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Abstract

We run a gift-exchange experiment under conditions of monetary neutrality: aggregate changes in nominal wages leave aggregate real wages unchanged. To achieve this, an employee's real wage is determined by the nominal wage divided by the price level (the average wages paid to others). Recent evidence (Grundmann, Giamattei and Lambsdorff 2019) shows that under these conditions, employees value the employers' intentions in setting nominal wages such that aggregate effort increases in response to increased aggregate nominal wages. We investigate whether this violation of the classical dichotomy leads to downward nominal wage rigidity and whether the violation can be exploited by policy makers. To do this, we implement an exogenous monetary policy shock after the first half of the experiment. Treatments UP and DOWN vary the direction of the shock. We hypothesize, first, that nominal wages exhibit downward rigidity because employers fear that a downward adjustment of the nominal wage would signal bad intentions, and second, that wages are upwardly flexible. We find that employers adjust wages flexibly upward and even excessively downward, while employees do not vary effort in response to the negative shock and reduce effort in response to the positive shock. We discuss possible reasons for these unexpected results as well as implications for our experimental design.

JEL C92, E31, E71

Keywords: Gift-exchange game; nominal wage rigidity; monetary neutrality, laboratory experiment, Phillips-curve.

1 Introduction

The idea that nominal wages are downwardly rigid has become a classical thought, originating with Keynes (1936: 264). It has been widely disseminated in economic textbooks. Samuelson and Nordhaus (2010: 801-804), to cite one popular example out of many, identify a Phillips-curve that is flat in a recession and steep in case of full employment and argue that this is partly explained by the downward rigidity of nominal wages. Downward rigidity of nominal wages has found broad empirical support (Kaur 2014, Dickens et al. 2007; Goette et al. 2007; Fehr and Goette 2005; Nickell and Quintini 2003; Dwyer and Leong 2003) and has also been held responsible for the large variation in unemployment and its correlation with the business cycle (Abbritti and Fahr 2013; Shimer 2005; Hall 2005). On the other hand, Elsby and Solon (2019) survey a wide range of more recent data to find that nominal wage cuts appear quite common and nominal wage freezes are infrequent. These opposing findings reflect a lack of consensus on when and why nominal rigidities occur, with heterogeneous explanations ranging from adverse selection in voluntary turnover (Campbell and Kamlani 1997) to money illusion (Agell and Bennmarker 2007). Held and Sadrieh (2017) examine nominal wage rigidity experimentally in a gift-exchange setting and find that employers do not sufficiently adjust nominal wages to externally induced variations of the exchange rate between nominal values and euros.

We take a different approach to the aforementioned studies and suggest a different reason for downward wage rigidity, namely the recognition of intentions. Our study is based on the prominent approach on nominal wage rigidity by Akerlof (2007): “A simple and natural amendment to the standard model explains such sticky money wages: that employees have a norm for what wages should be. According to that norm, they will lose utility from a money wage decline.” Changes in wages are then not only seen as a method for clearing the market. Rather, they signal adherence to or violation of norms that affect utility beyond purely monetary payoffs. They signal kind or unkind intentions and might bring about reciprocal action.

We investigate Akerlof’s conjecture experimentally to find out whether nominal wages are downwardly rigid in the face of monetary shocks, whether this can be explained by intentions and whether an expansionary monetary shock increases effort. To do so, we build on an experimental design by Grundmann, Giamattei and Lambsdorff (2019).

Our approach links the role of intentions to the positive slope of the Phillips-curve: Reductions in nominal wages can be seen as intentionally unkind, even when real wages are constant, inducing a reciprocal reduction in effort. The experimental design preserves monetary neutrality such that an aggregate reduction in nominal wages leaves aggregate real wages unchanged. Under these conditions, it has not yet been identified whether, first, wages are indeed downwardly rigid, second, whether attempts to decrease wages in response to a policy shock lower effort and, third, whether expansionary monetary shocks increase effort. Our aim is thus to investigate whether the non-neutrality reacts to policy changes. We hypothesize that nominal wages remain inertial in response to a downward policy shock, because employees would interpret decreases in nominal wages as signalling unkind intentions that deserve lower effort and reduced output. An expansionary policy shock, on the other hand, should lead to a flexible upwards adjustment. If the positive effect of increased nominal wages on effort persists even though the increase in wages is externally induced, this would mean that policy makers could exploit the positively sloped Phillips-curve.

Our results show that employers adjust nominal wages downward excessively and adjust wages upwards flexibly. Employees do not negatively reciprocate this downward adjustment and lower their effort in response to the wage increases. We thus find no evidence for downward wage rigidity and find effects that are contrary to what we would have expected. Some of these counterintuitive results, however, seem to be a result of substantial session differences in response to the downward shock. We extend our main analysis by discussing what this implies for our experimental design. Our investigation can thus be viewed as an exploratory study, which offers first indications of possible effects and discusses new avenues to address the research question in the future.

2 Experimental Design

Our basic design builds strongly on the design by Grundmann, Giamattei and Lambsdorff (2019). We adapt the gift exchange game from Fehr et al. (1993) and frame it as an experimental labor market. In each session, 20 subjects are randomly allocated the roles of employers and employees and keep these roles throughout the entire experiment. The experiment runs for 20 rounds *t.* At the beginning of each round, one employer and one employee are randomly matched into a pair *i.* Further, each pair *i* is randomly matched into a group *g* consisting of 5 employers and 5 employees, thus 5 pairs.

We use two currencies in the experiment, one being euros € and the other the experimental currency unit Taler 𝕋, with an endogeneous exchange rate between the two currencies.

In each of the 20 rounds, subjects make decisions in two stages. In the first stage, the employer chooses a nominal wage w_{it} to pay her employee in the currency Taler. Employers enter the nominal wage in a continuous manner and can also insert decimal numbers.[1] The range of possible wages differs between treatments and will be discussed in more detail below. The real wage in euros x_{it} results from dividing the nominal wage w_{it} by the mean wage paid by the four other employers in the group $o_{it} = \frac{1}{4}\sum_{j \in g; j \neq i} w_{jt}$:

$$(1) \qquad x_{it} = \frac{w_{it}}{o_{it}}$$

This endogenous exchange rate between Taler and euros implies that an employee's nominal wage positively impacts his own real wage but at the same time negatively impacts the other four employees' real wages. Therefore, the group's average real wage always amounts to $\frac{1}{5}\sum_{i \in g} x_{it} = €1$ such that an aggregate increase in nominal wages has no real effect (monetary neutrality).

