 \leq y \leq 9$). In either case the game ends. If the responder accepts, the agents will earn the respective payoffs $(x, y) = (10 - y, y)$ corresponding to X's proposal. If the responder rejects the proposal the agents will earn their conflict payoffs (c_x, c_y) . We assume that c_x is cuommonly known. However, c_y is known only to Y . For simplicity $c_y \in \{\underline{c}, \bar{c}\}$ can assume only two values. In the experiment we distinguish different values of $\bar{c}$. Some treatments have $\bar{c} = 3$, while others have $\bar{c} = 6$, while $c_x = 2$ and $\underline{c} = 0$ are constant over treatments. We implement the case, in which the higher conflict payoff for Y is *a priori* twice as likely as the low conflict payoff of 0. Since X does not know Y's conflict payoff she may choose to purchase precise information about this conflict payoff.

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[5] Ambiguity aversion (see Ellsberg, 1988 and Weber,...) for instance, suggests that transparency improves the willingness to invest.

[6] Our more general conjecture which is partly based on experimental findings (e.g., from the fair-division game-experiments of Güth at al., 2002) is that privately known payoffs render equity theory (see originally Homans, 1961) not applicable since its information prerequisites are not granted.

So X can decide whether she wants to be perfectly informed about Y's outside option at some price or whether she prefers to bear uncertainty. More specifically, X-participants are asked to choose their willingness to pay for information. Since the actual price in case of trade is randomly determined, it is the only undominated strategy to bid one's true value for information (Becker, de Groot...) We do not allow for intermediate cases such as different qualities of information for example.

Another treatment aspect is whether X's decision on information acquisition is revealed to Y (strategic information acquisition) or not (secret information acquisition). (Not) Knowing c_y proposer X determines her offer, which Y can accept or reject.

In order to economize on participants we apply the strategy method, i.e.

- X must choose an offer for all possible states in addition to deciding whether to buy information, and
- Y has to select between acceptance and rejection for all possible offers and all cases of what he knows about what X knows and both levels of c_y .

To also assess the effect of experience the experiment is repeated once with new partners but by pertaining one's role X or Y . Technically, four participants (two $X-$ and two $Y-$ participants) formed a matching group which qualifies as an independent observation in the repetition. The English translation of the instructions can be found in appendix. The participants were recruited when attending the Microeconomics course during their first semester studies at the University of Freiburg.

The game theoretic solution is based on commonly known opportunism (maximization of own payoff expectation) of both players. Assuming that responder Y accepts in case of indifference[7] the optimal responder strategy of Y is to accept all offers y of at least c_y . Thus if X is aware of c_y he should offer $y^*(c_y) = c_y$. Otherwise there are two candidates for the optimal offer y^* : the minimal offer 1 or $\bar{c}$. Since $\bar{c}$ is twice as likely as $\underline{c}$ the candidate for y^* is $y^* = \bar{c}$ (resp. 1) is $10 - \bar{c} \gtrless \frac{1}{3}(10-1) + \frac{2}{3}c_x$ (or $7 \gtrless \bar{c} + \frac{2}{3}c_x$) according to our parameter specification. Thus one has $y^* = 3$ for $\bar{c} = 3$ and $y^* = 1$ for $\bar{c} = 6$. Finally in case of $\bar{c} = 3$ information acquisition increases X's payoff from bargaining by

$$10 - \frac{2}{3}\bar{c} - \frac{1}{3} - 7 = \frac{2}{3} \tag{1}$$

whereas the incentive to inform about c_y is

$$10 - \frac{2}{3}\bar{c} - \frac{1}{3} - \frac{13}{3} = \frac{4}{3} \tag{2}$$

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[7] The benchmark solution when Y rejects in case of indifference can be derived analogously (see the next footnote)

TABLE 1.

Y behaviour in the case of Minimal Transparency

Behaviour of Y	Outside Option 3		Outside Option 6	
	Good	Bad	Good	Bad
1	1	**16**	0	**21**
2	0	5	0	1
3	**3**	10	0	12
4	**19**	3	1	15
5	11	4	5	9
6	5	1	**19**	2
7	2	0	**35**	1
8	0	0	1	0
9	0	0	0	1

in case of $\bar{c} = 6$, what, of course, assumes risk neutrality.[8]

3. DESCRIPTION OF STRATEGIES

Let us start with an analysis of individual play in the various scenarios. We will begin with the case when Y does not observe potential information acquisition by X (section 3.1). We will interpret this case as implementing an information barrier between players. In this case transparency is minimal. We will then consider the case, when Y can observe whether X has acquired information in section 3.2.

