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by

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Abstract

Numerous laboratory experiments show that workers reciprocate to high wages with high effort, when there is perfect information on the surplus created. Recent field experiments, however, suggest that trust and reciprocity may be lower – or absent – when the information is incomplete. We report a laboratory experiment with symmetric and asymmetric incomplete surplus information in a "bilateral gift exchange" setting. We find that trust and reciprocity have a significant positive effect on wages, effort and efficiency. But, all three are substantially lower under incomplete than under complete information. The negative impact on wages and efficiency is even greater with information asymmetry.

Keywords

trust, reciprocity, efficiency, incomplete information, asymmetric information

JEL Codes

C92, D82, J41

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1. Introduction

The "gift exchange" approach in labor relations (Akerlof 1982; Summers 1988; Akerlof and Yellen 1990) has recently found some strong experimental support (Fehr, Kirchsteiger, Riedl 1993; Fehr, Kirchler, Weichbold, and Gächter 1998; Gächter and Falk 2002). Labor relations in these experiments are modeled such that the employer can choose to pay a wage above the minimum level hoping for the worker's reciprocity. The worker can then choose to exert an effort level above the minimum. The principle finding in these studies is that a vast majority of the experimental employers "trust" their workers by paying wages well above the minimum level. In response, a majority of the experimental workers "reciprocate", i.e. they exert the more work effort, the greater the wage is that they receive. The consequence of this high degree of trust and reciprocity is that efficiency is much higher than in the equilibrium of the game with money-maximizing rational agents.

So far, the experimental research on the topic has concentrated on environments in which both employers and workers have complete information on the costs and benefits. In some labor relations, however, the assumption of symmetric and complete payoff information seems empirically too strong. Sometimes workers may have some general knowledge of the positive correlation between their work effort and the surplus of the employer (i.e. the firm), but may not be able to quantify the actual marginal effect of work effort on the employer's payoff. An office secretary, for example, who increases his[1] effort by doubling the number of chores he completes in a day, generally, will not know the exact amount of additional surplus created for the firm owners.[2] Not only the workers, but also the employer may have incomplete information on the surplus effect of workers' increased work effort. This is especially true

[1] For simplicity, we will always refer to the employer in female gender and to the worker in male gender.

[2] We thank Reinhard Selten for pointing out this example.

when the job is concerned with administrative tasks or when the business success is stochastic to some extent. It is quite conceivable, for example, that the employer of the secretary can measure the payoff effect of his increased effort only *ex post*, but not *ex ante*.[3]

In this paper, we study labor relations with symmetric incomplete and asymmetric incomplete surplus information. Our model is based on the "bilateral gift exchange" game presented by Fehr, Kirchler, Weichbold, and Gächter (1998 – abbreviated as FKWG from now on). In that game, the employer makes a wage offer to the worker, who can accept or reject the contract. If the contract is accepted the worker chooses some work effort level. The employer's payoff increases at a constant marginal rate with an increase in the worker's effort. There is complete information concerning the surplus, since all costs and benefits of the employer and of the worker are known to both parties.

We consider two incomplete information variants of the basic symmetric complete information game by FKWG. In both of our incomplete information games, the constant marginal effect of work effort on the employer's surplus is a random variable that can either take a high or a low positive value, each equally likely. In the symmetric incomplete information game, neither employers nor workers are informed on the outcome of the random draw before making their decisions. In the asymmetric information game, the employer is informed on the realization of the random variable, while the worker is not.

There are several reasons to believe that the informational setup may affect behavior in labor relations. First, there is evidence that behavior may be significantly different when comparing the symmetric complete information and the asymmetric incomplete information of a simple game, even when the game theoretic predictions are the same (Roth, Malouf, and Murnighan

[3] The secretary's hard work, for example, may create a greater marginal surplus in extremely busy times than in relatively quiet periods.

1979; Roth and Murnighan 1982; Mitzkewitz and Nagel 1993, Irlenbusch and Sliwka 2003). Second, there are some clues that the puzzling discrepancy in the results of two recent experimental papers studying workers' real effort reciprocity may be explained by the difference in the information that was available to the subjects. In a real effort laboratory experiment, Gneezy (2003) lets some subjects (employers) pay other subjects (workers) lump-sum wages to solve mazes on the computer. He finds clear evidence of greater work effort on the part of the workers who are paid higher wages. It is important to note that the workers in this experiment were fully informed on the exact dollar value of an increase of their work effort for the employer. In contrast, Hennig-Schmidt, Rockenbach, and Sadrieh (2003) report a field experiment in which typists who are paid hourly wages are given no exact information on the benefit structure of their employer. While the authors find no evidence for work effort reciprocity in the original no information setting, they do find support for the presence of positive effort reciprocity in a follow-up experiment with increased information.

We find strong support for the conjecture that the informational setting affects behavior in contractual relations that rely on trust and reciprocity. Trust and reciprocity are also present under incomplete payoff information, but they are both substantially reduced. The wage offers chosen by the employers and the effort levels chosen by the workers are substantially lower than in the case with complete information. The negative impact of incomplete information on wage offers is especially strong in the setting with asymmetric incomplete information. In this treatment, we find that employers with a high marginal benefit from work effort mimic the behavior of those with a low marginal benefit, by making especially low wage offers. The significantly lower wages they offer lead to significantly lower payoffs for employers and workers, even though workers' reciprocity is not different from reciprocity in the other treatments. We conclude that reducing the incompleteness and asymmetry of payoff information in relationships that rely on trust and reciprocity (such as employer-worker

relations) is to the benefit of both employers and workers, because it enhances efficiency and leads to mutual gains that can be shared by the two parties making them both better off.