The second stage of the experiment consists of employees choosing a level of effort e_{it} after they have been informed about their wage in Taler as well as the average wage paid by the four other employers. The higher the effort, the larger the benefit for the employer. Higher effort induces increasing marginal costs for the employee, which are displayed in table 1. All values in table 1 are common information and are given in Euros.

Table 1.
Benefits and costs of different effort levels

Benefit $\boldsymbol{e_{it}}$ for employer in €	1	2	3	4
Cost $\boldsymbol{c}(\boldsymbol{e_{it}})$ for employee in €	0	0.1	0.3	0.6

Finally, payoffs are calculated. The employer's payoff is determined by subtracting the real wage in euros that she pays from the benefit she receives from the effort exerted by the employee. The payoff for the employer in euros Π_{it} is given by (2):

$$(2) \qquad \Pi_{it} = e_{it} - x_{it}$$

[1] Around 90% of nominal wages entered turned out to be integers.

The employee's payoff is calculated by subtracting the costs of his effort $c(e_{it})$ from the real wage x_{it} he receives. The payoff for the employee in euros Θ_{it} is given by (3):

$$\Theta_{it} = x_{it} - c(e_{it}) \tag{3}$$

At the end of each round, all subjects are informed about all relevant variables for the current round: the nominal wage w_{it}, the average of four other nominal wages o_{it}, the resulting real wage x_{it}, the benefit resulting from the employee's effort level, the employer's round payoff Π_{it}, the cost resulting from the employee's effort level $c(e_{it})$ and the employee's round payoff Θ_{it}.

In each round, we also elicit beliefs. In the first stage, employers and employees are asked for their expectations regarding the average nominal wages paid by the other four employers in the group. This was incentivized with 0.5€ for a belief that was within a range of 0.1 of the correct value. During the second stage, employers are asked for their expectations regarding the effort exerted by their employee. Subjects received 0.05€ for a correct belief.

At the beginning of the 11th round of the experiment, we implement a monetary shock which alters the range of possible nominal wages. This is announced to all subjects at the beginning of round 11 and they are informed that everyone receives this information. Our treatment variation relates to the direction of the shock and varies the range of Taler wages. It either switches from a low wage range between 𝕋2 and 𝕋10 to a high wage range between 𝕋3 and 𝕋15 or the other way around.

In our UP treatment, subjects start off with the low range and are confronted with an expansionary monetary shock, increasing the nominal wages available. Our DOWN treatment runs in the other direction. Here, the first ten rounds are played using the high range and subjects experience a contractionary monetary shock in round 11, after which they switch to the low wage range for the rest of the experiment.

Importantly, both shocks, UP representing an expansionary policy and DOWN a contractionary one, are only nominal as they change the range of wages for all employers. Under such conditions of monetary neutrality, one might expect employees to only care about real wages. The shock should then be neutral for the choice of effort, because the average real wage still amounts to 1€ in every round. Nevertheless, in the presence of intention-based reciprocity, the shock is likely to induce real effects. An employer might be reluctant to reduce the nominal wage in wake of a contractionary monetary shock, fearing that this might be regarded as a signal of unkind intentions that might lead to retaliation

by her employee. Such fears are then likely to induce downward wage rigidity. Table 2 displays an overview of the treatments.

Table 2
Treatments overview

	UP	DOWN
Wage range	Low → High	High → Low

3 Procedures

We conducted the experiment at the PAULA Laboratory at the University of Passau using z-Tree (Fischbacher 2007) and Orsee (Greiner 2015). We ran 6 sessions in May and June 2019. 120 subjects participated of which 84.2 percent were female and who were on average 22.5 years old. The most frequent fields of study included cultural studies, law, teaching and media and communication studies. Subjects in the PAULA lab subject pool received an invitation to the experiment with the only selection criteria being German language skills and no prior participation in any of the sessions of this experiment as well as sessions of Grundmann, Giamattei and Lambsdorff (2019).

At the beginning of each session, subjects entered the lab and took their randomly allocated seats. They then received some general oral instructions which had been pre-recorded by one of the experimenters. After these, subjects were told to read detailed written instructions which were provided on paper. Subjects had 4 minutes to read the instructions, after which incentivised comprehension questions followed. Given that subjects received the instructions on paper, they could always refer back to them at a later point. Participants had to answer the comprehension questions correctly in order to continue and earned €0.1 per question if the question had been answered correctly in the first try. If subjects chose a wrong answer, a box appeared stating that the answer was wrong and had to be altered.

4 Model and hypotheses

The Nash equilibrium predicts that the employee will exert the lowest level of effort $e_{it} = 1$. The employer will anticipate this and thus only pay the lowest wage $w_{it} = \mathbb{T}3$ when confronted with the high wage range and $w_{it} = \mathbb{T}2$ when confronted with the low wage range. This means that the real wage will amount to $x_{it} = €1$, which results in a round payoff of $\Pi_{it} = €0$ for the employer and $\Theta_{it} = €1$ for the employee. This holds true in all rounds, given that the number of rounds is finite. We expect subjects to deviate from the Nash equilibrium and derive alternative hypotheses based on the model developed in Grundmann, Giamattei and Lambsdorff (2019). Employees are assumed to be guided not only by material interests $x_{it} - c(e_{it})$ but also by a sense for fairness or reciprocity. Therefore, utility for employee i in round t equals

$$U_{it} = x_{it} - c(e_{it}) - \beta_i(\dots) + \lambda_i(\dots). \quad (4)$$

β_i captures the disutility for unfairness, which depends on the real wage x_{it}. λ_i represents the gains from reciprocity, which depend on intentions and are determined by the nominal wage w_{it}. We allow β and λ to differ between subjects.

To capture employees' fairness concerns, we turn to Fehr and Schmidt (1999). We assume that employees experience disutility if their income $x_{it} - c(e_{it})$ exceeds that of their employer $e_{it} - x_{it}$. Inequality can thus be measured by $x_{it} - c(e_{it}) - (e_{it} - x_{it})$. Instead of employing a linear utility function like Fehr and Schmidt do, we assume increasing marginal disutility from inequality (Bolton and Ockenfels 2000) resulting in $\beta_i(2x_{it} - c(e_{it}) - e_{it})^2$. This means that high real wages above the equal split of $x_{it} = \big(e_{it} + c(e_{it})\big)/2$ imply a trade-off between income and fairness, inducing employees to increase effort.

Regarding the reciprocity term, we follow Rabin (1993) and Dufwenberg and Kirchsteiger (2004). We assume that employees gain utility from reciprocating intentionally unkind actions with low effort and kind actions with high effort. The kindness of the employer's wage choice is likely to be judged against a norm regarding an "equitable" payoff that the employee holds. In the first half of the experiment, we expect employees to infer this equitable payoff from the range of possible payoffs.