3.1. Minimal Transparency

Population of Y *Players.* When Y cannot observe the information acquisition of X , under rational play her decision should only depend on her outside option. Table 1 presents the empirical distribution of behavior of Y-participants in our experiment ("Good" represents the outside option $\bar{c}$ with $\bar{c} = 3$ or $\bar{c} = 6$ while "Bad" represents the zero payoff $\underline{c} = 0$).

The economic agent, *homo oeconomicus,* is indifferent between the offer that is identical to her outside option and she prefers any better offer. So, the rational agent Y would accept any offer that is not lower than her outside option. Formally, the set of Y acceptance threshold is $\{c_y, c_y + 1\}$. Does the observed behavior accord to the theory of rational play?

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[8] If the responder rejects in case of indifference X's information incentive is 1 for $\bar{c} = 3$ and $\frac{2}{3}$ for $\bar{c} = 6$.

We can find in our sample a systematic deviation from optimal responses.[9] More precisely, the "willingness" to play optimally increases with the outside option. More than 85% of players play "accept" 6 or "accept" 7 in the case of outside option 6. This share is significantly[10] higher than 53% in the case of outside option 3. The success rate falls to approx. 43% and 36% for the two cases of zero outside options.

Which other strategies can we observe? We do not see much support for accepting no less than the "fair" solution (5,5). About 25% of Y-participants ask for half the pie in the first column, and almost 15% of this type of agents in the last column. On the other hand, the relatively high share of players playing 3 and 4 in the last column of Table 1 could be explained by another concept of fairness that is probably employed by the agents – they ask for the fair (i.e., equal) division of the gain (dividend, surplus) that arises by cooperation (as suggested by the Nash (1950, 1953) bargaining solution which suggest for $\underline{c} = 0$, for instance, $y = \frac{10+c_y-c_x}{2}$).

This observation corresponds to our intuition as well as to the literature. The population of players is composed of heterogeneous types of players, i.e., it is composed of opportunistic agents, of agents that try to enforce a fair distribution and, possibly, of a small share of outliers that just randomize over strategies (due to non-understanding or non-serious deliberation). For outside option 3 the Nash-bargaining ($y = \frac{11}{2}$) and fifty-fifty types almost coincide. For outside option 6, where Nash-bargaining suggest 7, these strategies even coincide with the rational strategy.

Population of Non-informed X Players. While the prediction of rational play is straightforward, the behavioral heterogeneity of Y's population described above, if rationally anticipated, generates a non-trivial decision problem for X . Table 2 presents the expected payoffs of particular strategies of X against the given Y population and the number of uninformed X that actually played this strategy (the second moments are presented in Table 14).

We can see here that even the heterogeneous population of Y's provides no strong incentives for X to deviate from equilibrium strategies (see similar or closely related finding of Harrison and McCabe (1996), and Güth et al.). In the case of outside option 3 the best offer is 4. In the case of outside option 6 basically all offers by X (smaller than 8) yield a similar expected payoff.

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[9] We denote in bold type the optimal behavior in all the tables throughout the paper.

[10] The following methodology is used. In the sample of z_3-choices (z_3 equals to one for the acceptance threshold 3 or 4 and to zero otherwise in case of $\bar{c} = 0$) we observe 22 successes in 41 trials, so z_3 has binomial distribution $b(41, \frac{22}{41})$. Correspondingly, z_6 is $b(61, \frac{54}{61})$. Considering the fact that z_i has approximate normal distribution the standard test concerning the equality of means can be employed. The zero hypothesis $\mu_3 = \mu_6$ can be rejected even at 0.01% significance level.

TABLE 2.

Strategies of non-informed X, Inf. Barrier

	Outside Option 3				Outside Option 6			
Strategy of X	Bad	Good	Eπ_x	# X	Bad	Good	Eπ_x	# X
1	**4,87**	2,17	3,07	2	**4,37**	2,00	**2,79**	**5**
2	5,23	2,15	3,17	5	4,13	2,00	2,71	3
3	5,97	**2,49**	**3,65**	**8**	4,74	2,00	2,91	13
4	5,49	**4,24**	**4,66**	**17**	5,16	2,07	3,10	19
5	4,92	4,49	4,63	9	4,81	2,30	3,13	9
6	4,00	3,90	3,93	2	3,94	**2,82**	3,19	5
7	3,00	3,00	3,00	0	2,98	**2,98**	2,98	6
8	2,00	2,00	2,00	0	2,00	2,00	2,00	0
9	1,00	1,00	1,00	0	1,00	1,00	1,00	0

