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Abstract

We investigate the impact of wage comparisons for worker productivity. We present three studies which all use three-person gift-exchange experiments. Consistent with Akerlof and Yellen's (1990) fair wage-effort hypothesis we find that disadvantageous wage discrimination leads to lower efforts while advantageous wage discrimination does not increase efforts on average. Two studies allow us to measure wage comparison effects at the individual level. We observe strongly heterogeneous wage comparison effects. We also find that reactions to wage discrimination can be attributed to the underlying intentions of discrimination rather than to payoff consequences.

Keywords

fair wage-effort hypothesis, wage comparison, gift exchange, horizontal fairness, discrimination

JEL Classification

J31, J71, C91, C92

I. Introduction

In a concept coined ‘fair wage-effort hypothesis’, Akerlof and Yellen (1990) stress the importance of fairness considerations for workers’ effort choices. In labor relations where effort is not perfectly contractible workers’ performance might depend on the perceived fairness of their salary. The core assumption of the fair wage-effort hypothesis is that workers compare their wage w to the fair wage w^*. Effort is assumed to be increasing in w as long as a worker’s wage falls short of w^*; wage increases beyond w^* do not increase effort further. In this paper, we investigate this hypothesis experimentally, using a three-person gift exchange game as our work horse.

There is by now a large body of experimental evidence showing the importance of reciprocity in social exchange situations. Starting with Fehr, Kirchsteiger and Riedl (1993), the literature on gift-exchange experiments shows that on average the effort of experimental workers increases in the generosity of the wage offered by the employer.[1] The existing experimental literature focuses largely on *bilateral* relations between an employer and a worker, or, in other words, on a ‘vertical’ comparison within a firm's hierarchy. Especially in real workplaces, however, it is most likely that Akerlof and Yellen’s “fair wage” is to a large degree determined by ‘horizontal’ comparisons among employees. It is likely that people take their peers, that is, co-workers who are comparable to them, as reference group for social comparisons (e.g., Falk and Knell (2004); Clark and Senik (2009)). If social comparisons are important for work morale, internal pay structures (including wages, fringe benefits, and other perks) are important for performance. In the words of Bewley (1999) who interviewed more than 300 personnel managers: “The main function of internal structure is to ensure internal pay equity, which is critical for good morale” (p. 82).[2]

In this paper we investigate these morale effects experimentally. We concentrate on wage effects and use a three-person gift exchange game (one employer, two employees) to measure the influence of wage differences on efforts. As common in gift-exchange experiments, effort is costly for employees but higher efforts increase total welfare. We are in particular interested in observing $e_i(w_i, w_j)$, where e_i denotes worker i’s effort as a function of his or her own wage and the wage of a co-worker. From previous experiments we predict that $\Delta e_i/\Delta w_i > 0$, that is, on average employees react reciprocally to their own wage (despite material incentives to choose minimal effort irrespective of wages). The three-person gift exchange experiment allows a direct measurement of $\Delta e_i/\Delta w_j$, that is, *wage comparison effects* – the average reaction of a worker's effort to an observed change in the co-worker's wage. Of particular interest for us are situations of “pure” pay inequity, that is, inequitable situations that are not justified by situational differences, or differences in performance or merit, which

[1] See, for instance, Fehr, Gächter and Kirchsteiger (1997); Fehr, Kirchsteiger and Riedl (1998); Fehr, Kirchler, Weichbold and Gächter (1998); Fehr and Falk (1999); Hannan, Kagel and Moser (2002); Brandts and Charness (2004); Charness, Frechette and Kagel (2004) and Charness (2004). For gift-exchange games with more than one employee see Maximiano, Sloof and Sonnemans (2007).

[2] See Campbell and Kamlani (1997) and Agell and Bennmarker (2007) for similar findings. Pfeffer and Langton (1993) and Clark and Oswald (1996) show that there is a significantly positive connection between an employee’s relative income and job satisfaction. Loewenstein, Thompson and Bazerman (1989) provide a psychological account of inequality in social comparisons.

equity theory (e.g., Adams (1965); Selten (1978); Güth (1994); Konow (2000)) would predict are acceptable. In the cases we study, unequal pay is simply wage discrimination.

For answering our research question we planned three studies. In *Study 1* we use three-person gift exchange games played in the usual sequential (direct response) mode. We repeat the basic three-person gift-exchange game eight times and randomly re-match groups of three players in each round. This is the simplest extension of the two-player game to allow for wage comparison effects. On average our experimental evidence supports Akerlof and Yellen's fair wage-effort hypothesis, if we assume that a worker takes the co-worker's wage as the reference wage. This assumption is plausible because in our experiment workers are identical, act in identical decision situations, and only receive information about their own and their current co-worker's wage. We find that experimental workers who face disadvantageous wage discrimination (that is, who are paid less than their colleague) significantly reduce their effort relative to a situation with equal wages.

In Study 1 we focus on average wage comparison. In *Study 2* we focus on individual differences in wage comparison. Heterogeneity is *ex ante* plausible in our environment, given what we know from previous research on social preferences (see, e.g., Fehr and Fischbacher (2002); Camerer and Fehr (2006); and Gächter and Thöni (2007) for surveys). Study 2 investigates individual heterogeneity by using the strategy method to elicit effort reactions given all possible wage combinations. This has the advantage that we can elicit $e_i(w_i, w_j)$ for each individual and *all* possible wage combinations, not just those that happen to arise under the direct response mode. The results show that the *average* effort reaction is again consistent with the fair wage-effort hypothesis. Yet, the average masks a large degree of heterogeneity. We observe a large variety of wage comparison patterns and provide a classification.

Finally, *Study 3* explores whether wage comparison effects are due to intentional wage discrimination or due to payoff differences. This question is interesting, given recent evidence that fairness concerns are strongly influenced by perceived intentions (e.g., Falk, Fehr and Fischbacher (2008)). To test for the role of intentions we conduct an experiment where a random device chooses the wages. Thus, employers are not responsible for discriminatory wage arrangements. We find that the employer's intention to discriminate wages rather than mere payoff consequences triggers the wage comparison effects.

We see our experimental approach as complementary to other, more conventional empirical methods. The existing empirical studies paint a mixed picture about the consequences of wage inequality.[3] We use laboratory experiments to cleanly isolate wage comparison effects from other confounding factors such as differential productivities and abilities. Our design allows us to observe morale effects directly.[4] Moreover, if wage comparison effects are behaviorally important and can have negative morale effects as

[3] Some studies find that internal pay dispersion is detrimental for work morale and job performance (e.g. Cowherd and Levine (1992); Pfeffer and Langton (1993); Grund and Westergaard-Nielsen (2008); and Martins (2008)), others fail to find that pay dispersion has any effect on employees' behavior (e.g. Leonard (1990)), and some studies even find that large pay differentials may have beneficial effects on firm performance (e.g. Main, O'Reilly and Wade (1993); Eriksson (1999); Winter-Ebmer and Zweimüller (1999); and Hibbs and Locking (2000)).

[4] For a neuro-economic study on social comparisons that uses a similar methodology see Fliessbach, Weber, Trautner, Dohmen, Sunde, Elger and Falk (2007).

suggested by Bewley's quote, we might not be able to observe wage comparison effects easily in the field because naturally occurring wage structures are already designed to avoid negative morale effects. Thus, experiments allow us to investigate the counterfactual, which helps us to understand the importance of internal wage structures.

Our paper contributes to a nascent experimental literature on pay comparison effects.[5] An early paper is Güth, Königstein, Kovács and Zala-Mezõ (2001). They investigate a trilateral principal-agent game where the two workers differ in productivity. The principal offers two separate contracts to the two workers. The treatment variable is the information workers receive about the contract of the other worker. The results show that contractual conditions are less asymmetric when workers can observe each others' contracts. Cabrales and Charness (2000) get a comparable result in a framework with asymmetric information (the principal does not know the type of his two agents). Our paper differs from these studies because our focus is not on contract design but on the agents' behavior. Charness and Kuhn (2007) lies closer to our goals. In contrast to Güth, et al. (2001) they ran three-person *gift-exchange games* where experimental workers differ in their productivities. They do not find systematic wage comparison effects.[6] Clark, Masclet and Villeval (forthcoming) study bilateral gift exchange games where workers learn the attractiveness of their work contract relative to other contracts in the market. They show that the rank of the own wage within the wages in the observed contracts significantly influences efforts. Abeler, Altmann, Kube and Wibral (forthcoming) look at a situation in which equality can also be unfair. To achieve this, they change the order of moves: Agents first choose their efforts and the principal then decides (in one treatment) whether to pay equal or unequal wages (in a control treatment the principal is forced to pay equal wages). The results support equity theory, which in their case, often predicts unequal wages due to unequal effort.