In treatment DOWN, subjects start off in the high wage environment which runs from 3 to 15 Taler. Employees might regard the average nominal wage of 9 as a norm that signals a neutral level of kindness in the sense of Akerlof (2007). In this treatment, the employee might also expect the high range's average nominal wage of 9 after the shock, which we will explain in more detail below. The employee will then judge the employer's choice of

$w_{it} > 9$ as kind and consider $w_{it} < 9$ to be unkind. The range of possible effort levels then determines the scope of the reciprocal response by the employee. Effort levels range from 1 to 4 with a mean of 2.5. The value of 2.5 thus constitutes a threshold, meaning that larger effort levels represent reciprocal kindness. Utility from reciprocity is thus determined by the product of the employer's kindness and reciprocal kindness. This implies $(w_{it} - 9)(e_{it} - 2.5)$. Following from this, an employee will suffer a utility loss if he, for example, receives the highest wage but exerts only the minimum level of effort. In the DOWN treatments, the employee's utility thus equals

$$(5) \quad U_{it} = x_{it} - c(e_{it}) - \beta_i(2x_{it} - c(e_{it}) - e_{it})^2 + \lambda_i(w_{it} - 9)(e_{it} - 2.5)$$

The first derivate yields

$$(6) \quad \frac{dU_{it}}{de_{it}} = -c'(e_{it}) + 2\beta_i(2x_{it} - e_{it})(1 + c'(e_{it})) + \lambda_i(w_{it} - 9) = 0.$$

In cases in which $\lambda_i > 0 \wedge w_{it} > 9$, employees will exert effort and accept the marginal costs this incurs. Next, we insert the continuous version of the cost function $c(e_{it}) = 0.05(e_{it} - 0.5)^2 - 0.0125$. The continuous version corresponds to the values for $c(e_{it})$ that we employed in our experimental design.[2] The first derivative gives us $c'(e_{it}) = 0.1(e_{it} - 0.5)$. For the sake of simplicity, we substitute $1 + c'(e_{it}) \sim 1$.[3] We thus obtain

$$(7) \quad \frac{dU_{it}}{de_{it}} = -0.1(e_{it} - 0.5) + 2\beta_i(2x_{it} - e_{it}) + \lambda_i(w_{it} - 9) = 0.$$

In optimum, effort is thus given by

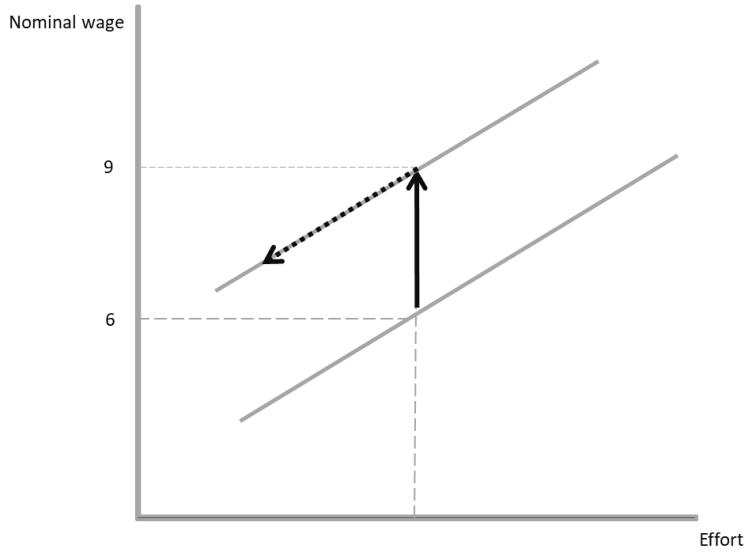
$$(8) \quad e_{it}^* = \frac{0.05 + 4\beta_i x_{it} + \lambda_i(w_{it} - 9)}{0.1 + 2\beta_i}$$

In treatment UP, subjects are initially faced with the low wage range of 2 to 10 Taler in the first half of the experiment. Figure 1 illustrates this. The bottom grey line represents the situation before the shock in the UP treatment and the top grey line represents the DOWN treatment before the shock.

While employees in treatment UP might have experienced a nominal wage of 6 that served as a benchmark for the equitable wage, we expect employees to quickly adjust the wage norms they hold upwards such that they substitute the former equitable payoff of 6 by the new equitable payoff of 9. Without delay, employees will have a new benchmark against which they judge the employers' kindness such that optimal effort after the shock would also be given by (8). This is illustrated by the solid upwards-facing arrow in figure 1. Given that employees adjust their expected equitable payoff, we do not expect aggregate effort to react if employers adjust the nominal wage to the new equitable payoff.

[2] This can be verified by inserting $e_{it} = 1,2,3 \; or \; 4$ into the cost function.
[3] For likely levels of e_{it} below 2, the marginal costs of effort $c'(e_{it})$ are smaller than 0.15. Simulations show that this simplification is immaterial to the findings of our model.

Fig. 1. Predicted relation between nominal wage and effort across treatments



In treatment DOWN, however, we do not expect subjects to adjust their wage norms to the new equitable payoff. Instead, we expect subjects to keep the old equitable payoff as their wage norm and react negatively reciprocal to downward wage adjustments. The adaption of reference wages is thus asymmetrical for downward and upward adjustments (Dickson and Fongoni 2019). This is again illustrated in figure 1, by the dashed arrow facing downwards. Employers will anticipate this reaction by the employees and be reluctant to fully adjust the nominal wages downwards in reaction to the negative monetary shock. We therefore expect under-proportional downward adjustment of the wages and a subsequent reduction in effort. We thus hypothesize:

Hypothesis 1: *In response to the shock, employers fully adjust wages upwards in treatment UP but not downwards in treatment DOWN.*

Hypothesis 2: *Employers expect no change in effort in treatment UP and expect effort to decrease in treatment DOWN.*

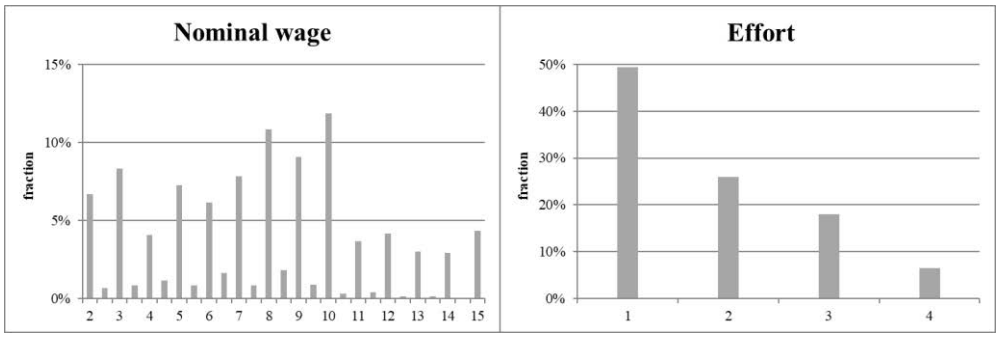
Hypothesis 3: *Employees keep effort constant in treatment UP and decrease effort in treatment DOWN.*

5 Results

First, we will give a short overview of the data and the overall effect of the shock. Second, we will analyse whether the data provides support for our hypotheses. Finally, we will discuss the results and their limitations, as well as implications for our experimental design.