Also, we can see empirically that there is a really small range to use the information. In the case of outside option 3 the largest expected profit of 4.66 is generated by an offer of 4. With the information about Y's outside option in hand X should slightly change her strategy and play 3 (yielding the maximal payoff 5.97 in that column) knowing that the outside option of Y is bad, resp. 5 (yielding maximum of 4.49 in that column) if she receives the information that Y's outside option is 3 . So, her value of the game is $\frac{1}{3}5.97+\frac{2}{3}4.49=4.98$. Considering this rational expectation-approach we can estimate the empirical value of the information for the given population as the difference of the expected payoffs in both cases being 0.32 .

Using the same analysis for the case of outside option 6 we can see that in this case the best strategy 6 yields 3.19 . With the information about Y's outside option the optimal strategy for X is either 4 or 7 yielding the expected profit 3.71=$\frac{1}{3}5.16+\frac{2}{3}2.98$. Consequently, in this case the empirical value of information is about 0.52.

Another estimation of the value of information could be obtained by simply comparing the average earnings of the non-informed and informed X's populations. The resulting difference[11] will not reflect the possibility of information gain, but the actual difference between the profit expectations of non-informed and informed X's. Our intuition is that the actual profit difference should be smaller than the one estimated above since the successful employment of the information require much more detailed prior beliefs about Y's population.

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[11] The actual earning difference of (non)informed X-participants is influenced by the random matching of X and Y participants which we ruled out by comparing the payoff expectations based on rational anticipation of Y-responders.

TABLE 3.

Strategies of Informed vs. Non-informed X (case 3)

	No Info vs. Bad (case 3)									No Info vs. Good (case 3)								
X	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
1	1	1									1	1						
2	4				1						1	2	2					
3	**5**	2		1							1	**2**	**5**					
4	**9**	3	3		1			1			1	**4**	**7**	4	1			
5	2	1	3	1	1				1				3	4	2			
6			1	1										1			1	
7																		
8																		
9																		
$\sum$	21	7	7	3	3	0	0	1	1	0	4	9	17	9	3	0	1	0

Population of Informed X *Players.* The X's behavioral patterns are nicely described by (Cross)Table 3. The columns present the strategies for the cases of being (un)informed, the rows describe behaviour in case of no information.[12] The table for the outside option 6 is presented in the appendix. Again, equilibrium-behavior can be attested only for a smaller portion of the population. Furthermore, absolute fairness concerns do seem to play a minor role.

3.2. Full Transparency

Let us now consider the case of full transparency. This is the case when information is acquired and respondents observe that information has been acquired.

Y *Population.* Now Y's choice depends not only on her own outside option, but also on the type of the opponent (informed vs. non-informed) she is facing. The empirical population of Y's is described by Table 4.

First, the heterogeneity of Y's population remains quite similar like in the case of the information barrier. Considering the bad outside option in the case of $\bar{c} = 3$, we can see the two separate clusters of agents: rational type of players that play 1, and the "fair" types playing 3 or 4. In the case of the good outside options the strategies of both types of agents coincide.

The number of Y's optimal behaviour increases with the outside option. Analysing the behaviour against noninformed (informed) X-players we observed 21

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[12] Due to the strategy method X-participants can be classified by their behaviour for all three cases, namely of being uninformed and when knowing that c_y is "Bad" (left part of Table 3) or "Good" (right part of Table 3).

TABLE 4.

Y behaviour in the case of Full transparency

Strategy	Outside Option 3				Outside Option 6			
	No Info		Info		No Info		Info	
	Good	Bad	Good	Bad	Good	Bad	Good	Bad
1	3	**13**	2	**24**	2	**13**	0	**30**
2	0	0	0	3	0	0	1	9
3	**3**	9	**2**	5	0	8	0	15
4	**18**	9	**26**	3	2	18	2	4
5	9	5	6	3	4	14	5	3
6	2	2	2	2	**14**	5	**13**	0
7	5	1	2	0	**34**	3	**36**	0
8	1	0	1	0	4	1	5	1
9	0	0	0	0	2	0	0	0

(28) optimal responses out of 41 in the case of outside option 3 in comparison to 48 (49) out of 62 in the case of outside option 6. Employing analogous test as in the full transparency case, we can reject the hypothesis of identical success rates at the 1% level only in the case of behaviour against noninformed X . The difference between the two populations is insignificant even at the 10% level in the case of behaviour against informed X .