Our study differs in two important aspects from all previous studies. Firstly, in our setup workers are *ex ante* in identical positions because they do not differ in their productivity at the time wages are set. Secondly, we are interested in individual heterogeneity and therefore offer two further experiments that allow us to discuss inter-individual differences.

II. Design and procedures

This section sets out the basic structure of the three-person gift exchange game that is common to all three studies, which we describe in detail in sections III to V. In order to study the effect of wage comparisons among workers we adapt the standard bilateral gift exchange game (Fehr, et al. (1993)). In particular, we study a three-person gift exchange game in which

[5] A related literature using the gift-exchange game or similar games is on 'social interaction effects', that is, how the mere observation of others' behaviors influences own decisions. See Gächter, Nosenzo and Sefton (2008), Thöni and Gächter (2009) and Mittone and Ploner (2009). For studies on social comparison effects using the ultimatum game see, e.g., Knez and Camerer (1995); Bohnet and Zeckhauser (2004) and Alewell and Nicklisch (2009).

[6] Hennig-Schmidt, Rockenbach and Sadrieh (forthcoming) found neither an own-wage nor a wage comparison effect in their field experiment. Subsequent laboratory experiments (which only controlled for own wage changes) revealed that the likely reason for the lack of an own-wage effect was that subjects in their field experiment did not receive any surplus information. Hence, attributions of fair or unfair treatment were hardly possible.

an employer is matched with two workers. The game proceeds as follows. First, the employer chooses two wages w_i and w_j for worker *i* and worker *j*, respectively. The employer is restricted to three wage levels – 10, 100, or 200 ECU (experimental currency units). The workers learn *both wages* and choose their effort $e_i, e_j \in \{1, 2, ..., 20\}$ simultaneously. This concludes the game and earnings are calculated. The employer's income is

$$\pi_E = 18\left(e_i + e_j\right) - w_i - w_j . \tag{1}$$

We restrict the employers' choice to three wage levels to reduce the complexity in wage comparisons. Three wage levels are sufficient to study effort choices in situations where the co-worker earns less, the same, or more. The production function is additively separable, that is, the two employees' efforts are perfect substitutes for the firm. We have chosen this simple way of aggregating the two efforts to total output deliberately since we want to examine the workers' wage-effort functions in a situation where the workers differ *only* with respect to the wage they receive.

The income of a worker *i* is given as

$$\pi_i = w_i - c(e_i) = w_i - 7(e_i - 1) . \tag{2}$$

Worker *j*'s income is calculated according to the exact same payoff function. The workers receive their wage and have to bear the costs of their own effort. For ease of understanding costs are linear in effort and minimal effort is costless. The marginal product of effort is always higher than marginal cost which makes full effort the surplus-maximizing solution.

Solving the three-person gift exchange game under standard assumptions results in minimal efforts and wages and thus predicts the absence of wage comparison effects. Introducing social preferences produces a large variety of possible patterns (see Thöni (2009)). This paper does not aim to test theories of social preferences but is designed to produce empirical facts about reactions to wage inequality in a stylized environment.

We ran all experiments in a computerized laboratory at the University of St. Gallen (Switzerland) using z-Tree (Fischbacher (2007)); and we used ORSEE (Greiner (2004)) for recruitment. Our data for the three studies covers a total of 544 subjects. Subjects were first year students with no prior experience in gift-exchange games. Upon arrival the subjects were allocated at random to the computer terminals. The experimental instructions explained the rules of the experiment in detail (see appendix). The subjects had to do several exercises to prove their understanding of the task. The experiment did not start before all subjects had answered all questions correctly. During the exercises and also when taking decisions subjects had access to a 'What-if-calculator'. This tool allowed calculating the payoff consequences for hypothetical values for w_1, w_2, e_1, and e_2. Before the experiment started, every subject had to calculate the three players' incomes for four exemplary wage and effort combinations. This procedure ensures familiarity with the 'What-if-calculator'. The participants used the 'What-if-calculator' frequently. On average they did 22 ($\sigma = 16$) calculations during the experiment. As in previous gift exchange experiments (e.g., Fehr, et al. (1997)) we presented the experiment in a 'buyer-seller' frame, where buyers first choose two prices and the seller chooses the quality level of product, which we deem to be more neutral with regard to our research question than a labor relations frame.

Note from the payoff functions (1) and (2) that both the workers and the employer can take losses. In order to prevent overall losses, all subjects received a fixed payment of 400 ECU at the beginning of the experiment. For the sessions with several rounds subjects were paid for one randomly selected round. Subjects earned on average € 9 in this experiment. The experiments in Study 1 lasted about an hour; in Study 2 and Study 3 about half an hour.

III. Study 1: The importance of wage comparison effects

For Study 1 we conducted three experimental sessions with 36 subjects each. This provides us with observations from 108 subjects, 36 employers and 72 workers. We repeat the game described in the previous section for eight rounds keeping roles constant and using a random matching protocol within matching groups of twelve subjects (that is, groups of three are randomly reformed each period). We applied random matching to minimize strategic effects. The three sessions provide us with nine independent observations and a total of 8×72 = 576 effort choices. At the end of each round the employer is informed about the efforts of both employees. Each employee is, however, only informed about her own payoff, which minimizes potential confounding interaction effects among the two workers.

Results

The employers in our experiment paid on average a wage of 63 ECU. In 44 percent of the cases they offered the lowest possible wage combination (10;10); more generous symmetrical wage offers occurred in 19 percent of the cases with (100;100) and 8 percent of the cases at (200;200). Asymmetric wage combinations occurred in 18 percent of the cases for (10;100 or vice versa); in 6 percent for (10;200); and in 5 percent for (100;200). Asymmetric wage combinations were quite frequent. More than half of all wage offers (52 percent) with at least one non-minimal wage contained asymmetric wages.

On average, the employees reacted reciprocally towards increases in their own wage. At the lowest wage the average effort was 1.37, at the intermediate wage 4.75 and at the highest wage 6.58. A minority of 19.4 percent of the workers chose the minimal effort in all eight rounds of the experiment. When paid the minimal wage, most of the workers (72 percent) always chose the minimal effort. These observations are consistent with a host of previous gift exchange experiments (see footnote 1).

Figure 1 shows the average effort for all nine wage combinations. Connected points show wage comparison effects, that is, the average efforts for a given own wage and for different co-worker's wages. Numbers indicate the number of observations for a given wage combination.

The wage comparison effects observed in this experiment do not seem to follow a clear pattern. At the minimum wage employees tend to increase their effort when the co-worker is paid a non-minimal wage. At the maximum wage employees tend to do the opposite, namely decrease their effort when the co-worker's wage increases. The intermediate own wage of 100 is the most interesting one for comparison effects. Here we can observe the reaction to both advantageous and disadvantageous wage inequality. Earning more than the co-worker does not seem to affect efforts, while earning less than the co-worker leads to a substantial drop in average effort relative to the case when both workers earn a wage of 100.

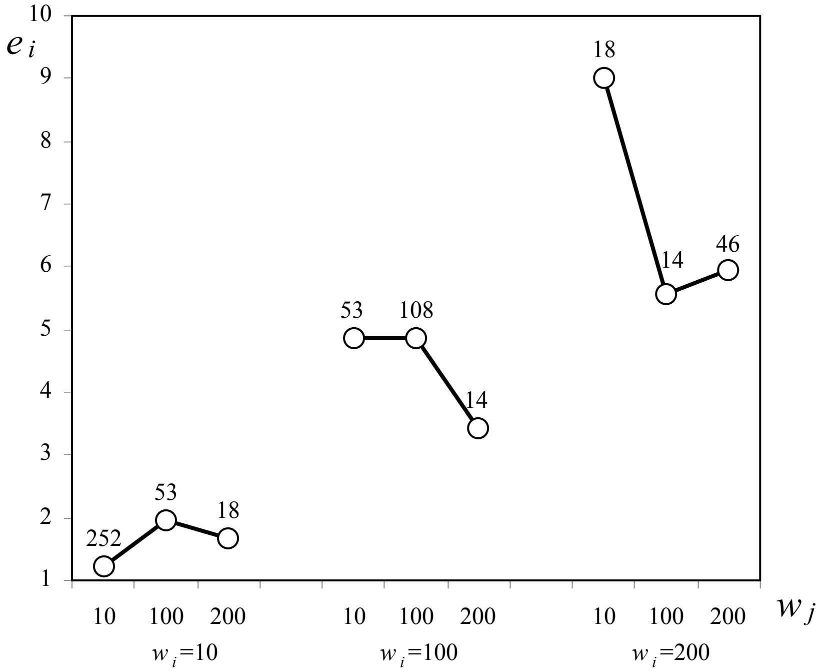


Figure 1: Average efforts for all nine combinations of the own wage and the other employee's wage. Numbers indicate the number of observations for a given wage combination.