Figure 2 displays the distribution of nominal wages and effort levels pooled for both treatments and all rounds. The figure shows that all wage levels and effort levels are made use of, meaning that subjects often depart from the Nash-equilibrium. The mean nominal wage equals 7.7 and the mean effort level equals 1.8.

Fig. 2 - nominal wages and effort



The hypotheses build on the assumption that our employees react to nominal wage changes and reciprocate employers' intentions, which are exhibited by nominal wages. In order to see whether this assumption holds in the rounds before the shock, we regress effort on the nominal wage before the shock, while controlling for the real wage, such that we can assess the effect of the nominal wage that goes beyond its effect on real wages. We further include the round to control for time trends and include session dummies to control for session-specific level effects. Results are shown in table 3. Regression 1 uses data for treatment UP and regression 2 shows results for treatment DOWN. Both regressions only use data for the employees. The coefficient for the nominal wage is positive and significant in both treatments. These findings replicate those of Grundmann, Giamattei and Lambsdorff (2019), who provide evidence that this effect can be related to intentions. Employees thus reciprocate employers' intentions displayed by nominal wage choices. In the following, we will test whether and when this effect remains influential in the face of a jointly observed shock and what this means for our hypotheses.

Table 1 – Random effects regressions

	Before Shock	
	UP	DOWN
Effort	1	2
Nominal wage	0.10**	0.10***
	(0.05)	(0.02)
Real wage	0.60***	0.59***
	(0.20)	(0.19)
Round	0.001	-0.04***
	0.01	0.02
Constant	0.64***	0.53**
	(0.23)	(0.22)
N	300	300
Rounds	1-10	1-10
Session Dummies	yes	yes
Within R^2	0.319	0.315
Between R^2	0.240	0.202
Overall R^2	0.303	0.295

Standard errors (clustered by employees) in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 4 gives a first overview over mean nominal wages and mean effort before and after the shock. In treatment UP, employers adjust mean wages upwards significantly (Mann-Whitney test, p<0.01) after the shock from 5.9 to 9.0. Mean effort decreases significantly (Mann-Whitney test, p=0.012) from 1.9 to 1.7, which is not in line with what the model would predict. Employers in treatment DOWN choose a mean wage of 10.0 before the shock and reduce this significantly (Mann-Whitney test, p<0.01) to 6.0 after the shock. Mean effort also drops significantly (Mann-Whitney test, p<0.01) from 2.0 to 1.7, which would be in line with subjects negatively reciprocating a downward nominal wage adjustment.

Table 4. Nominal wages and effort before and after the shock

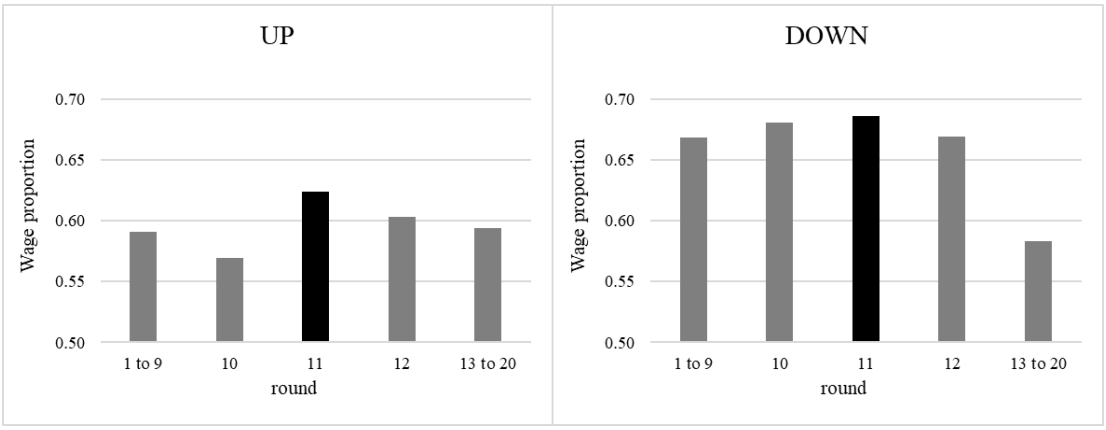
		Wage	Effort
UP	Before shock	5.9	1.9
	After shock	9.0	1.7
DOWN	Before shock	10.0	2.0
	After shock	6.0	1.7

This simple comparison entails two caveats. First, comparing the means before and after the shock might blur the actual effect of the shock, as the means will also pick up possible time trends. Second, given that the lowest nominal wages (< 3 Taler) are no longer available after the shock in treatment UP and highest nominal wages (> 10 Taler) are no longer available in treatment DOWN, some employers may be forced to adjust their wages. Such an adjustment might not be intentional and might provoke different reactions than

intentional adjustments. Rather than using nominal wages, a better measure that avoids this problem is the nominal wage proportion paid by employers in each round. For this, we use the nominal wage paid and compare it to the maximum nominal wage available. If employers adjust perfectly to the new wage range, the wage proportion they pay should not change.

Figure 3 displays the evolution of nominal wage proportions over rounds. It shows the mean nominal wage proportion paid in rounds 1-9, in the round before the shock (round 10), the first round with the new wage range (round 11), the next round after the shock (round 12) and in rounds 13-20. In treatment UP, the nominal wage proportion should remain constant if employers adjust wages to the new range perfectly as predicted by hypothesis 1. The figure reveals that wage proportions remain quite constant in most rounds. In round 11, in which the shock occurs, employers increase the nominal wage proportion from 0.57 to 0.62, which means that employers raise nominal wages over-proportionally. A Mann-Whitney test shows that the adjustment of the wage proportion between rounds 10 and 11 is not significant (p=0.349).