Here we can nicely see a new feature of the behavioral patterns that is related to the non-existence of the information barrier. The share of rational and fair play strongly depends on the information type of X (informed vs. non-informed) that is faced by Y . This phenomenon is particularly observable in the case of bad outside options where the two strategies (fair vs. rational) differ. While on average five from eight Y's with the bad option accept (rationally) the smallest offer 1 from the informed X , just one from three Y's accepts it when X is non-informed in the case of $\bar{c} = 3$. A similar behavioral pattern shows up for $\bar{c} = 6$: almost half of Y's with the bad outside option accept the offer 1 from informed X and only approx. one fifth of Y's accepts this offer from not-informed X . The strategies of Y's with bad outside options in 2×2 representation are presented in Appendix in Table 11. (Lines correspond to strategies against informed X's, while columns against the non-informed ones.) The asymmetry of strategies is captured by the triangular shape of the distribution in Table 11. The majority of players play in the upper-right triangular and quite many players are off the diagonal. Less than one fourth of players (11) play the equilibrium strategy (1,1). We only observe four outliers below the diagonal.

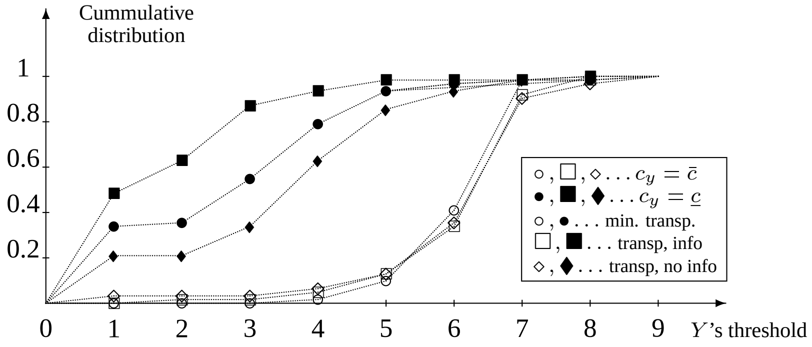

FIG. 1. Cummulative distributions of Y's acceptance thresholds, $\bar{c} = 6$

Figure 1 presents another way of visualizing the impact of the role of transparency on Y's behaviour. At the vertical axis we see the share of Y's with the threshold that does not exceed the given level at horizontal axis (cumulative distribution). The fact that in the case of good outside option $c_y = 6$ players Y's do not care about neither X's information nor the transparency is demonstrated by the confluence of the "white" lines ○ , □ , ◇ . In the case of bad outside option we observe the highest share of aggressive (or irrational) agents in the case of full transparency and non-informed X (line ■). The other extreme is reached in the case of full transparency and informed X-players (line ⧫) in that Y's are aware that X's use the information proposing the offer. The case of minimal transparency (line ●) rests between the two. Figure 2 that depicted the similar behavioural pattern for the case of $\bar{c} = 3$ is presented in the Appendix.

In the absence of an information barrier the acquisition of information has an additional value. Not only can X adjust her strategy regarding the information, but also the Y population plays much less aggressively when its bad outside option is known.

Acquisition of information has an additional value with no information barrier. Not only that X can adjust her strategy regarding the information, also the Y population plays much less aggressively in the case that its bad outside option is known.

Population of X *Players.* Let us study now, what are the best reactions to the empirical population of Y . (Table 5 presents the results.)

In the case of outside option 3, the best strategies are 4-5 without information, 1 knowing that Y's outside option is bad, and 4 against the Y player having the

TABLE 5.

X strategies in the case of Full transparency

	Outside Option 3						Outside Option 6					
	Unknown		Bad		Good		Unknown		Bad		Good	
X	Eπ_x	#X	Eπ_x	#X	Eπ_x	#X	Eπ_x	#X	Eπ_x	#X	Eπ_x	#X
1	3,12	1	**6,20**	**19**	2,34	0	**2,64**	**2**	**5,39**	**26**	2,00	1
2	2,96	2	6,05	8	2,29	1	2,55	3	5,77	17	2,10	0
3	**3,43**	**7**	6,00	3	**2,49**	**6**	2,67	5	6,35	6	2,08	2
4	**4,62**	**14**	5,50	4	**4,93**	**21**	3,01	10	5,74	4	2,19	4
5	4,53	14	4,85	5	4,63	7	3,11	16	4,95	5	2,39	5
6	3,79	3	4,00	3	3,85	2	3,10	18	3,97	1	**2,68**	**14**
7	2,98	0	3,00	0	2,98	4	2,93	6	2,98	0	**2,92**	**33**
8	2,00	2	2,00	0	2,00	2	2,00	0	2,00	0	2,00	1
9	1,00	0	1,00	1	1,00	0	1,00	0	1,00	1	1,00	0

good outside option. It turns out that X-participants surprisingly often behave in this way. Basically two thirds of them played either best or second-best replies in all the three cases.