2. Game and experimental setup

We study two incomplete information variations of the "bilateral gift exchange" game introduced by FKWG. In this game, the employer makes a wage offer w to the worker, who may accept or reject this offer. If the worker rejects, he receives an unemployment benefit c_0 and the employer receives nothing. In case the worker accepts the wage offer, he must choose a work effort e. Effort is costly for the worker and beneficial for the employer. The payoffs in case of an accepted wage offer are:

$$\Pi_{employer} = (v - w) \cdot e$$

$$\Pi_{worker} = w - c(e)$$

where v represents an exogenously given redemption value and $c(e)$ represents the strictly increasing cost of effort e.

We modify the game by introducing incomplete information about the marginal benefit of the worker's effort for the employer's payoff. This is modeled by inserting the *employer profit factor (EPF) f* into the employer's payoff function

$$\Pi_{employer} = (v - w) \cdot e \cdot f$$

The parameter f is the realization of a random variable that can take either a high or a low value. A high value of f resembles a high marginal benefit of the worker's effort for the employer's payoff and vice versa. In this way, we generalize the original model without losing the feature of a constant marginal benefit of effort. Furthermore, our modification leaves the worker's profit function unchanged.

The base game of FKWG can be represented as a parameterization of our game with symmetric complete information (SC), where f is equal to 1 with probability 1. We study the game with symmetric incomplete information (SI) as well as with asymmetric incomplete information (ASI). In the symmetric case, neither the employer nor the worker is informed about the realization of the employer profit factor f, while in the asymmetric case only the employer knows the value of f.

The game theoretic analyses (applying the subgame perfect equilibrium concept to the complete information game and the sequential equilibrium concept to the modified games) yield the same predictions: The worker accepts any wage offered and exerts the minimal effort, while the employer offers the minimal wage. To allow direct numerical comparisons of our results to those of FKWG, we use exactly the same game parameters, with v=120, c_0=20, and $c(e)$ as shown in table 1.

Table 1 – Effort costs

effort e	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
effort cost $c(e)$	0	1	2	4	6	8	10	12	15	18

To avoid excessive losses and to achieve the minimal participation requirements, wages had to be in the range between the redemption value and the unemployment benefit. In the incomplete information games, the employer profit factor could either take the value f=0.5 or f=1.5, where both were equally likely. Thus, the expected value of f in the incomplete information treatments equals the value of f in the base game.

We use the same matching procedure as FKWG. There were twenty subjects in each session, with ten subjects randomly assigned to the role of the employer and the remaining ten subjects assigned to the role of the worker. Each subject played ten rounds of the game, all rounds in the same role (employer or worker). Subjects were matched using a revolving (or

round-robin) matching scheme, such that each employer met each worker only once and vice versa (Kamecke 1997).[4] The employer profit factor was randomly and independently drawn at the beginning of each round and the incomplete information was resolved at the end of each round by announcing *f*.

We conducted 4 sessions of the SI treatment and 3 sessions of the ASI treatment. Each session is one independent observation. Our non-parametric tests are based on the session data. Table 2 summarizes the parameters of the original FKWG treatment SC and our two treatments with symmetric SI and asymmetric ASI incomplete information.

Table 2 – Experimental treatments

treatment abbreviation	treatment name	information on employer surplus is known to	number of pairs (employer/worker)	number of independent observations
SC*	symmetric complete information	both employer and worker	40	4
SI	symmetric incomplete information	neither employer nor worker	39	4
ASI	asymmetric incomplete information	employer only	28	3

*) The SC treatment is part of the experiment by FKWG and is abbreviated "BGE" in that paper. We report it here, because we use it as the complete information control for our treatments.

All our sessions were conducted at the Erfurt Laboratory for Experimental Economics (*elab*) at the University of Erfurt. The communication was computerized with software based on *zTree* (Fischbacher 1999). The subjects were seated in cubicles and received written instructions (see the appendix). With the exception of the necessary modifications, the instructions were identical to the original instructions by FKWG. After the instructions were read aloud, any remaining questions of the subjects were answered privately at the cubicle.

[4] In three sessions only 18 subjects were present. The played 9 consecutive rounds in the revolving scheme.

The sessions lasted approximately one hour and the subjects, on average, earned Euro 10, a little more than $10.[5]

3. Results

In the following, we analyze in which ways the interaction between employers and workers is affected when the information conditions are varied. The data of the SC treatment that we incorporate in our analysis were collected and reported by FKWG. The main result on the SC treatment in that paper is that employers generally offer wages well above the minimal wage and that many workers reciprocate by choosing work effort above the minimal level. Hence, the observed behavior in the "bilateral gift exchange" of the SC treatment leads to substantially more efficient outcomes than predicted by theory.

3.1 Wage offers (Trust)

We begin our evaluation with the analysis of wage offers. We observe that, in all treatments, the vast majority of wage offers exceeds the minimum wage by more than one point.[6] In SC, only 9 of 391 wage offers were smaller or equal to the minimum wage plus one. In SI, the count was 3 of 261 and, in ASI, it was 12 of 381. It seems clear, that employers do not follow the strict logic of money maximization with sequential rationality. Instead, they are willing to pay substantially more than the minimum wage. The average wage offer in SC is 59.9, in SI it is 55.5, and in ASI it is 46.1.