Fig. 3 – wage proportion over rounds



We further analyse this in regressions 3 and 4, displayed in table 5. We include only data for the employers and use the nominal wage proportion as the dependent variable and regress it on a variable for the rounds after the shock. The variable *post-shock* is a dummy that takes a value of 1 if an observation stems from round 11 or later. The variable for the round is again included in order to control for time trends and we also include session dummies, to control for session-specific level effects. Regression 3 contains data for the rounds 1-11, such that the post-shock variable shows the short-term effect of the shock on the nominal wage proportion paid by employers. Regression 4 contains data for all rounds, thus exhibiting long-term effects that persist beyond round 11. The shock has a

positive effect on the nominal wage proportion in the short run (3.31 percentage points) and in the long run (1.30 percentage points), but the two coefficients are insignificant (p=0.438 and p=0.741, respectively). The round does not have a significant influence, either (p=0.955 and p=0.895, respectively).

In treatment DOWN, for hypothesis 1 to hold the wage proportion should increase, given that a constant or only slightly downward adjusted nominal wage represents an increase in the wage proportion after the shock. Figure 3 exhibits that this is not the case. Instead, the wage proportion stays quite stable in round 11 in which the shock occurs, meaning that employers decrease the wages proportionally to the new wage range. A Mann-Whitney test shows that the adjustment of the wage proportion between round 10 and 11 is not significant (p=0.852). In the following rounds, employers even decrease the wage proportion.

Regressions 5 and 6 in table 5 show results for treatment DOWN. Regression 5 shows short-term effects of the shock by including only rounds 1-11 and regression 6 shows long-term effects. Both regressions again only use data for the employer. Regression 5 shows that, compared to the previous 10 rounds, the wage proportion does not increase in round 11, when controlling for the effect of the round. The coefficient of -4.81 is even insignificantly negative (p=0.348), implying a drop of the nominal wage of almost 5 percentage points relative to the maximum. Regression 6 shows that, in the long run, this negative adjustment increases in magnitude to -7.45 and is marginally significant (p=0.079). The nominal wage thus drops by around 7.5 percentage points relative to the maximum. This does not support downward nominal wage rigidity and provides evidence against hypothesis 1. The round exhibits a significantly positive effect (p=0.013) on the nominal wage proportion in regression 5, meaning that employers pay higher wages over the rounds up to round 11. The coefficient for the round is no longer significant (p=0.831) when including all 20 rounds.

Table 5
Results of Random Effects regressions

	UP		DOWN	
Nominal wage proportion	3	4	5	6
Post-shock	3.31	1.30	-4.81	-7.45*
	(4.72)	(3.93)	(5.13)	(4.24)
Round	0.04	-0.04	1.18**	0.07
	(0.62)	(0.33)	(0.48)	(0.33)
Constant	63.1***	63.8***	68.7***	78.5***
	(4.11)	(3.60)	(2.97)	(3.27)
N	330	600	330	600
Rounds	1-11	1-20	1-11	1-20
Session Dummies	yes	yes	yes	yes
Within R^2	0.003	0.001	0.035	0.026
Between R^2	0.038	0.056	0.265	0.422
Overall R^2	0.019	0.021	0.130	0.137

*Standard errors (clustered by employers) in parentheses, * p<0.10, ** p<0.05, *** p<0.01*
Notes: Nominal wage proportion multiplied by 100 before entering the regression

Therefore, hypothesis 1 finds support in respect to upward wage flexibility, but we must reject the idea of downward rigidity of nominal wages. We can state:

Result 1: *Employers adjust wages upwards proportionally after the shock in treatment UP and adjust wages downwards proportionally after the shock in treatment DOWN and even over-proportionally in the long run.*

A reason why employers adjusted wages flexibly might be that they also expected all other employers to do so. This thought can be seen in light of recent approaches that focus on limited rationality. Angeletos and Lian (2016; 2018) and García-Schmidt and Woodford (2019) assume that downward rigidity arises (equally to upward rigidity) as a result of strategic complementarity. In this case, subjects might fail to iteratively delete all dominated strategies. They do not jump to a new equilibrium instantaneously because they assume others might not do so or because they believe that others believe that others might fail to do so, and so on ad infinitum.[4] The focus of this macroeconomic reasoning is thus to regard non-standard beliefs as the source of (upward and downward) inertia. But if employers in our experiment adjust their beliefs downward quickly, this argument would not find support. To test this, we look at employers' expectations regarding the wage proportion paid by others. This is derived from the question asking for expectations regarding the nominal wage paid by four other employers and then calculated analogously to the wage proportion by dividing it by the available wage range.

[4] Results of beauty contest games are often explained with a similar logic, because rational players have an incentive to mimic level-0 players (Nagel 1995; Ho et al. 1998; Slonim 2005).

Fig. 4 –expected wage proportion of 4 others over rounds

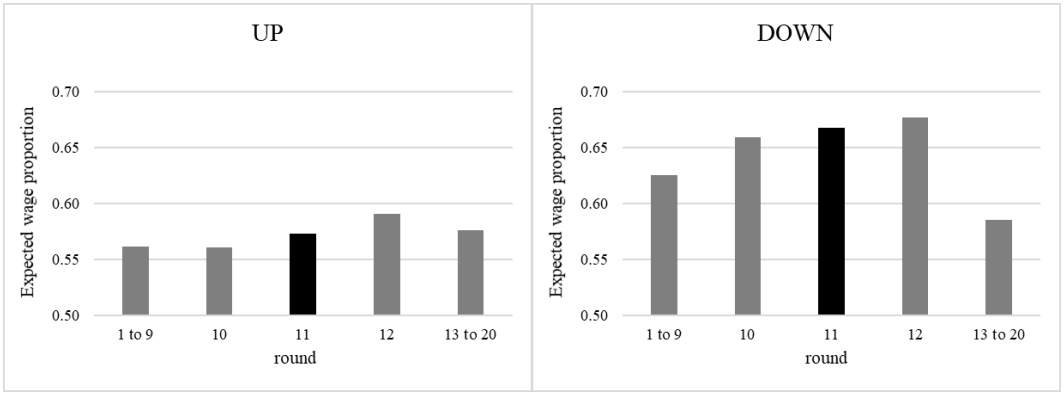


Figure 4 displays expected wage proportions over rounds for treatment UP (left panel) and treatment DOWN (right panel). In the round of the shock, the expected wage proportion remains on a similar level compared to the previous round in both treatments. Compared to round 10, the expected wage proportion in round 11 is neither significantly different in treatment UP (Mann-Whitney, p=0.847) nor in treatment DOWN (Mann-Whitney, p=0.807). Given that we asked for expected nominal wages and not for wage proportions, this means that employers adjusted their nominal wage expectations upwards to the new wage range in treatment UP and downwards in treatment DOWN. Therefore, the jointly observed shock seems to have been salient enough to make employers adjust their expectations proportionally to the new wage range.