The similar feature is captured by the rest of the Table 5 presenting the results for the outside option 6. Also here X reacts well to Y . The 2×2 tables with similar triangular distributions can be found in the Appendix (Table 13).

Overall we find some confirmation of optimal behavior. Given the empirical population characteristics, however, such behavior is not optimal. Surprisingly, on average, real play performs better given the empirical population characteristics than equilibrium strategies that make the responder indifferent between the offer and the outside option (offer $\bar{c}$). In this sense respondents' behavior seems smart on average. Respondents behave as if they have a better estimate about the true distribution of Y-players than the one implied by rational choice analysis. On the other hand the empirical strategy of X could be dominated by offers slightly higher than outside option, $(\bar{c}+1)$.

4. VALUE OF INFORMATION

In the previous section we already discussed how player X with rational expectations about the Y-population in principle could use the information. Let us now consider the empirical value of information.

TABLE 6.

Average payments and Acceptance Ratios for Different Strategies

Setup		Outside Option 3					Outside Option 6				
Tr.	Info	Acc.	π_x	$\sum \pi$	Eq.	Fair	Acc.	π_x	$\sum \pi$	Eq.	Fair
Min	No	0,58	4,19	7,74	3,65-4,66	4,63	0,35	3,01	8,16	2,79	3,13
Min	Yes	0,54	4,10	7,27	3,28-4,45	4,63	0,50	3,20	7,89	3,34-3,44	3,13
Full	No	0,65	4,11	8,31	3,43-4,62	4,53	0,42	2,99	8,35	2,64	3,11
Full	Yes	0,71	4,63	8,27	3,72-5,35	4,70	0,63	3,64	8,56	3,58-3,74	3,24

4.1. Social Value of Information

First, we match all the X and Y and we compare the *per capita* payoff regarding different scenarios (results are presented in Table 6)[13]. The value X is willing to pay for the information is not considered here, we just compare the average payoffs with and without information, i.e. we explore the information incentives according to the actual average empirical earning difference of (non)informed X-participants.

The first row of Table 6 represents the case of outside option 3 with the information barrier. Although the value of information for the perfect belief strategy of X is 0.32 in this case (see the computation in Subsection 3.1), the value of the information is negative for the average X-player. (The payoff to the average informed X is 4.1 in comparison to 4.19 of the non-informed X .) The average player X uses the information by 0.41 worse than the X with perfect priors.

If the outside option of Y increases to 6 information becomes valuable, since the average payoff to X without information is 3.01 , while the payoff with information is 3.2 . However, also here the gain of 0.19 is pretty below the perfect belief effect (0.52).

The value of information becomes significant[14] in the case of full transparency. The payoff of the average X increases from 4.11 to 4.63 in the case “3” and from 2.99 to 3.64 in the case “6.” However, that one suffers from non-rational expectations, is still true. In the case of $\bar{c} = 3$ the informational surplus is 0.51 (vs. 0.73 for rational expectations), in the case 6 this is on average 0.65 (vs. 0.95).

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[13] In Table 6 “Tr.” stands for transparency with “Min” representing the information barrier and “Full” full transparency, “Info” whether or not information has been acquired, “Acc.” is the acceptance ratio, “π_x ,” resp. “$\sum \pi$” the average of all X-, resp. $X + Y$-payoffs, “Eq.” compares the payoff in the theoretical equilibrium case (lower bound for offer $\bar{c}$, upper bound for offer $\bar{c} + 1$) and “Fair” in the case of fifty-fifty offer 5.

[14] When comparing the distribution of π_x in case of “Full” one obtain that “Yes” yields significantly (1% level) larger profits than “No.”

TABLE 7.