[5] Since the FKWG experiment was run with paper and pencil, the average duration of the SC sessions were about two hours at an hourly payment of ca. $17.

[6] From a game theoretic point of view, it makes sense to check for wage offers either equal to the minimum wage of 20 or equal to the minimum wage plus one (i.e. 21), because each of these two can be part of an equilibrium. Some authors argue that the latter equilibrium may be more robust than the former, in which one of the players (the worker) is indifferent between playing the equilibrium strategy (i.e. accepting any wage offer greater or equals 20) and playing other out-of-equilibrium strategies (Mitzkewitz and Nagel 1993).

Figure 1 shows the development of average wage offers in the three treatments. It seems that the average wage offers are different across treatments from the beginning and stay different, since they are almost unchanged over time. The average wage offer in the ASI treatment lies well below the average wage offers in the two symmetric information treatments in every single period of the game. In fact, testing non-parametrically for statistical differences between the treatments, we find that the average wage offers in ASI are significantly lower than in SC and SI (Mann-Whitney U-test, p=.029 and p=.057, respectively), while no statistically significant difference can be found between the average wage offers in the two treatments with symmetric information. The comparison of the average accepted wages across treatments yield the same results at the same significance levels.

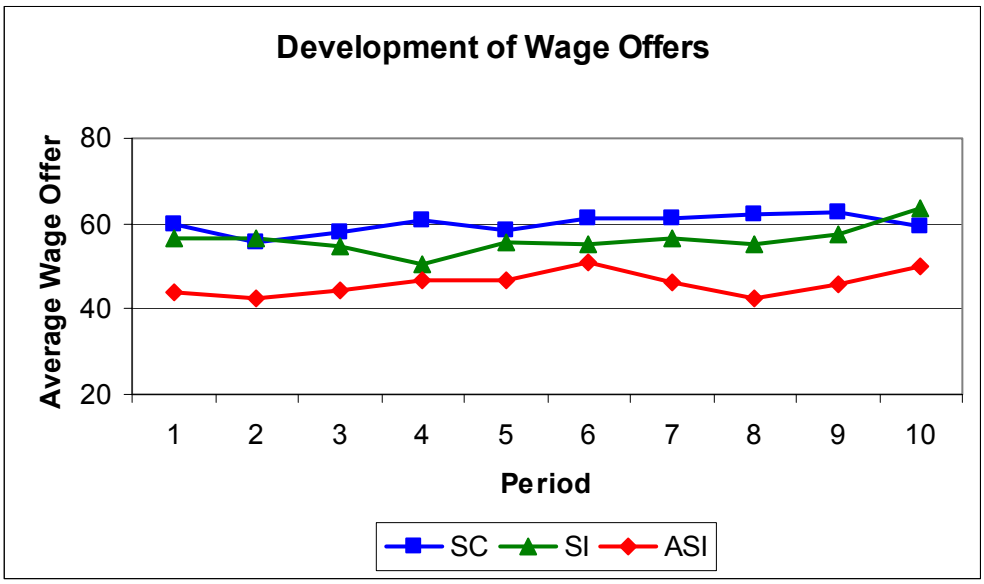


Figure 1 – Development of average wage offers over time

Even though the non-parametric tests pick up no statistical differences between the two symmetric treatments SC and SI, a comparison of the cumulative distribution of wage offers, shown in figure 2, suggests that there may be a slight difference between the symmetric complete information and the symmetric incomplete information treatments. The cumulative distribution of wage offers in SI lies to the left of the distribution in SC for all but the lowest

wage interval. Clearly, the difference is not as strong as it is between ASI and SC, but it is perhaps strong enough to emerge from less conservative statistical procedures than the non-parametric tests that we have applied so far.

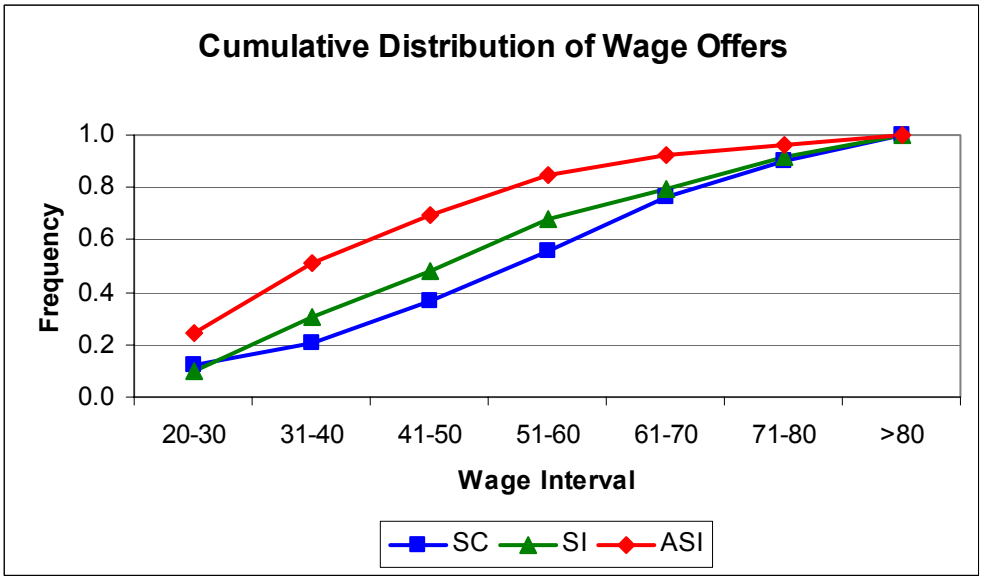


Figure 2 – Cumulative distribution of wage offers.