The question is whether these wage comparison effects are systematic. We use random-effects estimates to check for significant wage comparison effects, controlling for time effects and individual heterogeneity. We include wage variation by two dummies indicating the low and high wage, with the intermediate wage as omitted case. The first model in Table 1 shows that efforts are significantly increasing in the worker's own wage. We add two similar dummies for the other worker's wage. The dummy for $w_j = 10$ is small and insignificant, on the other hand, the dummy for $w_j = 200$ is much larger and just about 10 percent significant ($p = .099$). The coefficient is negative, which means that employees tend to reduce their effort for a *ceteris paribus* increase of the co-worker's wage from 100 to 200. The estimate does not change if we include period effects (second model).

We apply additional estimates to investigate separate wage comparison effects in case a worker is paid the low, intermediate or high wage. The remaining three models in Table 1 show the results of random effects models for each of the three levels of a worker's own wage. These estimates correspond to a set of three line-connected dots in Figure 1. The wage comparison effect at $w_i = 100$ for a high co-worker's wage is now highly significant. Workers do reduce their effort when they are paid less than their co-worker. Note that this is basically the only comparison that allows to measure employees' reactions to disadvantageous wage inequality, because in the situations with $w_i = 10$ efforts are so low that most employees cannot react to changes in w_j. So the reaction to disadvantageous wage inequality shown in Figure 1 is highly significant when we control for period effects and individual heterogeneity.

This is not the case for the pronounced drop at $w_i = 200$, which remains insignificant in our estimates.

	Random effects GLS				
	All obs		w_i=10	w_i=100	w_i=200
w_i=10	-3.675**	-3.553**			
	(0.449)	(0.436)			
w_i =200	2.474**	2.505**			
	(0.723)	(0.745)			
w_j=10	0.005	0.123	-0.667	0.316	2.203
	(0.389)	(0.411)	(0.404)	(0.299)	(1.570)
w_j=200	-0.695	-0.665	-0.271	-1.225**	0.291
	(0.421)	(0.405)	(0.411)	(0.393)	(0.981)
Period		-0.106*	-0.060	-0.153	-0.251
		(0.046)	(0.049)	(0.099)	(0.215)
Constant	4.919**	5.253**	2.209**	5.447**	7.046**
	(0.271)	(0.354)	(0.472)	(0.432)	(1.366)
prop> χ^2	0.000	0.000	0.125	0.005	0.079
N	576	576	323	175	78

Table 1: Random effects GLS estimates for the effort choice, all observations and for the three levels of a worker i's wage. In parentheses: robust standard errors clustered on matching group; * denotes significance at 5 percent, ** at 1 percent. The intermediate wages are the omitted cases.

Discussion

It is interesting to contrast our findings with those of Charness and Kuhn (2007) who also found a strong own-wage effect but little evidence for wage comparison effects. We find clear support for the importance of wage comparison in the domain of disadvantageous wage inequality.[7] The results for $w_i = 100$ fit perfectly to the asymmetric pattern proposed by Akerlof and Yellen (1990), if we assume that the other worker's wage determines the reference wage. At $w_i = 200$, where we only observe advantageous wage inequality, we cannot find systematic wage comparison effects.

While we allow for individual heterogeneity in efforts in our estimates, we still measure an average reaction to wage changes. However, it might well be the case that also these reactions to wage changes differ systematically across individuals.[8] Furthermore, wage offers, and therefore also wage inequality, arise *endogenously* in this experiment, which implies that

[7] One reason for the difference between Charness and Kuhn and our results might be the fact that in their experiment workers differed in productivity. A setup with asymmetric workers makes the interpretation of wage discrimination more difficult and thus lead to more variance in the behavioural reactions.

[8] Given the literature on heterogeneity with regard to reciprocal behaviour, one should also expect heterogeneity with regard to wage comparisons. The best explored area of individual heterogeneity is public goods experiments conducted with the strategy method. In these experiments subjects indicate how much they contribute as a function of others' contribution. The result is great heterogeneity: Some are free rider types, whereas others reciprocate others' contributions. See, e.g., Fischbacher, Gächter and Fehr (2001); Fischbacher and Gächter (forthcoming); Herrmann and Thöni (2009); Kocher, Cherry, Kroll, Netzer and Sutter (2008); Muller, Sefton, Steinberg and Vesterlund (2008) and Thöni, Tyran and Wengström (2009). For an experiment using the strategy method in the gift exchange game see Gächter, et al. (2008).

some wage combinations are quite rare and therefore individual reactions to different wage combinations are only observed infrequently and unequally across cells. Running the experiment for more rounds does not solve the problem because it might induce strategic confounds (due to unavoidable re-matchings) and still does not guarantee the collection of a sufficient number of observations in all the different wage combinations for all employees. In Study 2 we therefore replicate our three person gift exchange game using the strategy method for the workers' effort decision. This will allow us to observe $e_i(w_i, w_j)$ for each individual, and not just some average $e(w_i, w_j)$.

IV. Study 2: The role of individual heterogeneity in wage comparison effects

We use the exact same experimental game as in Study 1 with the exception that we elicit workers' efforts by a variant of the strategy method (Selten (1967)). Like in the previous study employers decide on the wages but workers in this study choose their effort *before* they know the wages. Specifically, all workers have to fill in a 3×3 matrix to indicate an effort decision for every possible combination of their own wage and the wage of their co-worker. This information allows us to isolate the marginal effects of changes in the own wage and the wage of the other worker on the effort decision, that is, it allows to observe the whole wage-effort function $e_i(w_i, w_j)$ at an individual level. After workers have decided on their efforts for all possible contingencies, payoffs are calculated given the actual wages the employers decided to pay. Unlike in Study 1, subjects play the game only once in this study.

The strategy method is cognitively more demanding than the direct response mode since the subjects have to take choices for all possible situations. Therefore, we took great care to explain the procedure in detail. Like in the previous study subjects had access to the 'What-if' calculator. In some of the experimental sessions the subjects in the role of the employer were asked to fill in the same 3×3 matrix as the workers. There they should enter their expectations about the wage-effort function of the workers. This was done after they had chosen their wages, but before they were informed about the outcome of the game. We will use these data to discuss the robustness of our findings.

Results

We ran twelve sessions and observe 185 individual wage-effort functions. Like in Study 1 employees on average reacted clearly positively to their own wage.[9] At the lowest wage, employees chose an effort of 1.4, at the intermediate wage the average effort was 5.0, and the high wage resulted in an average effort of 9.1 (see Figure 2). Forty-seven of the 185 employees (25 percent) chose the own-payoff maximizing strategy (minimal effort in all nine cases). A majority of the employees (121 subjects, or 65 percent) chose a consistently reciprocal pattern, that is, given w_j, an increase of w_i led to weakly higher efforts. Most of the

[9] Wages were similar as in Study 1: In 33 percent of the cases employers chose (10; 10); symmetric non-minimal wages were chosen in 27 percent for (100;100) and 9 percent for (200; 200) of the cases. Unequal wages were paid in 14 percent (10; 100 or vice versa); in 2 percent (10; 200) and in 15 percent (100; 200) of the cases. Again, once an employer chose to pay at least one non-minimal wage, unequal wages are observed in about half of the cases (47 percent).

remaining employees chose some non-monotonic strategy, while one employee chose a decreasing pattern.

Figure 2 uses the same structure as Figure 1 to illustrate average efforts at any given wage distribution. Here we do not display the number of observations because the strategy method gives us all 185 individual decisions for all wage combinations. For comparison we show the results of Study 1 by small dots. The overall degree of reciprocity towards the employer seems to be quite similar when we consider the low and the intermediate wage. For high wages ($w_i = 200$) we cannot confirm the large variation in the co-workers' effort observed in the direct response version of the game from Study 1. At least for the two lower wage levels, where the vast majority of observations from Study 1 stem, the two elicitation methods seem to produce very similar results. This supports the conclusion of a recent review of the literature on comparisons between the two elicitation methods by Brandts and Charness (2009).