Distribution of empirically realized value of the information

Tr.	$\bar{c}$		$-1,4$		$-1,2$		-1		$-0,8$		$-0,6$		$-0,4$		$-0,2$		0		$0,2$
min	3	2	3	1						1			3	8	4	3	1	3	1
min	6					1					1	1	3	3	2	6	2	7	9
full	3	1	1		1			1	1			1		1			1	1	5
full	6				1										1		1	1	4

Tr.	$\bar{c}$		$0,4$		$0,6$		$0,8$		1		$1,2$		$1,4$		$1,6$		$1,8$		2
min	3	5					5	1			2								
min	6	8	7	5	5														
full	3	1	1	2	6	8	4	1									1	4	1
full	6	2	6	6	13	7	6	4	3	4		1							

Although the value of the information for X is positive in the three of four cases, the whole society (whose value is "$\sum \pi$"="$\pi_x + \pi_y$", see Table 6) is worse off since Y must bear the costs.[15] The informational loss of the society is 7.74-7.27=0.47 (3 and no transparency), 8.16-7.83=0.27 (6 and no transparency) and 8.31-8.27=0.04 (3 and transparency). Only in the case "6 and transparency" the per pair profit increases by 0.21.

While the social value of information is at least problematic in our experiment,[16] the positive efficiency effect of transparency is the phenomenon that is revealed in all the scenarios. The informational transparency runs from 0.19 (3 without information acquisition) and 0.57, resp. 0.67 (6 without acquisition, resp. 6 with acquisition) even to remarkable 1.0 in the case "3 with acquisition." The same behavioral pattern is captured by the acceptance ratio, that increases after removing the informational barrier by 7–17% with respect to the particular case.

Comparing the cases $\bar{c} = 3$ vs. $\bar{c} = 6$ we can observe systematically higher social profits for the case of $\bar{c} = 6$. However, even the maximal difference 0.67 in the case "information, no transparency" is below the difference between the social outside option that is $2 = [\frac{2}{3}(2+6) + \frac{1}{3}2] - [\frac{2}{3}(2+3) + \frac{1}{3}2]$, i.e. by always relying on conflict a much larger collective effect would be realized. This is, of course, due to the much lower acceptance ratio in the case of outside option 6. The much larger conflict ratios for $\bar{c} = 6$ than for $\bar{c} = 3$ indicate a curse of strength: To prove their larger conflict payoff Y-participants risk conflict more often.

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[15] Since $\sum \pi$ is 10 whenever y is accepted by Y, the variation of $\sum \pi$ is due to the different acceptance rates in Table 6 and the randomness of $\pi_y = \underline{c}$ or $\pi_y = \bar{c}$ in case of conflict.

[16] Since conflict occurs with substantial probability a higher outside option $\bar{c}$ leads to better average payoff.

TABLE 8.

Distribution of information overvaluation

info value		0		2		4		6		8		10
min3	4	5	5	7	9	6	2	3	1	1		
min6	3	8	19	7	10	5	2	4	1		1	
full3	5	7	12	12	1	2	2		1	1		
full6	5	20	16	6	6	4	1			1		1

4.2. Individual Value of Information

Until now we have only discussed the aggregate data. What does our experiment reveal about individual behaviour? The individual value of information ν_i resulting from the strategic profile of X_i that is applied against the empirical population of Y's will be analysed in the next section. Table 7 presents the empirical distribution of ν_i . The scale 0.1 is employed, the numbers in rows present the numbers of players with informational value in the corresponding interval. The upper part presents interval (-1.4,0.2), the lower part (0.4,2).

Considering these results and the price p_i being the reservation price of information indicated by player X_i we can define the individual overvaluation of the information as $e_i = p_i - \nu_i$ (see Table 8). We can see that the distribution of e_i has the main features of a skewed normal distribution with the number of players highest close to the average. Further, we observe an extreme overestimation of the value of the information (e.g. in the case of outside option 3 and minimal transparency more than 50% of X-players are willing to pay for the information at least 3 units more than the information yields given their strategic profile and the empirical population of Y).

Based on this huge information overvaluation the following question seems to be natural: do we observe this failure in the overall X-population, or can we characterize a cluster performing significantly better (worse) than the average? The following hypothesis is tested: we suppose that the agents that perform poorly with their strategic profiles (i.e. they have small ν_i) fail also in their price-setting behaviour (big e_i).

This intuition is supported particularly well in the case of maximal transparency and outside option 6. Analysing the median-split of the population of X-players with respect to e_i and ν_i we get the following table:

	good $(e_i \leq m_e)$	bad $(e_i > m_e)$
good $(\nu_i \geq m_\nu)$	22	8
bad $(\nu_i < m_\nu)$	6	24

TABLE 9.