The fact that employers expected others to also adjust their nominal wages downwards after the shock serves as a possible explanation for why they adjusted wages flexibly. In a next step, we will analyse employers' expectations regarding employees' effort and assess whether these expectations also help in explaining flexible downward wage adjustments. Given that employers expected all others to also adjust nominal wages downwards flexibly, they might not expect any negatively reciprocal reactions to the decreased nominal wage. Alternatively, their expectations might be in line with our model, which would expect negative reciprocal reactions to the decreased nominal wage. Further, in treatment UP, employers adjust nominal wages by 5 percentage points in round 11, while they expect wage proportions of others to hardly increase. They therefore might expect increases in effort. Given that the upwards adjustment of nominal wages is over-proportional, an increase in expected effort would also be in line with our model due to the expectation of positive reciprocal reactions.

Figure 5 shows the evolution of the employers' expected effort over the rounds. The figure shows that employers' expectations are quite consistent with their behaviour in treatment UP. Employers expected significantly higher effort in round 11 than in round 10 (Mann-

Whitney test, p=0.049), as can be seen in the left panel of figure 5. This is consistent with the slightly over-proportional increase in nominal wages. In the course of the rounds, expectations decrease again.

Fig. 5 – expected effort over rounds

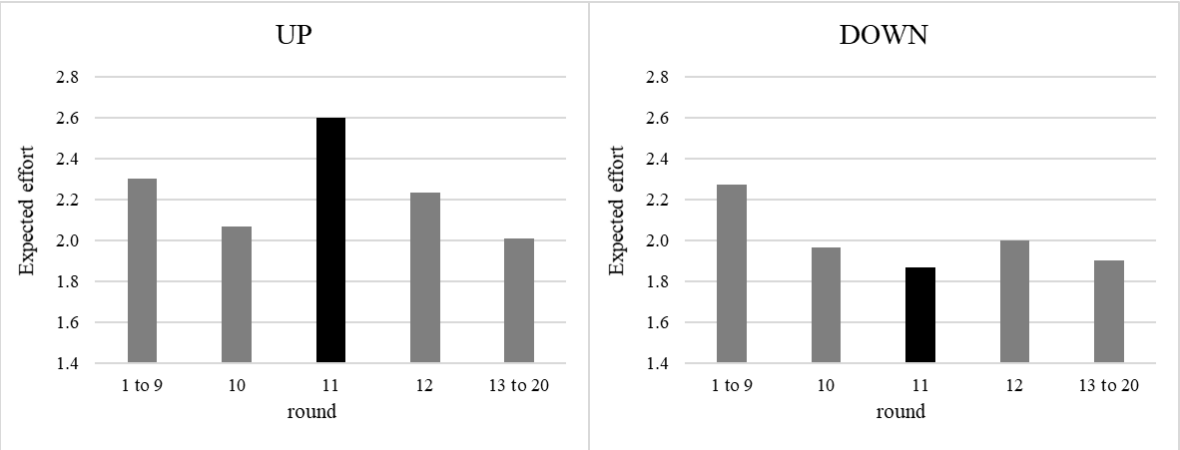


Table 6 shows regression results for employers' expectations. The regressions use the expected effort as dependent variable and regress it on the shock, controlling for the nominal wage proportion, the expected real wage, the round and session dummies. To calculate the expected real wage, we divide the nominal wage paid by employers by their expectation regarding the four wages of others. This gives us the real wage that employers expect their employee to receive. By including this, we can control for expectations the employer might have regarding the employee's reaction to the real wage. We include the nominal wage proportion to capture the general effect of the nominal wage on expected effort. The variable for the post-shock rounds then picks up adjustments to the shock that go beyond the general effect. The results of figure 4 are confirmed by regressions 7 and 8 in table 6. Regression 7 shows that the shock has a significantly positive effect ($p<0.01$) on expected effort in the short run in treatment UP. In the long run, the effect is still positive, but smaller and only marginally significant (p=0.061).

Even though employers expect other employers to also adjust downwards in treatment DOWN, the model would predict negative reactions of the employees towards the new reduced nominal wage. Figure 5 shows that employers do in fact anticipate slight negative reactions of employees towards the decreased nominal wages in the round of the shock. The decrease of expected effort between round 10 and round 11 is, however, not significant (Mann-Whitney test, p=0.556). Nevertheless, it is an indication that employers might have been aware of possible negative reactions towards the decrease of nominal wages.

Regression 9 shows short-run effects in treatment DOWN and reveals that, when controlling for the significantly negative effect of the round, the effect of the shock on expected effort is positive, small in size and insignificant (p=0.973). The same applies for the long-run effect in treatment DOWN shown in regression 10 (p=0.727). Employers thus do not seem to have expected negative reactions of their employees towards the reduced nominal wage. The fact that employers did not expect negative reciprocal reactions, and also expected all other employers to also decrease nominal wages, can help explain why they adjusted wages downwards.

Table 6
Results of Random Effects regressions

	UP		DOWN	
Expected effort	7	8	9	10
Post-shock	0.45***	0.23*	0.005	0.05
	(0.13)	(0.12)	(0.16)	(0.15)
Nominal wage proportion	2.39***	2.52***	2.67***	1.89***
	(0.47)	(0.34)	(0.35)	(0.28)
Expected real wage	0.03	0.02	-0.31	0.24
	(0.24)	(0.16)	(0.29)	(0.22)
Round	-0.04*	-0.04***	-0.08***	-0.02*
	(0.02)	(0.01)	(0.02)	(0.01)
Constant	1.01***	2.70***	0.88***	0.61**
	(0.19)	(0.18)	(0.32)	(0.28)
N	330	600	330	600
Rounds	1-11	1-20	1-11	1-20
Session Dummies	yes	yes	yes	yes
Within R^2	0.326	0.370	0.293	0.320
Between R^2	0.398	0.467	0.678	0.626
Overall R^2	0.353	0.400	0.412	0.402

