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Wage dispersion and workers` effort

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Abstract

We study experimentally the relationship between intra-firm wage dispersion chosen by principals and workers" performance. Principals show a preference for more egalitarian wage schemes, and workers are negatively influenced by high levels of wage inequality.

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1 Introduction

It is widely accepted that workers' efforts are positively influenced by their own wages (Fehr and Gächter, 2000). Less is known, however, with respect to the impact of intra-firm wage dispersion on workers' efforts and thus, the performance of the firm. Some theories —such as tournament models in the line of Lazear and Rosen (1981)— claim that intra-firm wage inequality has a positive effect on workers' efforts. They suggest that a large dispersion in performance-based wages, rewarding the most productive workers, stimulates workers' efforts since it increases the marginal incentives. Other theories suggest that within-firm wage compression enhances effort, though, due to the importance of fairness and cooperation among coworkers (Akerlof and Yellen, 1988, 1990). The importance of fairness in labour markets has been confirmed in a series of experimental gift-exchange games, initiated by Fehr et al. (1993). Contrary to standard game theoretical predictions under the assumption of rational payoff-maximizers, they found a positive relation between wages and effort, and wages above the market clearing level. Since the experimental setting of Fehr et al. (1993) and follow-up papers match one principal with one worker it is impossible to study the effects of intra-firm wage dispersion in such a design, however. It is equally problematic to measure the effects of wage dispersion on work effort outside the lab, because (i) it is often difficult to measure workers' efforts in the field, (ii) it is hard to determine a worker's reference group, and (iii) coworkers' wages are often not observable (perfectly) in the field. These limitations of field studies can be overcome in the lab. Charness and Kuhn (2007) designed an experiment where they were mainly interested in how coworkers' wages affect a worker's effort choice. They matched one principal with two differently productive workers. The principal could pay different wages to the two workers, and workers had to choose an effort. Charness and Kuhn (2007) found that the own wage, but not the co-worker's wage, determined a worker's effort level. Since workers were not informed about their coworker's productivity, though, it is possible that the null-effect of coworkers' wages was due to uncontrolled expectations about the coworker's productivity. For instance, if a worker expected the coworker to be more productive, and observed a higher wage of the coworker, this might be perceived as fair and there might be no need to condition one's own effort on the coworker's wage. Yet, if a worker perceived the coworker's wage as too high in relation to his expected (but unknown) productivity, then a worker might be inclined to reduce his effort contingent on his coworker's wage.

In this paper, we are going to resolve the possible confound through uncontrolled expectations and report the results of an experiment where productivity is known. By matching one principal with four workers we also extend the analysis of the effects of wage dispersion on effort levels to a larger setting where a worker can compare himself to more than one other coworker (as is typically the case in reality). We let a principal choose among various wage schemes that differ with respect to intra-firm

wage dispersion. By this approach we can examine principals' preferences for the wage dispersion among their workers and the relationship between intra-firm wage dispersion and workers' efforts.[1]

We find that in 44% of the cases principals choose the most egalitarian wage scheme, in 30% of the cases the intermediate scheme, and in 26% of the cases the scheme with the highest wage dispersion. Workers' efforts depend positively on their own wage, but they are negatively affected by high levels of wage dispersion.

In the following section we present the experimental design and procedures, in section 3 the results, and in section 4 we conclude.

2 Experimental design and procedures

In the experiment subjects played for 20 periods in groups of 5 members each, where each group included one principal and four workers. The roles of principal and workers were determined through a general knowledge quiz at the beginning of the experiment. Each session was run with 20 subjects. The four subjects with the highest number of correct answers were assigned the role of principal. The remaining 16 subjects were divided into quartiles, according to the number of correct answers, and the best quartile was assigned the role of worker 1, and the second, third, and fourth quartile the role of worker 2, worker 3, and worker 4, respectively.[2] All subjects kept their roles throughout the experiment. The groups of 5 members each were randomly rematched after each period, subject to including one principal and four workers in the roles of workers 1 to 4. The workers had different productivities, and all this was common knowledge.