Table 3 summarizes the results of a regression analysis with wage offers as the dependent variable. We use the SC treatment as a baseline and add two dummy variables for the SI and the ASI treatments. In addition, we include a variable (ASIxEPF) that captures the effect of the information on the employer profit factor that is available to the employers in the ASI treatment. This variable is not relevant in the SC and the SI treatments, because in the former the EPF is always equal to one, while in the latter it's realization is unknown to the employer at decision time.

The main result is that both treatment dummy coefficients are negative and highly significant, indicating that employers in both of the incomplete information treatments SI and ASI offer lower wages than in the complete information treatment SC. But, note that the negative effect of information incompleteness on wage offers is much stronger in the asymmetric case (ASI) than it is in the symmetric case (SI), even when we take the positive coefficient of the

ASIxEPF variable into account. This positive coefficient implies that employers in the ASI treatment use the information on the realization of the stochastic term in their payoff function, on average making a 6.7 point higher wage offer when the marginal benefit of work effort is high. But even the wage offers by the high benefit employers in ASI are substantially lower than the wage offers in the two symmetric treatments.[7]

Table 3 – Tobit regression of wage offers

	coefficient	std. error	t	P > |t|	[95% conf.	interval]
period	.4067754	.2135204	1.91	0.057	-.012212	.8257629
SI-dummy	-4.095764	1.540773	-2.66	0.008	-7.119196	-1.072331
ASI-dummy	-20.72198	2.413191	-8.59	0.000	-25.45734	-15.98662
ASIxEPF	6.674693	1.973072	3.38	0.001	2.802967	10.54642
constant	57.58001	1.515837	37.99	0.000	54.6055	60.55451

Notes: 2-sided censored Tobit regression with wage offers as the dependent variable. SC is the base treatment, SI-dummy and ASI-dummy are dummy variables for the SI and ASI treatments, respectively. In the SI and ASI treatments, the employer profit factor EPF takes one of the values .5 or 1.5 for employers with a low or a high marginal benefit from work effort, respectively. We regress wage offers on the EPF only in the ASI treatment (i.e. ASIxEPF), because only here the realization of the EPF is know to the employers at decision time. The regression is based on 1028 observations.

Finally, notice that the regression also provides some (rather weak) evidence on a slight increase of wage offers over time. The decision period's coefficient is positive and weakly significant, but only a small fraction of the value of coefficients of the treatment dummies. The regression suggests that wage offers, on average, increase by about four points over the ten rounds. Since our workers exhibit strong reciprocity (as shown in the next subsection), the increase in wages over time may be due to learning on part of the employers who receive positive feedback in response to high wages.

[7] We also ran tobit regressions correcting for the dependencies in our data set. The results we report here are also supported by those regressions. The estimated error probability on the coefficient of the SI-dummy, however, increases slightly above the significance level we apply here.

Result 1 *(Wage offers and accepted wages)* Wage offers in the asymmetric incomplete information treatment ASI are significantly smaller than in both symmetric information treatments SC and SI. Wage offers in the symmetric incomplete information treatment SI also seem to be smaller than in the symmetric complete information treatment SC, but not significantly so when applying the non-parametric tests. The corresponding results also hold for accepted wage offers.

3.2. Work effort (Reciprocity)

In the last section, we found that the employers offer to pay wages well above the minimum wage. This behavior can only be sensible, if an employer expects the worker to reciprocate to high wage offers by choosing higher than minimum work effort.[8] To check whether workers behave reciprocal or behave money maximizing (i.e. choose the minimum work effort at any wage), we plot the average observed work effort against seven wage brackets in Figure 3.[9]

Figure 3 clearly shows that there is a positive correlation between the observed work effort and the wage in all three treatments. The relationship between wage and work effort seems to be almost linear in the symmetric complete information case, perhaps slightly "flattening out" for the very high wages. In the two incomplete information treatments the relationship is not completely monotonic, but all in all quite similar to the complete information case. It is interesting to note, however, that there is no wage interval, in which the observed average work effort in SC is smaller than in either of the incomplete information settings.

[8] Note that not even a preference for equal payoffs can induce the employer to offer a wage above the minimum, if the worker is a money maximizer. Since a money maximizing worker chooses the minimum effort at any wage greater or equal to the minimum wage, the employer confronted with this worker receives the maximum payoff by offering him the minimum wage. But, since even the employer's maximum is far below the worker's payoff in that outcome, paying a higher wage only increases the inequality of payoffs.

[9] For the sake of comparability, we plot the same wage brackets as used by FKWG.