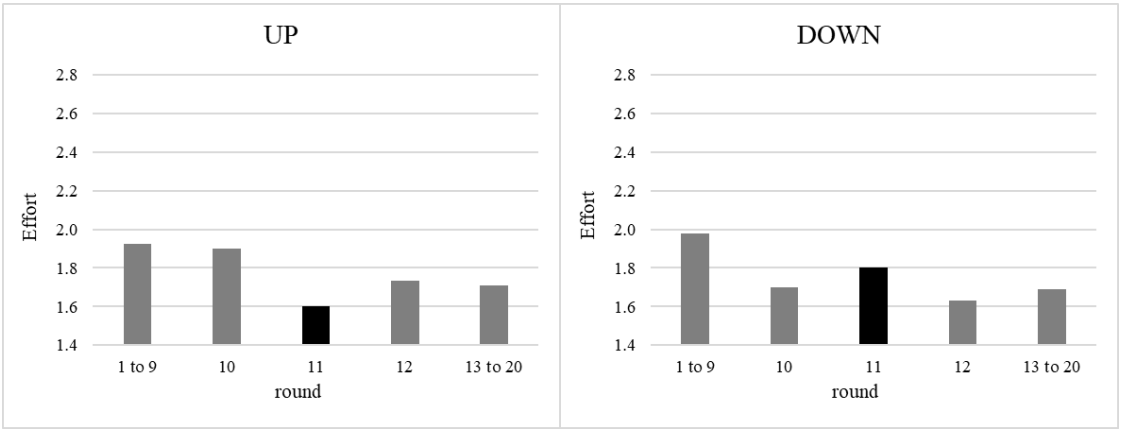
Standard errors (clustered by employers) in parentheses, * p<0.10, ** p<0.05, *** p<0.01

This allows us to state partial support for hypothesis 2:

Result 2: *In treatment UP, employers' expectations are in line with the model's predictions given the wage adjustments after the shock. Employers' expectations given the wage adjustments are not in line with the model in treatment DOWN. Expected effort increases in UP and remains constant in DOWN.*

In the next step, we look at employees' actual reactions to the adjustment of nominal wages after the shock and assess whether they reciprocate perceived intentions. Figure 6 shows employees' effort levels over rounds. First of all, comparing this figure to figure 5, it becomes evident that actual effort levels are lower than expected effort levels. Employers seem to have had overly optimistic expectations about employees' effort. They also do not learn to correct for their overoptimistic expectations over the course of the experiment, as effort is persistently smaller than employers' expectations.

Fig. 6 – effort over rounds



In treatment UP, employees adjust effort downwards from round 10 to round 11. This is not what employers expected and not what the model would have predicted, given employers' wage-setting behaviour. The downward adjustment is however not significant according to a Mann-Whitney test (p=0.391). Table 7 shows regression results, using employees' choice of effort as dependent variable and regressing it on the shock, controlling for the nominal wage proportion, the real wage (as this was known to employees as oppose to employers), the round and session dummies. Regression 11 exhibits a significantly negative effect of the shock (p=0.022) in the short run. In the long run, the effect of the shock stays negative but is smaller and no longer significant (p=0.109) as can be seen in regression 12. This means that an externally induced expansionary shock cannot achieve an expansion in output. Employees did not positively reciprocate the slight increase in nominal wage proportions and instead even reduced their effort. Employers' expectations of positive effort adjustments were thus not correct.

Looking at treatment DOWN, figure 6 shows that effort increases slightly from round 10 to round 11. This is again not in line with the model's predictions, given employers' wage-setting behaviour. The difference in effort between round 10 and round 11 is not significant though (Mann-Whitney test, p=0.632).

Regression 13 displays short-term effects for treatment DOWN. The coefficient for the shock is positive, but insignificant (p=0.527). In the long run, the coefficient becomes smaller and stays insignificant (p=0.779), as shown in regression 14. This implies that employees do not seem to punish employers for adjusting wages downwards in reaction to the shock. It also means that employers had correct expectations regarding the non-adjustment of employees' effort.

Table 7
Results of Random Effects regressions

	UP		DOWN	
Effort	11	12	13	14
Post-shock	-0.36**	-0.16	0.07	0.03
	(0.16)	(0.10)	(0.11)	(0.09)
Nominal wage proportion	0.93**	1.01**	1.59***	0.85***
	(0.43)	(0.40)	(0.35)	(0.26)
Real wage	0.62***	0.47**	0.51**	0.80***
	(0.18)	(0.22)	(0.21)	(0.16)
Round	0.001	-0.01	-0.05***	-0.023**
	(0.01)	(0.01)	(0.02)	(0.01)
Constant	0.71***	0.86***	0.54**	0.67***
	(0.23)	(0.22)	(0.23)	(0.19)
N	330	600	330	600
Rounds	1-11	1-20	1-11	1-20
Session Dummies	yes	yes	yes	yes
Within R^2	0.319	0.282	0.313	0.355
Between R^2	0.197	0.072	0.221	0.228
Overall R^2	0.297	0.244	0.295	0.333

Standard errors (clustered by employees) in parentheses, * p<0.10, ** p<0.05, *** p<0.01

All in all, we can thus state:

Result 3: *Employees' chosen effort decrease in UP, which is not in line with employers' expectations or the model. Effort remains constant in DOWN, which is in line with employers' expectations but not with the model.*

6 Discussion of results

Intentions after the shock

Even though we find that employees reciprocate nominal wages before the shock, employers adjust wages downwards in treatment DOWN and do not expect employees to reduce effort. Employees do not negatively reciprocate this downward adjustment. In treatment UP, employers adjust wages upwards over-proportionally and expect increases in effort. Instead, employees reduce their effort. In the following, we will explore reasons that might have led to these unexpected results and discuss what this means for our experimental design.

The fact that we did not find evidence for downward rigidity might be seen in light of the strength with which intentions play a role after the shock. To illustrate this, we run the same regressions as in table 3 for the rounds after the shock. Results are displayed in table 8. Regression 15 shows that in treatment UP, the nominal wage retains a positive influence, but that this effect is smaller in size than before the shock and only marginally significant ($p<0.087$). In treatment DOWN, regression 16 reveals that the nominal wage no longer has a significant influence on effort in treatment DOWN after the shock ($p=0.659$). It appears that employees do not only not reciprocate wage adjustments to the shock as predicted by the model, but do not reciprocate employers' intentions displayed by the nominal wage at all anymore. After the shock, the signal of intentions conveyed by the nominal wages might not be as clear anymore. A recognition of intentions might be possible only in a stable environment. After the shock, employees might find it harder to infer intentions from nominal wages and might neither punish low nominal wages nor reward high nominal wages as strongly as before.