Each period had two stages. In the first stage the principal had to choose a wage structure among the three different schemes shown in Table 1. In the second stage, the 4 workers were informed about the selected wage scheme, and thus about their wage, since the wage scheme determined each worker's wage. Then workers had to choose an effort level, with effort costs shown in Table 2.

SCHEME 1			**SCHEME 2**			**SCHEME 3**		
	Wage	Productivity		Wage	Productivity		Wage	Productivity
Worker 1	60	0.40	Worker 1	75	0.40	Worker 1	90	0.40
Worker 2	45	0.30	Worker 2	45	0.30	Worker 2	45	0.30
Worker 3	30	0.20	Worker 3	22.5	0.20	Worker 3	12	0.20
Worker 4	15	0.10	Worker 4	7.5	0.10	Worker 4	3	0.10
Total	150	1	Total	150	1	Total	150	1

Table 1: Wage schemes

[1] A paper by Clark et al. (2006) is somewhat related to our research question. They analyzed the effects of income comparison on effort where the reference group consisted of equally productive workers in different firms. They found that income comparison matters, especially downwards. While they were interested in inter-firm comparison our focus is on intra-firm comparions with differently productive workers.

[2] In case of ties, the computer ranked the subjects with the same number of correct answers randomly.

Effort	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Cost	0	2	4	8	12	16	20	24	30	36

Table 2: Effort levels and costs

Table 1 shows also the workers' productivities, which did not depend on the wage scheme. Worker 1 had always the highest productivity, and received the highest wage in each wage scheme. Worker 4 was the one with the lowest productivity, and got the lowest wage in any scheme. Whereas the ratio of most productive to least productive worker was fixed at 4:1, the three schemes imply ratios of the highest to the lowest wage of 4:1, 10:1, and 30:1.

The single workers' productivities yielded the average effort in the firm as follows:

$$Average\ effort = Effort_1 * 0.4 + Effort_2 * 0.3 + Effort_3 * 0.2 + Effort_4 * 0.1 \quad (1)$$

where *Effort*$_i$ is the effort level chosen by worker i. The average effort determined the firm's total product, and consequently the earnings of the principal and the workers, as follows:

$$Total\ product = Average\ effort * 300 \quad (2)$$

$$Earning\ Principal = 20 + 3/4 * Total\ Product \quad (3)$$

$$Earnings\ Worker\ i = Wage_i\ -\ Cost(effort_i) + 1/16 * Total\ Product \quad (4)$$

where $i = \{1, 2, 3, 4\}$. $Wage_i$ is the wage of worker i, and $Cost(effort)_i$ is the cost of his chosen effort level.

The experiment was conducted at the University of Innsbruck with the help of z-Tree (Fischbacher, 2007). Recruitment was done with ORSEE (Greiner, 2004). We conducted six experimental sessions, in which 120 subjects participated. Earnings were accumulated over the 20 periods, and each point was converted at the end of the experiment into 0.02 €. Sessions lasted less than 90 minutes, and on average subjects earned 18.30 euros.

3 Results

Table 3 shows how frequently the three wage schemes were chosen by the principals. A chi-square test reveals that the different schemes were not chosen randomly (p-value < 0.01). The most egalitarian scheme 1 was chosen most often, and scheme 3 with the largest wage dispersion least often.[3]

[3] This result is in line with Güth et al. (2001) and Charness and Kuhn (2007). They found that principals consider horizontal fairness and therefore reduce wage differences when the co-worker's wage is known.

Wage scheme	Absolut Frequency	Relative Frequency
1	213	0.44
2	143	0.30
3	124	0.26
Total	480	1

Table 3: Frequency of choosing different wage schemes

Table 4 shows the average effort (defined in section 2) contingent on the prevalent wage scheme. The first conclusion that can be drawn from table 4 is that average efforts are higher than the minimum of 0.1. The second conclusion is that the different wage schemes do not lead to significantly different efforts in the aggregate.

Wage scheme	Average effort
1	0.24
2	0.23
3	0.25

Table 4: Average effort and wage schemes

Table 5 reports average efforts by the different types of workers. Obviously, there is a positive relation between the wage and the chosen effort, as the workers with higher wages chose higher efforts (with a single exception for worker 3 in wage scheme 1, which is driven by an outlier). Accordingly, the dispersion in efforts is increasing in the dispersion in wages.