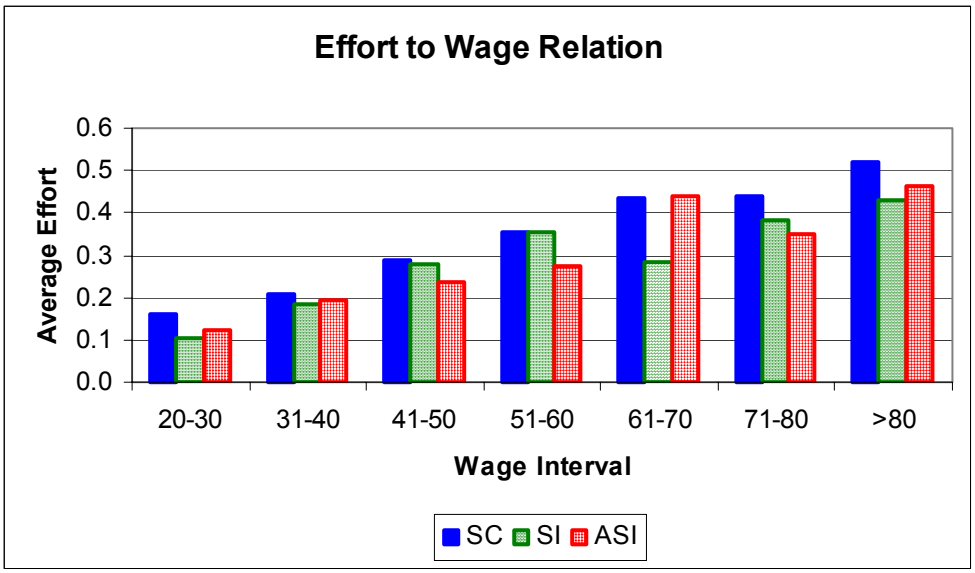


Figure 3 – Effort to Wage Relation

Although our non-parametric tests do not find a statistical difference when comparing session averages across treatments, Figure 3 seems to indicate that aggregate reciprocity (i.e. average work effort per unit of wage) is higher when the surplus information is complete than when it is uncertain. This impression is supported by Figure 4 that shows the average ratio of work effort to wage. In the symmetric complete information treatment SC, each unit more in wage results in an increase of work effort by an average of 0.0059 effort units. The employer's "best bargain" is at wages between 41 and 70 that return more than 0.0060 effort units per unit of wage. In contrast, the average increase of work effort per unit of wage is only about 0.0050 in both incomplete information treatments, with the ratio going over 0.0060 just for a small range of wages in each treatment (for 51-60 in SI and for 61-70 in ASI).

To have a clearer picture of the determinants of workers' effort choices table 4 summarizes the results of a regression with work effort as the dependent variable. As in the previous regression, we use the SC treatment as a baseline, add two dummy variables for the SI and the ASI treatments, and include the period variable to check for dynamic effects. Since the graphs show strong evidence for reciprocal behavior, it comes as no surprise that the coefficient of

the wage offer is positive and highly significant. In fact, the estimated coefficient is exactly in the range that we expected when looking at figure 4. For each unit more wage the workers provide roughly 0.0054 more units of work effort. Thus, our regression strongly favors a model of reciprocal behavior over the model of money maximizing behavior, in which effort choices are invariant to the wage. The level of reciprocity, however, drops substantially with the introduction of incomplete information. Both treatment dummy coefficients are negative and highly significant. But, since the two coefficients are almost equal, we must conclude that information asymmetry in the ASI treatment does not have an additional negative effect on the work effort as it does on the wage offers.

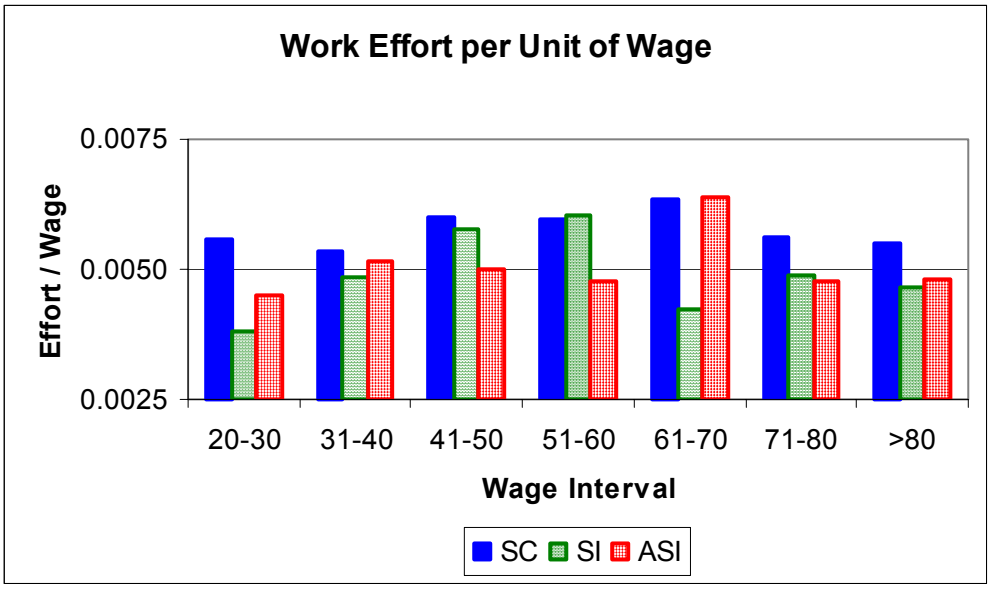


Figure 4 – Work Effort per Unit of Wage

So far we have only established workers' reciprocal behavior in the aggregate. An obvious question is to which extent we can find reciprocal responses of individual workers. To analyze behavior on the individual level, we calculate Spearman rank correlation coefficients between

wages and effort choices of each worker separately.[10] We then distinguish three types of workers. (1) The "money maximizers" are workers who choose the minimum effort level in all rounds. (2) The "reciprocators" are workers with a positive rank correlation coefficient between wage and effort that is significant at 10%. (3) The "others" are workers who do not belong to the first two categories. Table 5 summarizes the result of the correlation analysis.