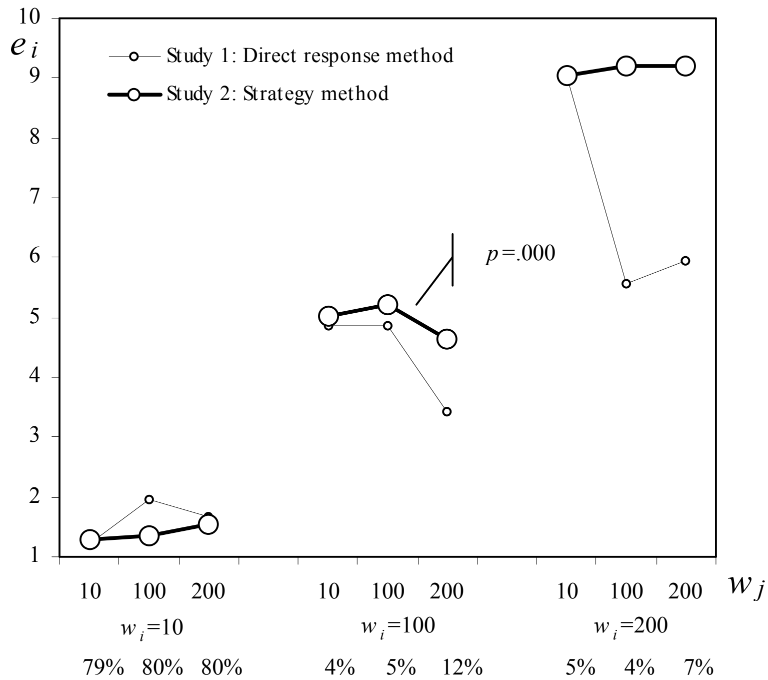


Figure 2: The average wage-effort function of all employees ($n = 185$). Percentage numbers below the figure show for all wage combinations the percentage of subjects with minimal effort among all subjects who at least once chose non-minimal effort ($n = 138$).

Concerning the most interesting case where employee *i* earns the intermediate wage we now observe an inverted u-shaped influence of the co-worker's wage. Efforts were highest when both employees earned the intermediate wage, decreased somewhat (by 0.22 effort units) when the other worker earned less and decreased more than twice as much (by 0.58 effort units) when the other worker earned more than worker *i.* This latter effect is highly significant ($z = 3.763$, $p = .000$, $n = 185$, Wilcoxon matched-pairs signed-ranks test). All other comparisons of line-connected dots in Figure 2 are insignificant with $p > .122$.

While the size of the wage comparison effect at the intermediate wage does not seem to be large (relative to reactions to changes in the worker's own wage) it is still a clear indication that, on average, people react negatively to disadvantageous wage discrimination. The comparison to the data from Study 1 suggests that average reactions to disadvantageous wage-discrimination might be underestimated in Study 2 due to the use of the strategy method.

This result supports the existence of wage comparison effects in case of disadvantageous wage inequality. Recall that the significant effort differential is the only case where an employee can react to *disadvantageous* wage inequality. There are two other wage combinations where an employee is also in a disadvantageous situation, namely $(w_i,w_j) = (10,100)$ and (10,200). However, even among the employees who chose non-minimal effort in at least one situation the vast majority (79 percent) could not lower the effort in this situation since they chose minimal effort already in the (10,10) situation. The percentage number of subjects who chose minimal effort in a particular situation is indicated on the bottom line in Figure 2 (the 25 percent of subjects who always chose minimal effort are excluded). Here we see further support for the notion that being put in the disadvantageous situation influences the effort decision. The percentage number of employees choosing the lowest possible effort increased from 5 to 12 percent. This change is significant at $p = .007$ (McNemar test). In the domains of advantageous wage discrimination, where employee i earns more than employee j, wage comparison effects are absent on average.

Heterogeneity

The average wage-effort function shows evidence for wage comparison effects in the domain of disadvantageous wage inequality. In the domain of advantageous inequality, wage comparison effects do not seem to matter. However it might be the case that the average wage-effort function hides interesting individual heterogeneity. This is in fact the case.

Among our 185 employees 47 (25 percent) chose minimal effort in all nine wage combinations. For these people own-payoff maximization apparently dominates any reciprocity or wage comparison effects. For the following analysis we therefore consider only the 138 observations with at least one non-minimal effort choice. We distinguish between four different patterns: (i) 20 percent of the employees do not differentiate their effort when the other employee's wage changes. We call this type of employee the *Unconcerned*. (ii) Fourteen percent of the employees seem to reward their employer for a generous wage policy towards the other employee, that is, their effort is weakly increasing in w_j. We call this type of behavior *Altruistic*. (iii) As an opposite reaction to altruism we have employees who (weakly) decrease their effort with higher co-worker's wages. The 28 percent of the employees who exhibit such a pattern are called *Envious*. These three types account for 62 percent of the observations.

Among the remaining observations many show a hump-shaped pattern at a wage of 100. Such a pattern can be interpreted as a preference for equal wages. An employee who, given the own wage, chooses a weakly higher effort in situations where the other employee has the same income is classified as *Equity-oriented*. Ten percent of our observations follow this pattern.[10] The remaining 28 percent of the observations show different patterns.[11] Figure 3 shows the average wage-effort function separated by type.

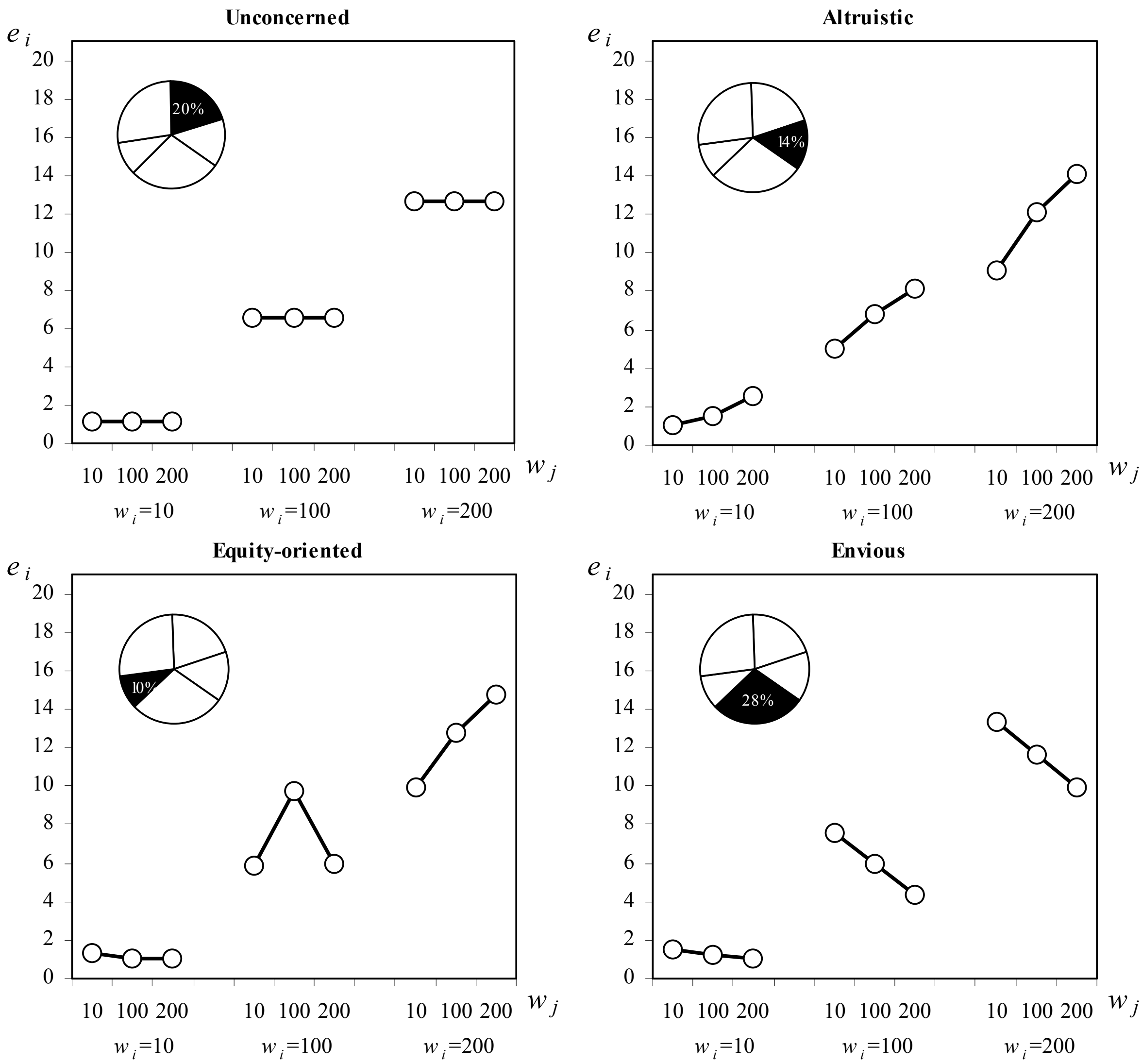


Figure 3: Average wage-effort function of the four types of employees' behavior with some non-minimal efforts across different wage combinations.