Information: analysing value vs. price

Scenario		Stat. description						OLS-estimation			Clustering	
Tr.	$\bar{c}$	μ_ν	σ_ν	μ_p	σ_p	μ_e	σ_e	trend	st.err.	Acc.	Diag.	Off
Min	3	-.081	.570	2.87	3.52	2.96	4.72	-.549	.378	.155	30	13
Min	6	.187	.118	2.88	4.18	2.69	4.36	-.265	.782	.736	38	22
Full	3	.521	.738	2.50	2.82	1.98	3.99	-.295	.302	.334	27	16
Full	6	.644	.138	2.42	3.52	1.78	4.19	-2.04	.601	.001	46	14

where more than 75% of the population rest on the diagonal. This difference is statistically significant for all the four scenarios (see the last two columns in Table 9. So we may conclude that the population of respondents is composed of individuals of different ability to negotiate prices and to value information.

One might think that one cluster is largely motivated to buy information because of ambiguity aversion, while the other cluster might value information more in line with standard rational choice. To test this hypothesis we run a linear regression of quoted reservation prices p on the underlying empirical values of information. A positive intercept might be interpreted as a measure of intrinsic motivation while a positive slope would measure the contribution of the underlying information value on reservation price quotes. By means of standard OLS we estimate the following relation

$$\begin{array}{rccccc} p = & 3.73 & - & 2.04 & \nu\,, \\ & (0.45) & & (0.60) & \end{array}$$

where both coefficients are significant even at 0.5% level. The negative covariance $Cov(p, \nu) < 0$ is proven in all scenarios, but the relationship is statistically insignificant. The results are summarized by Table 9.

This finding seems to suggest a strong degree of intrinsic motivation or equivalently of ambiguity aversion in the sample of our test participants. This is particularly true for individuals with a low absolute value, or even negative, of ν. The overall reservation value, however, decreases to the extend that the bidding strategy requires information. The more “rationally” bidding behaviour requires information, the less test participants are willing to overpay their information. (Note that average ν measures .644 so that the reservation value for an average v type would constitute $3.73 - 1.29 = 2.44 > .644$, which is still considerably higher than average ν.) This “correction”, however, does not always seem statistically significant. Thus, by way of summarizing, intrinsic motivation seems to be the driving factor for explaining the enormous amount of overbidding.

5. CONCLUSIONS

Our experiment has generated the following insights:

1. The underlying population of Y-players can be viewed as being generated by a mixture of seemingly rational and fair individuals.

2. Overall X-players seem to entertain relatively good priors about the Y-population. On aggregate their responses provide higher payoffs than equilibrium strategies against the same population of Y-players what suggests a high degree of “social intelligence.” However, both strategies (equilibrium and empirical) are dominated by “equilibrium plus one offers” which avoid the indifference of the responder. The empirical X strategy performs approximately so good as (absolutely) fair offers as well as the Nash-bargaining solution offers.

3. The empirical value of information is positive for X-players in case of the high outside option 6. However, it falls short of the difference in the equilibrium payoffs of X-players.

4. In the case of the low outside option 3 the empirical value of information is even negative when Y-players cannot observe whether X is informed or not. In such cases X-players seem to play too aggressively and are often punished by similarly aggressive Y-participants.

5. In the case of low outside options knowledge about the information type which X-players enjoy seems more valuable (in terms of final average payoffs) than the actual information itself. In the case of high outside options the information itself is relatively more important.

6. X-players systematically overweight the individual value of information by large margins. This is also true for the second round of trading, i.e after one period of familiarity with the decision environment.

7. Ambiguity aversion seems to constitute a dominant factor in explaining the high degree of individual overbidding.

We interpret these findings as evidence for a systematic overestimation of the value of private information. Hence, in our setting of pairwise strategic interaction individuals seem to over-invest in information. This inclination to overinvest can be moderated when market conditions are transparent and everybody is informed about the knowledge of others.

Our evidence is similar to social learning models. Also Kraemer et al. (2001) and Kübler et al. (2001) find excessive information acquisition in non-strategic sequential purchasing models, where prices are unaffected by individual information. The emphasis of this literature is to test whether individuals do take into account sufficiently social information. These papers find an excessive evaluation of individual signals leading to excessive purchase of information. In contrast to this literature we establish excessive information acquisition in a strategic bilateral bargaining situation, where the terms of trade decisively depends on the information acquired and social learning is not feasible.[17]

It would be interesting to learn more about the individual incentives to acquire information in true market environments, where interaction is non-strategic not since there are trading partners but to an atomistic market structure. Rötheli (2001) is a first attempt in this direction suggesting the possibility of under-investment in information acquisition in such a non-strategic context.