Table 4 – Tobit regression of work effort

	coefficient	std. error	t	P > |t|	[95% conf.	interval]
wage offer	.0053562	.0003951	13.56	0.000	.0045809	.0061315
period	-.0031303	.0025645	-1.22	0.223	-.008163	.0019023
SI-dummy	-.0510275	.0186645	-2.73	0.006	-.0876558	-.0143992
ASI-dummy	-.0481782	.0176639	-2.73	0.006	-.082843	-.0135135
constant	.0527794	.0297893	1.77	0.077	-.0056808	.1112397

Notes: 2-sided censored Tobit regression with work effort as the dependent variable. SC is the base treatment, SI-dummy and ASI-dummy are dummy variables for the SI and ASI treatments, respectively. The regression is based on 956 observations.

The majority of workers in each treatment are the reciprocators, while the money maximizers typically constitute the smallest group. Although the asymmetric incomplete information treatment ASI exhibits the smallest relative frequency of reciprocators (54%) and the greatest relative frequency of money maximizers (23%), the treatment differences are not statistically significant. Furthermore, since we find the greatest relative frequency of reciprocators in the symmetric incomplete information treatment SI (71%), we conclude that the informational setup does not influence the number of reciprocal workers, but the degree of their reciprocity.

Result 2 *(Wage Effort Relation)* The majority of workers in all three treatments exhibit reciprocal behavior. The degree of reciprocity is higher with complete information (SC) than without (SI and ASI). Information asymmetry has no additional negative effect on reciprocity.

[10] This coefficient takes a value between –1 and +1, where –1 indicates that the sorting of the two analyzed data series are perfectly negatively correlated, 0 indicates no correlation, and +1 perfect positive correlation. The coefficient is "significant at x%," if the (one-tailed) probability of it being zero is smaller or equal to x%.

Table 5 – Worker types

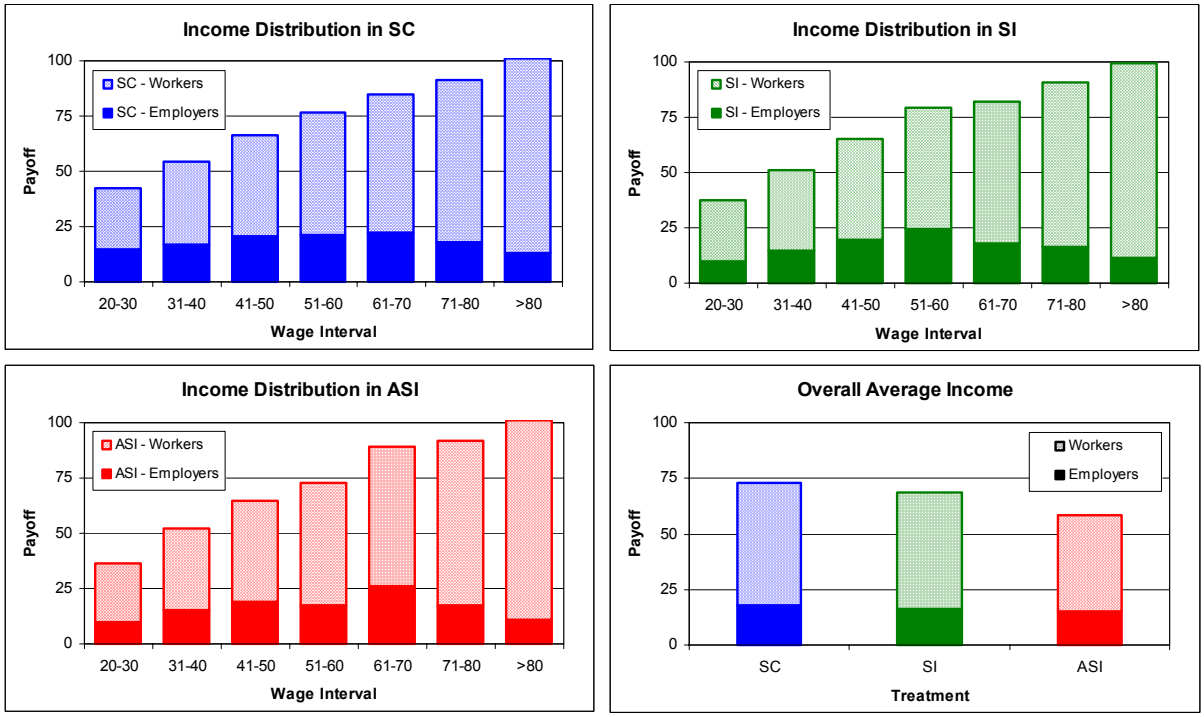
	SC	SI	ASI
Money maximizers (choose minimal effort in all rounds)	5 (12.5%)	3 (10.7%)	9 (23.1%)
Reciprocators (positive rank correlation coefficient, significant at 10%)	24 (60.0%)	20 (71.4%)	21 (53.8%)
Others	11 (27.5%)	5 (17.9%)	9 (23.1%)
Total	40	28	39

3.3. Payoffs and Efficiency

Figures 5 shows the distribution of income over wage and the overall average income in each of the three treatments. The dark part of each bar in the figure represents the average income of the employer and the light part the average income of the worker. The fact that the sum of the two payoffs increases monotonically with the wage in all three treatments is evidence for the positive impact of trust and reciprocity on efficiency. The higher the wage paid by the employer, the more effort is exerted by the worker, and the greater is the joint income. Hence, the combination of employers' trust and workers' reciprocal behavior leads to enormous efficiency gains in all our experimental economies.