[10] Note that the definitions *Equity-oriented*, and either *Envious* or *Altruistic* are not mutually exclusive. Our classification scheme favors *Envious* or *Altruistic* over *Equity-oriented.* If we would favor the *Equity-oriented* classification over the other two we could classify 16 percent of our observations as *Equity-oriented*.

[11] When introducing a large number of types there is a potential danger of classifying noise into categories. We check whether the distribution of types observed in our experiment is systematic by comparing it to the distribution of types generated by random wage-effort functions. If we assume that efforts are chosen randomly the observed distribution of types is trivially different from randomly generated types due to the fact that in the latter case *Unconcerned* occur with virtually zero probability $(.05^2)^3 \approx 0.000$. In a less restrictive scenario we allow for a systematic increase of effort in w_i. We assume that each worker chooses some intermediate e_i whenever w_j=100 and then randomly decides to increase, decrease or leave unchanged the effort for every change in w_j with equal probability. Also in such a simulation the probability of observing an *Unconcerned* is very small ($p=((⅓)^2)^3 \approx .0014$, which is still an order of magnitude away from what we observe in our experiment. A χ^2-test of the simulated against the observed distribution of types yields p=.000, thus our wage comparison effects are clearly not random.

The pie diagram shows the fraction of employees who chose a wage-effort function of the respective type. Interestingly, the average reaction to changes in an employee's own wage is very similar across the four types. This can be confirmed when comparing the average effort increase connected with an increase of the own wage. The hypothesis that the average increase in effort of all four types stem from the same distribution cannot be refuted ($p = .471$ for the step from $w_i = 10$ to 100 and $p = .500$ for 100 to 200, Kruskal-Wallis tests).

Strength of wage comparisons

Our analysis thus far showed that a majority of our subjects who at least once chose a non-minimal effort reacted in some way to the other worker's wage. Since the strategy method allows us to observe a complete wage-effort function for each individual we can also investigate how important, on average, reactions to own wages are relative to reactions to wage inequality. We calculate for both wages the average absolute reaction to *ceteris paribus* changes in wage.

Figure 4 shows how the two effects compare in strength. The size of bubbles is proportional to the number of underlying individuals. On the horizontal axis we denote the average reaction to a worker's own wage. On the vertical axis we depict the average reaction to changes in w_j. Both effects are measured in absolute average values.

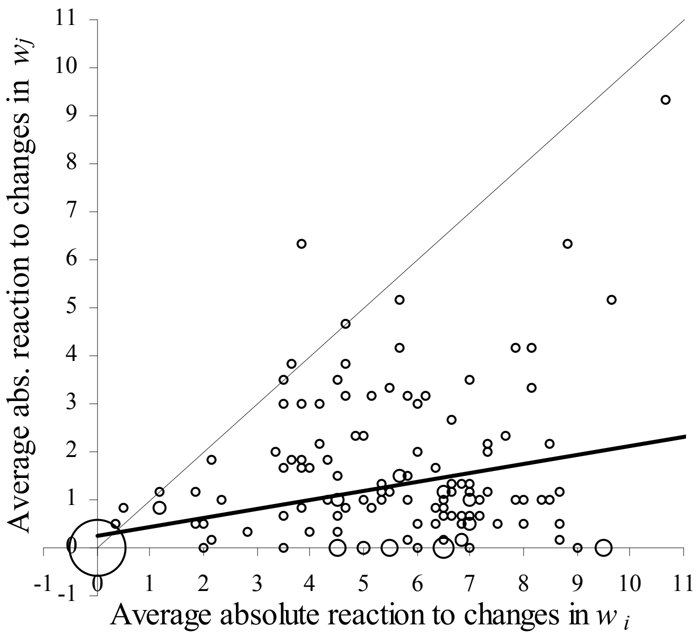


Figure 4: Bubble plot of the intensity of the reaction to the own wage and to the wage of the other worker. The thin line is the 45 degree line, the thick line is the OLS regression line.

Figure 4 shows that almost all observations are below the 45 degree line, that is, the reaction to changes in a worker's own wage are stronger than reactions to the changes in the co-worker's wage. A few observations are on the x-axis, that is, these subjects only react to their own wage but not at all to the wage received by the co-worker. There is also a substantial number of observations at 0-0. These subjects react neither to their own wage nor to their co-worker's wage.

The thick line depicts an OLS regression line, which indicates that reactions to w_i and w_j are positively correlated. The slope is.19 ($p = .000$), which shows that on average reactions to the co-worker's wage are one fifth of the average reaction to own wage.

Robustness

For a subset of subjects in the role of the employer we elicited their expectations about an employee's wage effort function. After they had chosen their wages we informed them that the experiment was over but asked them to fill in the same 3×3 matrix used for the employees. They were asked to indicate how they think an employee would react to different wage combinations. Subjects were informed that the answer to this question was not relevant for their payoff. Subjects entered their expectations before they learned the outcome of the game.[12]

We use these expectations data as a robustness check for our results. Figure 5 shows the average expectation about the employees' effort for all nine wage combinations. The thin lines show the decisions of the 185 employees observed in our experiment. Our expectations data from 75 employers presents a very similar pattern as that of the actual efforts. In particular, employers anticipated the asymmetric reaction to wage inequality: like in Figure 2 we find a significant drop in effort in case of disadvantageous wage inequality at the intermediate wage and no systematic effects in case of advantageous wage inequality. At intermediate wages the employers' expectations about the effort level are surprisingly close to the actual efforts, while for high wages employers tend to underestimate the reciprocity of the workers. However, the difference is not significant.[13]

Apart from average efforts we also observe quite similar heterogeneity of patterns in our expectations data. Among the employers 27 percent entered minimal effort for all wage combinations while in the actual decisions we observed 25 percent money maximizing behavior. In case of the wage-effort functions with non-minimal efforts we observe some differences between expectations and decision data. In the expectations data the frequency of *Unconcerned* and *Altruistic* is seven percent and thus lower than in the decision data. The *Envious* type is expected to occur in 38 percent (compared to 28 percent in employees' actual decisions). The *Equity-oriented* type is with 13 percent slightly more frequent and a relatively large portion of the data could not be classified (35 percent, compared to 28 percent in the decision data).[14] These differences are weakly significant (Pearson $\chi^2(4) = 8.021$. $p = 0.091$).

[12] Note that we did not ask them about their belief about their employee's efforts for the wages they actually paid. We did this deliberately in order to avoid problems of aggregating the wage-effort combinations of the two employees to a single belief. For beliefs it would make sense to think about the average wage-effort function. Our method puts employers in the shoes of an employee and gives an account for their expectation about what an employee would do in this situation.

[13] We compare the average effort at $w_i = 200$ using a two-sample Wilcoxon rank-sum test: $z = 1.22$, $p = .222$.

[14] This is not surprising given that the expectations elicitation was done without financial incentives. It is often observed that not paying the subjects increases variance in the data (see Smith and Walker (1993); Gächter and Renner (2006)).

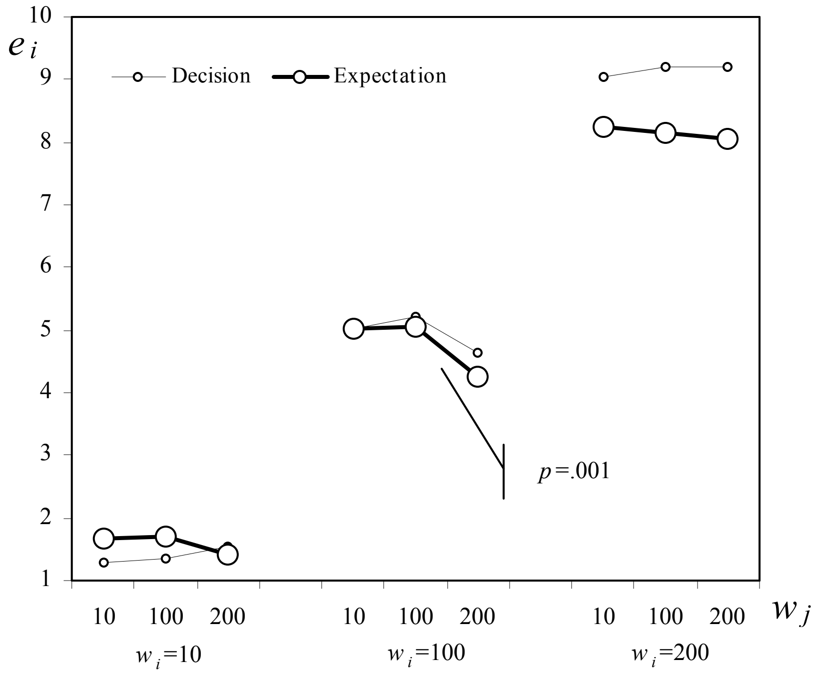


Figure 5: Employers' expectations about the workers' wage-effort functions.