Type of player	Wage scheme 1	Wage scheme 2	Wage scheme 3
Worker 1	0.26	0.27	0.33
Worker 2	0.22	0.23	0.21
Worker 3	0.27	0.22	0.20
Worker 4	0.18	0.15	0.13

Table 5: Average effort by wage scheme and type of player

The overall percentage of subjects that chose the minimal effort is 48%, 52% and 57% in schemes 1, 2, and 3, respectively, with the difference between schemes 1 and 3 being statistically different ($p = 0.001$; Mann-Whitney U-test.) The large fraction of workers choosing the minimal effort is mainly due to workers 3 and 4. Workers 3 chose the minimal effort in 39%, 48%, and 60% of cases (with $p < 0.08$ in each pairwise comparison; Mann-Whitney U-tests), and workers 4 in 56%, 69%, and 82% of cases (with $p < 0.02$ in each pairwise comparison; Mann-Whitney U-tests).

So far we have examined the effects of different wage schemes on workers' efforts without controlling for the wages received by the workers. To determine the effects of the wage dispersion more rigorously we show in Table 6 the results of a panel tobit estimation with the effort level as the dependent variable. The independent variables are dummies for the wage schemes (with scheme 1 as the benchmark), the own wage, two interactions terms between the wage scheme and the own wage, the age, the gender (takes value 1 if the subject is a female), a dummy variable that takes value 1 if the subject studies Economics or Social Sciences, and the period.

Random-effects Tobit	Coefficient		*p-value*
	(I)	(II)	(III)
Wage scheme 2	-0.0062	-0.0186	-0.0140
	0.43	*0.30*	*0.44*
Wage scheme 3	-0.0119	-0.0416	-0.0351
	0.15	*0.03*	*0.07*
Own wage	0.0021	0.0012	0.0016
	0.00	*0.06*	*0.02*
Wage scheme 2 * Own wage		0.0003	0.0002
		0.44	*0.63*
Wage scheme 3 * Own wage		0.0008	0.0006
		0.09	*0.19*
Age			-0.0002
			0.95
Female			0.0393
			0.10
Study Econ/Soc.Sciences			-0.0134
			0.55
Period	-0.0071	-0.0071	-0.0071
	0.00	*0.00*	*0.00*
Constant	0.2237	0.2552	0.2298
	0.00	*0.00*	*0.01*
Number of observations	1920	1920	1920
Prob > chi2	0.0000	0.0000	0.0000

Table 6: Tobit estimation of the effort level chosen by the workers

As expected, the own wage has a strong and significantly positive effect on efforts. But in addition to that we find a significantly negative effect of the most extreme wage scheme 3, if compared to the most egalitarian scheme 1. Working in a group with an extreme dispersion of wages seems to undermine work morale. There is no such effect when we check the influence of the intermediate wage scheme 2. Although it has also a negative sign, it is not significant, suggesting that wage dispersion has a non-linear influence on effort levels. Low and intermediate dispersion have no downside effect on a worker's effort, hence the coworkers' wages are not important for own effort choices (which is then a finding similar to the one of Charness and Kuhn, 2007). The variable *Period* is significant and has a negative sign, i.e. effort levels decrease across periods, which is a standard finding (see Fehr and Gächter, 2000). The interacted variables are not significant, meaning that the combination of wage dispersion and own wage does not affect a worker's effort in systematic ways.

In sum, the results in Table 6 suggest that subjects care about wage dispersion when it becomes very large. This is also an indication that subjects have social preferences, i.e. they do not only care about their own wage, but also about the wage of the other subjects in their group.

4 Conclusions

This paper has analyzed the influence of wage dispersion on workers' efforts. We let principals in an experimental gift-exchange game choose among various wage schemes with different degrees of wage dispersion among four workers. We found that principals chose most often the wage scheme with the lowest wage dispersion, showing a preference for relatively egalitarian wage schemes. Workers reacted to

higher wages with an increase in efforts. However, workers reduced their effort, controlling for the own wage, when the wage dispersion reached its highest level, indicating that coworkers' wages matter.

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