The overall average income bars in the lower right panel of the figure indicate, however, that the efficiency gains are smaller in the incomplete information treatments than in the complete information treatment SC. This is the case with incomplete information, not only because the reciprocal response of workers is weaker, but also because the employers offer lower wages. Since the second effect is substantially stronger in the asymmetric ASI treatment than in the symmetric incomplete information treatment SI, the loss of efficiency in ASI is significantly greater than in SC and SI. The Mann-Whitney U-test applied to the session averages returns significant differences between SC and ASI as well as between SI and ASI ($p=.023$ and $p=.057$, one-tailed, respectively), no significant difference is picked up between SC and SI.

Summarizing, it seems that incomplete information is harmful for the efficiency of trade in these markets and asymmetric information is even worse.



Figures 5 – Income distribution

The additional information that employers in ASI have, when compared to those in SI, not only harms the efficiency of trade, but it also decreases the employers' average income, which ranges between 17.9 in SC and 16.4 in SI, but is down to 14.9 in ASI. The variation across sessions (i.e. independent observations), however, is so high that none of the differences prove significant using non-parametric tests. But, since the majority of observed wage offers in SI and ASI are well below the wage that provides the maximum payoff in the inverse U-shaped distribution of employer income in figure 5, it seems clear that employers earn substantially less than they could, if they would offer higher wages in these treatments.

Result 3 *(Efficiency)* Efficiency of trade in ASI (with asymmetric incomplete information) is significantly smaller than the efficiency in SC and SI. Average efficiency in SI (with symmetric incomplete information) is lower than in SC, but the difference is not statistically

significant. Similarly, average employer income drops going from SC to SI and to ASI, but the differences are not statistically significant.

4. Discussion and Conclusion

The experimental research on gift-exchange in labor markets with non-verifiable effort has concentrated on the case in which both employers and workers are fully informed on the surplus that is created through their interaction. In these complete information settings, employers' trust (i.e. the voluntary payment of higher than minimal wages) and workers' reciprocity (i.e. the voluntary provision of effort above the minimum level) have been found to be very high and robust, leading to substantial efficiency gains when compared to the equilibrium prediction. But, such high levels of trust and reciprocity may be especially easy to attain in a world where all payoff information is readily at hand and the fairness of the payoff distribution is verifiable. The question that we address in this paper is whether and in which way the lack of complete information affects the level of trust and reciprocity in relationships governed by voluntary "gift exchange".

We examine two incomplete information settings. In both cases, we model the employer's payoff to be a function of the work effort, the wage, and of a stochastic term. In one case, the asymmetric incomplete information treatment, the employer is informed on the realization of the stochastic term, but the worker is not. In the other case, the symmetric incomplete information treatment, neither the employer nor the worker are informed on the realization of the stochastic term when they make their decisions.

We compare the data from our two experimental treatments with the data from the corresponding complete information treatment that was experimented by Fehr, Kirchler, Weichbold, and Gächter (1998). Our results are surprisingly clear. On the one hand, trust and reciprocity prove to be robust behavioral phenomenon in labor relations with non-verifiable

work effort, even in the presence of information incompleteness and asymmetry. Wage offers, effort levels, and efficiency in both of our incomplete information settings are significantly greater than predicted in the game theoretic equilibrium with payoff maximizing agents. On the other hand, information incompleteness has a negative impact on trust and reciprocity. Wage offers, effort levels, and efficiency in both of our incomplete information settings are substantially lower than in the complete information baseline. The damaging effect of information incompleteness on trust is especially dramatic in the asymmetric treatment, in which the employer is fully informed, but the worker is uncertain about the surplus that his work effort generates. Wage offers in the asymmetric case are significantly lower than in any other treatment, leading to significantly lower efficiency levels than in the other treatments.

Surprisingly, there is no comparable negative impact of the information asymmetry on the workers' reciprocity. This means that, for any given wage, the average work effort in both incomplete information treatments is almost the same. But, if the workers' reciprocity is not lower in the asymmetric case, then why do the employers make lower wage offers? We suggest the following answer. While employers in the asymmetric information treatment are perfectly informed whether their matched worker provides them with a high or a low marginal benefit (i.e. whether the realization of the stochastic term in their payoff function is high or low), employers in the symmetric incomplete information treatment only know the expected marginal benefit of effort, which is exactly midway between the high and the low case. One might expect that informed high (low) benefit employers will pay wages higher (lower) than the uninformed employers facing a risk. But, instead of this separation, we observe that the high benefit employers try to "mimic" the low benefit employers by offering substantially less than the uninformed employers in the symmetric incomplete information treatment. Perhaps, they hope that their low wage offers will not cause a strong negative reaction by the workers, who cannot tell whether low offers are due to greed or to a low marginal benefit from work

effort. But, since the extent of workers' negative reaction to low wages is not affected by the information asymmetry, making low wage offers actually hurts the employers who could have earned substantially more by offering higher wages.

In summary, our experiment gives strong support for the hypothesis that incomplete surplus information is detrimental to trust and reciprocity and substantially reduces payoffs and economic efficiency in relationships with incomplete contracts, such as labor relations with non-verifiable effort. It is very probable that the negative impact of the information incompleteness is due to the fact that determining a reference point for reciprocity and fairness in these settings is difficult. Things get even worse, when there is asymmetric incomplete information, because the informed side's attempts to cash in on the information advantage are bound to impair trust and reduce market efficiency. In fact, as our experiment shows, this negative effect of information asymmetry may make the informed market side even worse off than it would be without the information "advantage". Thus, it seems that efficiency in markets that rely on interpersonal trust can be substantially enhanced by reducing the uncertainty about the surplus information. Furthermore, we can expect the most dramatic positive effects in those cases, in which the informed market side is forced to reveal the private payoff information or does so voluntarily to enhance trust and reciprocity.