Discussion

The results of Study 2 confirm the results of Study 1 in showing that there are significant wage comparison effects in the domain of disadvantageous wage discrimination. Consistent with the fair wage-effort hypothesis employees tend to reduce their effort when they are paid less than their co-worker but no equivalent effect is observed for overpayment. These average effects mask a surprisingly large variety of different patterns of wage comparison effects. Some workers seem to reward the employer for a generous wage for the co-worker, others do the opposite. These opposite sort of reactions can explain why on average wage comparison effects appear to be weak when in fact they are quite strong.

Why do we observe these wage comparison effects? In particular, what is the role of payoff differences relative to intentional wage discrimination, for wage comparison effects? Our Study 3 will address this question.

V. Study 3: The role of intentional wage discrimination for wage comparison effects

The goal of this study is to check whether the effort-reducing effect of disadvantageous wage inequality stems from aversion against intentional discrimination. Experimental and theoretical research on social preferences suggests that in addition to payoff comparisons intentions play a substantial role (e.g., Blount (1995); Dufwenberg and Kirchsteiger (2000); Falk, Fehr and Fischbacher (2003); Charness (2004); Falk and Fischbacher (2006); Falk, et al. (2008)). Therefore, effort reactions might be different if the resulting wage offers do not arise from the deliberate choice of the employer.

We ran three additional sessions with a non-intentional variant of our three person gift-exchange games. The experiment is exactly the same as in Study 2 with the exception that the employer does not choose the wages. Instead, a random device chooses the two wages on behalf of the employer, who does not take any decision (for similar designs see Blount (1995), Charness (2004), and Falk, et al. (2008)). The probabilities for each of the nine wage combinations are chosen to match the frequencies of wage offerings observed in Study 2. All subjects were informed about this procedure.

What should we expect from such a *Non-intentional* treatment? Workers presumably choose lower efforts in the case of disadvantageous wage inequality in order to express their discontent with the situation. If the employer is not responsible for wage inequality, there is no reason to punish him for unequal wages. We therefore expect the wage comparison effects to disappear in the experiments of Study 3. We also expect a reduced own-wage effect, in particular for non-minimal wages, because attributed kindness, in addition to payoff comparisons has been shown to be important in gift exchange (Charness (2004); Falk and Fischbacher (2006)).

Results

We observe the wage-effort functions of 70 employees. Figure 6 shows the average wage effort function of the *Non-intentional* treatments. For comparison we also show the results from Study 2. Similar to Charness (2004) we find that removing the 'intentionality' behind the wage offer reduces the strength of the reaction to wage changes. Low wages induce slightly higher efforts and high wages induce lower efforts relative to the case with intentional wage offers. Especially in the latter case our data shows stronger effects between the *Intentional* and the *Non-intentional* treatment than those found by Charness (2004). The average effort in all nine wage combinations is 5.2 in *Intentional* versus 3.9 in *Non-intentional*. This difference is highly significant.[15]

[15] A two-sample Wilcoxon rank-sum test returns $p = .002$. This is partly due to the fact that a higher fraction of the subjects (37 percent) chose minimal effort in all nine wage combinations. In Study 2 we observed 25 percent. The difference is weakly significant by a two sided Fisher exact test ($p = .087$). However, even if we consider only the subjects with at least one non-minimal effort the difference between the two treatments in average efforts remains significant with $p = .005$.

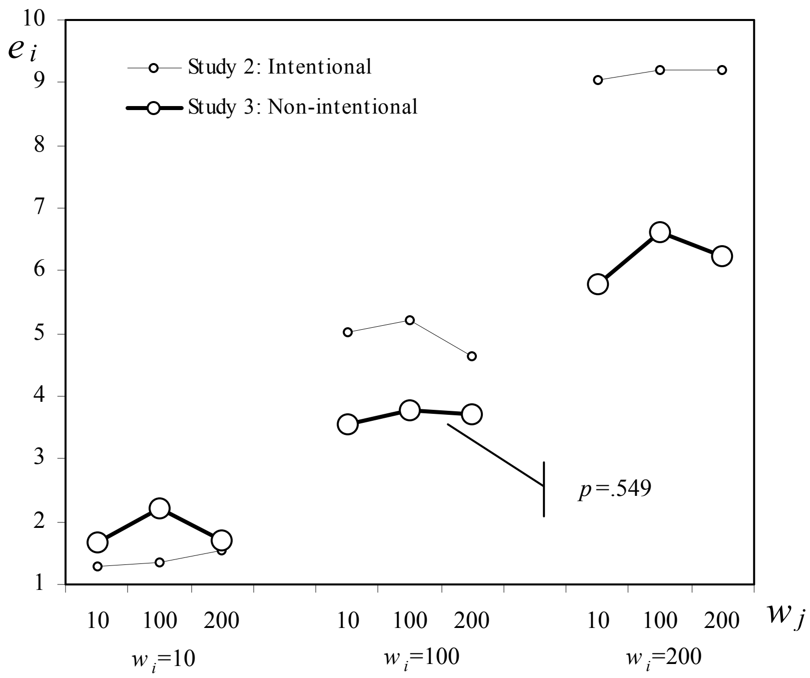


Figure 6: Average wage-effort function in the *Non-intentional* treatments of Study 3 and the results of Study 2 for comparison.

The drop in efforts in case of disadvantageous wage inequality at intermediate wages disappears almost entirely. The tiny drop of .07 effort units is insignificant and so is a McNemar's test for the probability of choosing a minimal effort between the $(w_i,w_j) = (100,100)$ and (100,200) situation. All differences between the line-connected dots in Figure 6 are insignificant at $p > .138$, with the exception of the increase between $(w_i,w_j) = (200,10)$ and (200,100). This comparison is significant at $p = .043$. Thus, removing the intentional aspect of disadvantageous wage discrimination does eliminate its effort-reducing effects.

This observation is also supported by the employers' expectations in the *Non-intentional* treatments (not shown in Figure 6). Average expected effort is with 5.0 in the (100,200) situation even slightly higher than in (100,100) with 4.9.

Heterogeneity

The fact that wage comparison effects disappear for the intermediate wage suggest that the change from the intentional to the non-intentional treatment also affects the distribution of types in the population. Figure 7 shows the percentage of each type of wage-effort function in the *Intentional* and *Non-intentional* treatment. Unlike in Figure 3 we now include observations from subjects choosing minimal effort in all nine situations, and coin them as *Egoistical*. Given that average efforts in *Non-intentional* were substantially below average efforts in *Intentional* it is not surprising that the percentage of *Egoistical* patterns is much larger in the former. Removing intentional wage payments leads to an increase in *Altruistic* types (from 11 to 14 percent). The other three types occur less frequently. Especially pronounced is the drop in *Envious* types (21 percent to 9 percent).

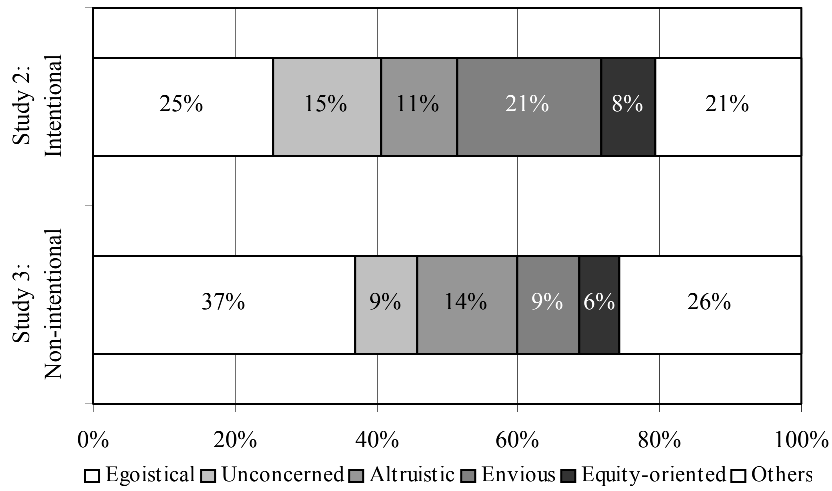


Figure 7: Average wage-effort function in the *Non-intentional* treatments of Study 3 and the results of Study 2 for comparison.