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[17] Recall that there was no feedback information between the two rounds.

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6. APPENDIX

TABLE 10.

Strategies of Informed vs. Non-informed X (case 6)

	No Info vs. Bad (case 6)									No Info vs. Good (case 6)								
X	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
1	**4**	1													**2**	**3**		
2	2	1										1		1		1		
3	3	7	2						1		2		1	4	1	5		
4	5	7	3	2		1	1					1	2	3	4	8	1	
5	3	3		3					1				3	1	2	3		
6	4														4	1		
7	4	1					1								3	3		
8																		
9																		
$\sum$	26	20	5	5	0	1	2	0	1	0	2	2	6	9	16	24	1	0

TABLE 11.

Y Behaviour vs. Informed and Non-informed X

	Info vs. No Info X (case 3)									Info vs. No Info X (case 6)								
Y	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
1	**11**		6	5	2					**11**		5	6	6		1	1	
2			1	2						1		1	4		2			
3	2		1	1	1					1		2	4	6	1	1		
4			1		2								2	1	1			
5				1		1							1	1	1			
6						1	1											
7																		
8																1		
9																		

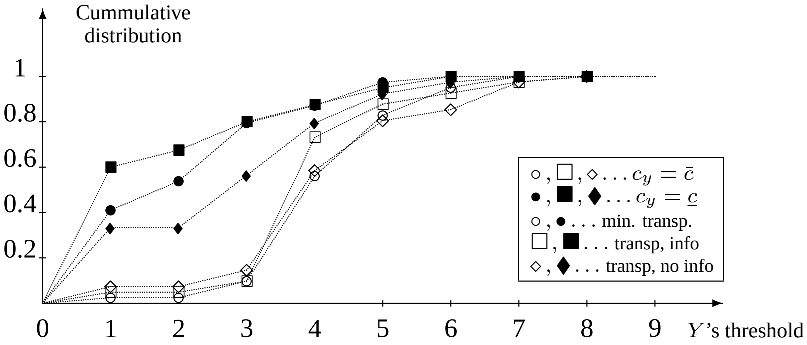

FIG. 2. Cummulative distributions of Y's acceptance thresholds, $\bar{c} = 3$

TABLE 12.

Strategies of Informed vs. Non-informed X (case 3, no barrier)

	No Info vs. Bad (case 3)									No Info vs. Good (case 3)								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
1	1											1						
2	1				1							1	1					
3	5	2										3	4					
4	7	2	2	1	1				1			1	10	2	1			
5	5	2	1	2	2	2					1		5	5		2	1	
6		1		1		1							1		1	1		
7																		
8		1			1											1	1	
9																		

TABLE 13.

Strategies of Informed vs. Non-informed X (case 6, no barrier)

	No Info vs. Bad (case 6)									No Info vs. Good (case 6)								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
1	1					1				1						1		
2	2	1													1	2		
3	1	2	1		1							1	1			3		
4	4	3	1	2									1		4	5		
5	6	5	4						1				1	3	3	9		
6	9	5		2	2							1	1	2	6	7	1	
7	3	1			2											6		
8																		
9																		

TABLE 14.

Second Moments

	Outside option 3						Outside option 6					
	Min. transp.		Max. transparen.				Min. transp.		Max. transparen.			
			Info		No Info				Info		No Info	
X	Good	Bad	Good	Bad	Good	Bad	Good	Bad	Good	Bad	Good	Bad
1	1,2	12,2	2,33	12,1	3,41	11,2	0	11,2	0	12,4	1,55	8,25
2	0,88	9,18	1,71	8,1	2,5	8,21	0	8,38	0,58	8,54	1,14	6,06
3	2,26	4,18	2,26	4,1	3,2	6,31	0	6,29	0,4	2,86	0,79	5,69
4	4,04	1,84	3,22	1,79	3,98	2,68	0,26	2,69	0,75	0,98	0,98	3,79
5	1,31	0,23	0,99	0,44	1,45	0,66	0,81	0,55	1,03	0,15	1,03	1,14
6	0,19	0	0,28	0	0,51	0,1	0,98	0,13	0,91	0,06	0,93	0,25
7	0	0	0,02	0	0,02	0	0,02	0,02	0,08	0,02	0,09	0,02
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0