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Appendix – Instructions

Instructions for the labor market experiment

- The 20 participants of the experiment are randomly divided into two groups: 10 **workers** and 10 **employers**. You will be informed at the beginning of the experiment whether you are a worker or an employer. You keep your role during the whole experiment.
- You play **10 rounds** in the situation described below. In each round, one employer and one worker play together who did not interact in any previous round and who will not interact with each other in any of the following rounds.

Wage

- In each round, the employer is given 120 by the experimenter. She can use this amount for paying the wage of „her" worker.
- The employer offers to the worker a wage that must lie between 20 and 120. If the employer offers, e.g., a wage of 120, than she will keep Zero for herself. If she offers, e.g., a wage of 20, than she will keep 100 for herself.
- The worker can accept this wage and work for it, or he can reject the wage.
- If the worker rejects the wage no contract is concluded. The worker receives an *unemployment benefit* of 20. The employer receives a payoff of Zero, and the round ends for both players.
- If the worker accepts the wage a contract is concluded. The worker receives the wage agreed upon and has to chose his *quantity of work*. The employer receives a payoff dependent on the wage agreed upon and the quantity of work chosen.

Quantity of work and worker's income

- The **quantity of work** is characterized by a number between 0.1 and 1.0. The lowest quantity of work is 0.1, 0.2 is a slightly larger quantity, and 1.0 is the highest quantity of work.
- The higher the quantity of work chosen
  → the larger is the **employer's income** and
  → the larger are the associated **costs for the worker**

quantity of work	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
costs for the **workers**	0	1	2	4	6	8	10	12	15	18

- The worker's income can be computed by the employer as well as by the worker in the following way:

Worker's income = Wage – Costs of the quantity of work chosen

——— The following part is only relevant for the symmetric incomplete information treatment SI. ———

Employer profit factor and employer's income

- The **employer profit factor (EPF)** determines **how much profit** the quantity of work chosen by the worker will create for the **employer**.
- The higher the EPF the more profit the quantity of work creates for the employer.
- The EPF does not influence the amount of the worker's income, however.
- The EPF can be either high (1.5) or low (0.5). Both values are equally likely.
- The EPF will be randomly drawn at the beginning of each round but will be revealed neither to the employer nor the worker.

- When making the decisions, the employer's income cannot be computed exactly because the EPF is not known. However, an upper and lower estimate of the employer's income can be calculated by assuming first a high and then a low EPF.
- After a round has ended the EPF will be told to both the employer and the worker, and the employer's income will be calculated as follows:

employer's income = (120 – wage) • quantity of work • EPF

——— The following part is only relevant for the asymmetric incomplete information treatment ASI. ———

Employer profit factor and employer's income

- The **employer profit factor (EPF)** determines **how much profit** the quantity of work chosen by the worker will create for the **employer**.
- The higher the EPF the more profit the quantity of work creates for the employer.
- The EPF does not influence the amount of the worker's income, however.
- The EPF can be either high (1.5) or low (0.5). Both values are equally likely.
- The EPF will be randomly drawn at the beginning of each round.
- The EPF will be revealed to the employer but not to the worker.
- The employer's income can be calculated by the employer as follows:

employer's income = (120 – wage) • quantity of work • EPF

- The worker cannot compute the employer's income exactly because the EPF is only known to the employer. However, the worker can calculate an upper and lower estimate of the employer's income by assuming first a high and then a low EPF.

——— What follows is relevant for both treatments. ———

Examples:

Example	wage offer	accepted?	quantity of work	worker's income	employer's income	
					EPF = 0.5	EPF = 1.5
1	110	no	-	20	0	0
2	110	yes	0.3	108	1.5	4.5
3	28	no	-	20	0	0
4	28	yes	0.7	18	32.2	96.6

Total payoff

- Your total payoff is the sum over the incomes in all rounds.
- Each point gained in the experiment is rewarded with 3 (Euro)Cent.

Let's have an exercise!

1. Let's assume that the employer makes a wage offer of **110** to the worker.

   A. The worker does not accept! What will be the worker's income and the income of the employer?

      Worker's income = ...

      Employer's income = ...

   B. The worker accepts the wage offer and chooses a quantity of work of **0.3**! What will be the worker's income and the income of the employer?

      Worker's income = ...

   B.1. Assume the employer profit factor (EPF) is **0.5**! What will be the income of the employer?

      Employer's income = ...

   B.2. Assume the employer profit factor (EPF) is **1.5**! What will be the income of the employer?

      Employer's income = ...

2. Let's assume that the employer makes a wage offer of **28** to the worker:

   A. The worker does not accept! What will be the worker's income and the income of the employer?

      Worker's income = ...

      Employer's income = ...

   B. The worker accepts the wage offer and chooses a quantity of work of **0.7**! What will be the worker's income and the income of the employer?

      Worker's income = ...

   B.1. Assume the EPF is **0.5**! What will be the income of the employer?

      Employer's income = ...

   B.2. Assume the EPF is **1.5**! What will be the income of the employer?

      Employer's income = ...