Overall the differences in the distribution of types is only weakly significant (Pearson $\chi^2(5) = 9.69$, $p = .085$). However, if we focus on two specific types where workers systematically punish the employer for disadvantageous wage inequality (*Envious* and *Equity-oriented*) we observe a combined drop from 29 percent to 15 percent when intentions are removed. If we test these two types against the remaining observations we observe a significant difference ($\chi^2(1) = 5.27$. $p = 0.022$). This clearly indicates that if we remove the intentionality behind wage discrimination the adverse effect of the co-worker's wage on a worker's effort is substantially reduced.

Discussion

The results of Study 3 show that it is rather the intentional aspect of wage discrimination that produces the effort reduction in case of disadvantageous wage discrimination and not pure payoff comparisons. On the other hand, when wage inequality is non-intentional, we observe slightly more *Altruistic* types, indicating that workers tend to compensate the employer not only for generous own wages but also for generous co-worker's wages. This makes sense if the driving force behind wage comparison effects is interdependent preferences (Sobel (2005)). For the *Intentional* treatments observed behavior is likely to be explained by a mix of interdependent preferences and reciprocal motives, leading to much more adverse reactions to unfavorable wage discrimination.[16]

We conclude that randomly generated wage discrimination does not systematically affect work morale. However, consistent with previous evidence (e.g., Charness (2004)) payoff concerns do matter with regard to own wages – higher wages induce higher efforts, although at a lower level than in the intentional treatment of Study 2.

[16] Pure reciprocity models like Dufwenberg and Kirchsteiger (2004) cannot explain wage comparison effects due to the fact that the kindness terms in these models solely depend on a worker's own (hypothetical) income. Explaining wage comparison effects would require a kindness dependent on how the employer treats the other worker. See Thöni (2009) for details.

VI. Concluding remarks

The results from laboratory experiments reported in this paper support the view that wage comparison is an important determinant for a worker's effort decision. We find strong wage comparison effects both in the three person gift exchange game in the direct response mode (Study 1) and when we use the strategy method (Study 2). Consistent with Akerlof and Yellen's fair wage-effort hypothesis (Akerlof and Yellen (1990)) we observe in both Study 1 and Study 2 that paying a worker less than his co-worker leads to a decrease in effort relative to a situation with equal wages. Paying a worker more than a co-worker does not increase effort levels *on average*. Study 3 revealed that the overall wage comparison effects are due to an aversion against intentional wage discrimination, and not due to resulting payoff differences.

A main result of our paper is that there is a large degree of individual heterogeneity in our data. We observe several patterns: some workers do not react at all to changes in the co-worker's wage, some increase or decrease their effort for changes in the co-worker's wage, and a fourth category chooses highest effort whenever the two wages are equal. Despite the high degree of heterogeneity, the observed wage comparison effects are clearly not random. In the case of advantageous wage discrimination the heterogeneous effects seem to counterbalance each other, leading to no systematic overall effect. In case of disadvantageous wage inequality the overall effect is clearly negative.

We see our experiment as a test for the existence of wage comparison effects: subjects in the role of the worker have no information about the reasons for wage discrimination and they take their decision under anonymity. We conjecture that our laboratory measure of wage comparison effects is a lower bound for the importance of wage comparison effects. This conclusion is suggested by a recent field experiment by Cohn, Fehr, Herrmann and Schneider (2009) who, consistent with our findings, found strong behavioral reactions to wage inequality.

Appendix

[In the following we will present all information subjects received during the experiment. We will show the information in the order the subjects received them. Editorial comments like this one are added in squared brackets.]

[First the subjects are welcomed orally outside the laboratory. After some introductory comments the subjects draw a card that assigns them randomly to one of the computer terminals. There they find the following written instructions:]

Instructions:

You are now taking part in an economic experiment that has been financed by various foundations for research promotion. If you read the following instructions carefully, you can – depending on your decisions – earn a considerable amount of money. It is therefore very important to read these instructions with care.

The instructions that we have distributed to you are solely for your private information. It is prohibited to communicate with the other participants during the experiment. Should you have any questions please contact us. If you violate this rule, we shall have to exclude you from the experiment and from all payments.

During the experiment your income will be calculated in points. You will receive an initial endowment of 400 points. It is possible that some decisions will result in losses. The points you lose will be subtracted from your endowment.

At the end of the experiment we will convert your point income to Francs at the following rate:

1 Point = 3 Rappen.

Your income will be paid out to you in cash at the end of the experiment.

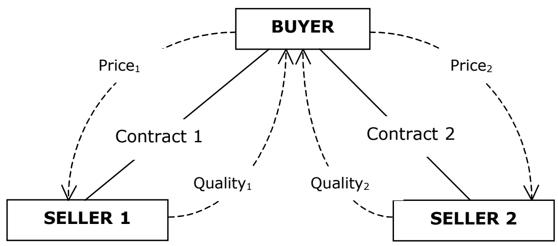
1. Introduction

In this experiment you will be matched with two other participants to a group of three persons. In the following the three persons will be called either "buyer" or "seller". **In each group there will be one buyer and two sellers**. At the beginning of the experiment you will be informed by the computer about whether you are a buyer or a seller.

The determination of your role and the group you are in is random. Neither during the experiment nor after the experiment you will be informed about the composition of your group, i.e., all your decisions are taken anonymously.

2. An Overview

The buyer has a separate contract with each of the to sellers as shown in the following figure:



In the first stage the buyer has to choose the **prices** he wants to pay to the two sellers. The sellers then choose the quality of the fictive product. A higher **quality** means higher production cost for the seller. On the other hand, the higher the quality of the product the higher is the income of the buyer.

The experiment has two stages:

1. The buyer chooses the price he wants to pay for the product for each of the two sellers. There are three possible prices that can be chosen. **The possible prices are 10, 100, or 200**.

2. The sellers choose the quality of their product. The **quality** of the product is represented by a **number between 1 and 20**.

The experiment is conducted only once.

3. The Calculation of the Incomes

When the buyer has chosen the two prices and the buyers have chosen their qualities then the incomes of the three participants of a group can be calculated. The calculation is as follows:

<u>Buyer</u>

The buyer receives revenue from the qualities the two sellers (1 and 2) have chosen. This revenue is 18 times the chosen quality in both contracts. From this revenue we have to subtract the two prices that the buyer pays. His income is therefore:

$$\boxed{\textbf{Income Buyer} = 18 * (\text{Quality}_1 + \text{Quality}_2) - \text{Price}_1 - \text{Price}_2}$$

The income of the buyer increases with higher quality of the two products. The prices he pays for the two products are subtracted from his income.

Seller 1

The income of Seller 1 depends on the price he receives from the buyer. From this price we subtract the costs of the provided quality. These costs depend on the provided quality. For each additional unit of quality the costs are 7 points. The minimum quality of 1 has no costs. Therefore the costs of the quality are calculated as 7 * (Quality – 1). The income of Seller 1 is calculated as:

$$\boxed{\textbf{Income Seller 1} = \textbf{Price}_1 - 7 * (\textbf{Quality}_1 - 1)}$$

The income of the seller only depends on his price and his quality. The higher the price the higher is his income. The higher the quality he chooses the lower is his income.

Seller 2

The income of Seller 2 is calculated exactly the same way as the income of Seller 1, except that, of course, the price and the quality of contract 2 enter the formula:

$$\boxed{\textbf{Income Seller 2} = \textbf{Price}_2 - 7 * (\textbf{Quality}_2 - 1)}$$

The calculation of the incomes will be shown with a hypothetical example:

Hypothetical example for demonstration purposes

Assume that the buyer chooses the following prices for his sellers:

Price for Seller 1 = 100

Price for Seller 2 = 10

The sellers choose the following qualities:

Quality Seller 1 = 9

Quality Seller 2 = 1

This situation results in the following incomes:

Income Buyer: The buyer receives 18 * (9 + 1) = 180 and pays a total of 110 to the sellers.

The income of the buyer is 180 – 110 = **70**.

Income Seller 1: Seller 1 receives a price of 100. The quality of 9 costs (9 – 1) * 7 = 56.

The income of Seller 1 is: 100 – 56 = **44**.

Income Seller 2: Seller 2 receives a price of 10. The quality of 1 costs (1 – 1) * 7 = 0.

The income of Seller 2 is: 10 – 0 = **10**.

When the experiment starts you will be informed about whether you are a seller or a buyer in this experiment. When you press the “continue” button a screen with control questions will appear. Here you will find a “What-if-calculator”. With this calculator you can try out different combinations of prices and qualities and calculate the resulting incomes. In the right panel of the screen you find the control questions. Here you have to calculate the incomes of all members of your group for four hypothetical situations. Press “Check” when you have completed the table. You will then be informed about whether your solution was correct.

It is important to note that all calculations you do with the “What-if-calculator” have no influence on the experiment and on the payments you will receive at the end of the experiment. The calculations are solely for your information.

When you have solved all control questions correctly you will be guided to the next screen where you have to make your decisions. Depending on whether you are a buyer or a seller you will have to choose two prices or a quality. In the screen where you enter your decisions you will again have the possibility to use the “What-if-calculator”.

Do you have any further questions?

[End of the written instructions. The subjects are then shown an introductory screen on the computer where they learn their type. The screen contains the following information:]

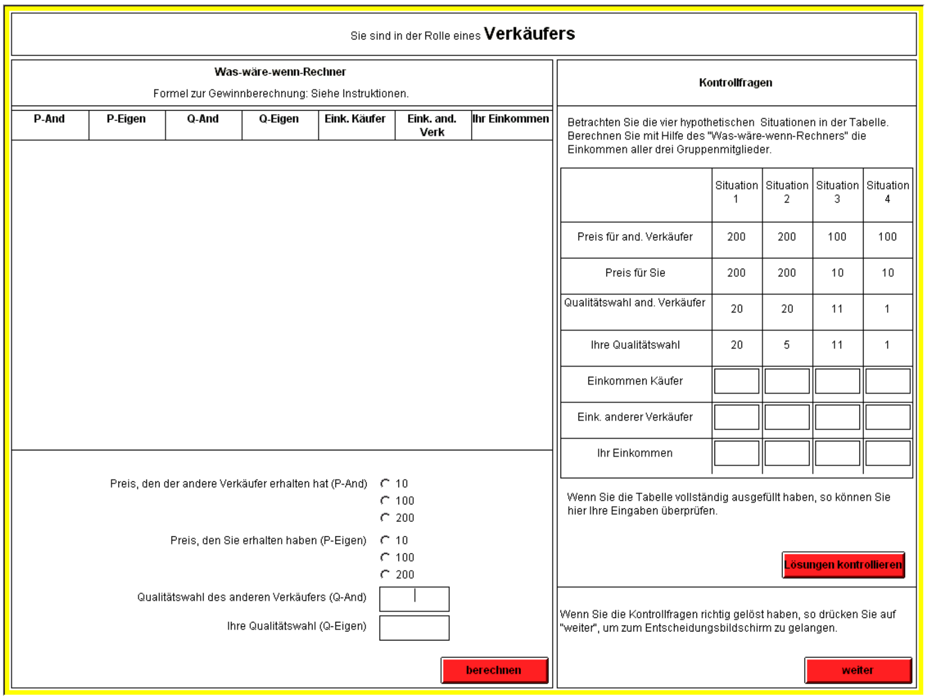
Welcome to the experiment

In this experiment you are in the role of a Seller [Buyer].

In the next screen you will be given some time to get used to the income calculation rules of this experiment. You will have to solve some control questions.

The purpose of the control questions is to test whether you have understood the calculation of the incomes of this experiment. Your answers do not have any influence on the experiment itself or on the payment you will receive at the end of the experiment.

[The next screen contains the “What-if-calculator” and four hypothetical plays of the game. The screenshot below shows the seller’s screen. The buyer’s screen differed slightly such that the subject’s own income was always on the rightmost column of the table. The four hypothetical plays of the game are the same for all subjects.]



[When the subjects succeed in answering the control questions they proceed to the next screen containing the following information:]

In the next screen you will have to enter your decisions. You still have access to the “What-if-calculator” where you can try out different combinations of prices and qualities before you make your final decision.

[The sellers’ screen provides additional information:]

The buyer in your group will choose his prices at the same time as you choose your quality. Therefore, you cannot know which price you will receive.

Since you do not know which price your buyer chooses, you will have to indicate your quality decision for each possible combination of your price and the price that the other seller in your group receives.

In the screen where you have to enter your decision you will be shown a table such as the one below. **For each of the nine possible combinations in this table you have to enter the quality (from 1 to 20) you want to choose in the corresponding situation**.

When you have completed the table and your buyer has chosen the prices then the computer will calculate the incomes with your quality according to the table. **One of the numbers in the nine fields of the table will be the decisive quality for the calculation of the incomes**.

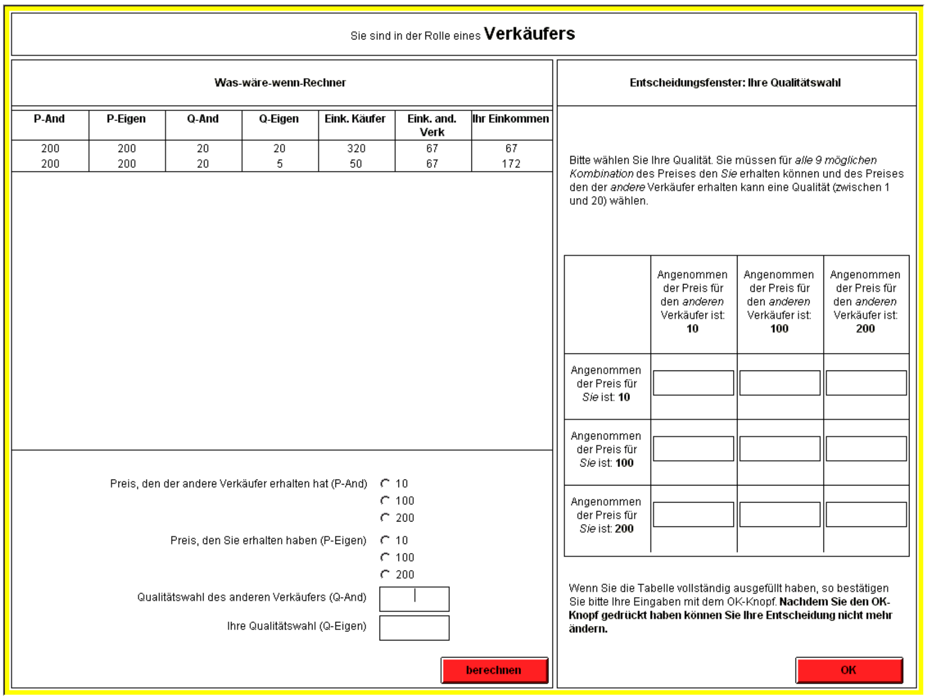
	Suppose the price for the *other seller* is: **10**	Suppose the price for the *other seller* is: **100**	Suppose the price for the *other seller* is: **200**
Suppose the price for *you* is: **10**	Here you have to enter the your quality	Y	
Suppose the price for *you* is: **100**			
Suppose the price for *you* is: **200**		X	

How to fill in the form: If you choose a quality of X in the situation where you receive a price of 200 and the other seller in your group receives a price of 100 then you have to enter X in the corresponding field (see the X in the table above).

Example for the income calculation: If your buyer chooses a price of 10 for you and a price of 100 for the other seller, then the incomes will be calculated with the quality you entered in the field marked by Y.

Please report to us if something remains unclear. Otherwise, please press “continue”.

[On the next screen the subjects have to make their decision. There is no explicit time limit. However, at the time most of the subjects have taken their decision we ask publicly to finish the decisions within the next 2 to 3 minutes. Below we show the input screen for the sellers. The left part of the screen is very similar in the buyers’ screen. On the right side, the buyers have to choose the two prices.]



[After having entered their two prices we ask them about their expectations. The buyers receive the following information:]

You have just chosen your prices. The experiment is therefore over for you. However, in the following we will ask you to answer a question. The answer on the question has no impact on your payoff in the experiment.

The question goes like this: What do you think the reaction of the sellers to different prices looks like? What quality will a seller choose if, e.g. he receives a price of 100 and the other seller receives a price of 10? What quality will he choose if both sellers receive a price of 100?

There are 9 different combinations of the two prices. In the next screen you should indicate which quality you think a seller will choose for all 9 combinations of the two prices. (Please note: You should not indicate the quality that you think is right from a moralistic point of view or the quality that you would like the sellers to choose. Instead, you should try to guess the quality that a seller will eventually choose.

[After having read this information the buyers see a screen where they can fill in the 3 x 3 matrix. The screen looks similar to the seller’s screen shown above. When all buyers and sellers have completed their entries the experiment ends.]

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