Table 8
Results of Random Effects regressions

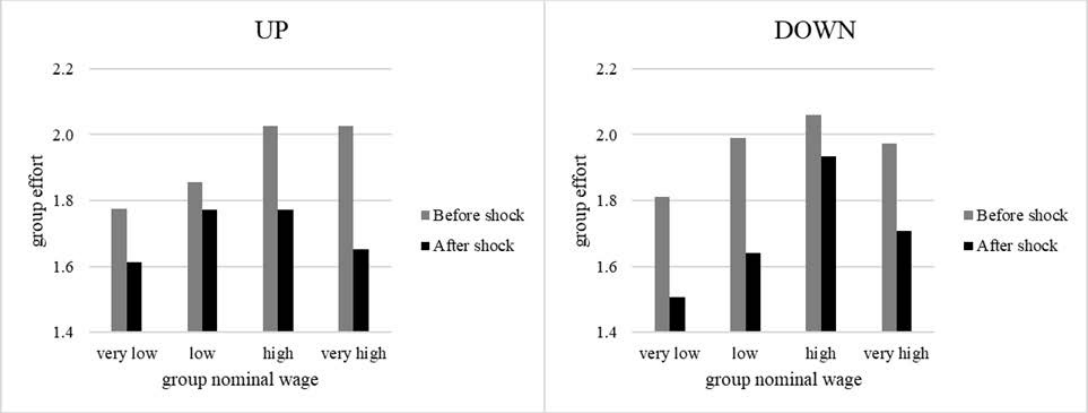
	After shock	
	UP	DOWN
Effort	15	16
Nominal wage	0.06*	0.02
	(0.04)	(0.05)
Real wage	0.37	0.98***
	(0.35)	(0.26)
Round	-0.01	-0.02
	(0.01)	(0.01)
Constant	0.98***	0. 86**
	(0.30)	(0.36)
N	300	300
Rounds	11-20	11-20
Session Dummies	yes	yes
Within R^2	0.248	0.389
Between R^2	0.014	0.333
Overall R^2	0.177	0.373

Standard errors (clustered by employees= in parentheses, * p<0.10, ** p<0.05, *** p<0.01

To investigate this further, we look at aggregate data. For this, we calculate the mean nominal wage paid and the mean effort exerted in each group *g*. As a nominal wage paid by an employer influences not only her own employee's real wage positively, but that of all others negatively, the mean real wage in a group equals 1€ by design. If nominal wages exert an influence beyond their effect on the real wage, on the aggregate level, an increase in mean group nominal wages should lead to an increase in mean group effort, as shown by Grundmann, Giamattei und Lambsdorff (2019). Given the observed effects on the individual level in tables 3 and 8, we would expect mean group nominal wages to have a positive effect on mean group effort before the shock but not after. Figure 7 displays mean

group effort for four different sizes of mean group nominal wages before and after the shock for each treatment separately. The four categories of group nominal wages were calibrated such that each contains roughly 25% of all observations in the respective treatment and section of the experiment.[5]

Fig. 7 – mean group nominal effort by mean group nominal wages



In treatment UP, the figure shows a positive relation between the group nominal wage and group effort before the shock. After the shock, effort increases for low and high group nominal wages, but decreases again for very high wages. Altogether, group effort is lower after the shock than before the shock.

Table 9 shows regression results. All regressions use the mean group effort as the dependent variable and regress it on the mean group nominal wage controlling for the round and including session dummies. Regressions 17 and 18 show results for before the shock (corresponding to the individual regressions in table 3) and regressions 19 and 20 analyse effects after the shock (corresponding to table 8). Regression 17 displays results for treatment UP. The coefficient for the mean group nominal wage takes a value of 0.08, thus displays positive aggregate effects of an increase in group nominal wages on group effort. However, the coefficient is not significant (p=0.153). The significantly positive effect found on individual level reported in table 3 and observed in figure 7 thus is not fully confirmed by the aggregate level regressions. This might in part be driven by the low number of observations on aggregate level, given that the data is split by treatments and into before and after the shock. Regression 19 displays results for the rounds after the shock. While nominal wages retain a marginally significant positive effect on the

[5] The boundaries of group nominal wages for treatment UP before the shock are as follows. Very low: ≤ 5.2, low: >5.2 & ≤ 5.92. high: > 5.92 & ≤ 6.4, very high: >6.4. Treatment UP after the shock: very low: ≤ 8, low: > 8 & ≤ 8.7, high: > 8.7 & ≤ 9.7, very high: >9.8. Treatment DOWN before the shock: very low: ≤ 8.6, low: > 8.6 & ≤ 10.4, high: > 10.4 & ≤ 11.1, very high: >11.1. Treatment DOWN after the shock: very low: ≤ 4.4, low: > 4.4 & ≤ 6.1, high: > 6.1 & ≤ 7.5, very high: >7.5.

individual level in table 8, the coefficient for the mean group nominal wages is negative, small and not significant (p=0.833), which is in line with the graphical results in figure 7. After the shock, aggregate increases in nominal wages seem to have hardly any effect on aggregate effort.

In treatment DOWN, figure 7 shows that group effort increases with higher group nominal wages but decreases again for very high wages before the shock. The same is true after the shock, but the decline in effort for the highest category of nominal wages is larger than before the shock. All over, group effort is lower after the shock. Table 9 again offers further insights. Regression 18 shows that the mean group nominal wage exerts a significantly (p=0.011) positive influence on the group mean effort before the shock. This is in line with the individual effects reported in table 3 and is also largely in line with the results found in figure 7. After the shock, the coefficient for the group nominal wage turns negative and insignificant (p=0.255). The non-significance is in line with the findings in table 8, the sign of the coefficient however is not. All in all, the aggregate results in table 9 only partly confirm the results in table 3 and table 8 but offer further support for the general tendency that the influence of nominal wages declines after the shock.

Table 9

Results of OLS regressions

	Before shock		After shock	
Mean group effort	UP	DOWN	UP	DOWN
	17	18	19	20
Mean group nominal wage	0.08	0.11**	-0.008	-0.05
	(0.06)	(0.04)	(0.04)	(0.04)
Round	0.003	-0.04**	-0.015	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Constant	1.59***	1.01**	1.82***	1.96***
	(0.35)	(0.41)	(0.44)	(0.34)
N	60	60	60	60
Rounds	1-10	1-10	11-20	11-20
Session Dummies	yes	yes	yes	yes
R^2	0.121	0.154	0.037	0.303

Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01

Session differences

In a next step, we look at possible differences between sessions. All our regressions control for session dummies, thus picking up any session-specific level effects. However, subjects might have reacted differently to the shock in different sessions of the same treatment. If this is the case, it could be problematic to pool data from all three sessions of each treatment, as different reactions to the shock in the sessions might bias our coefficients.

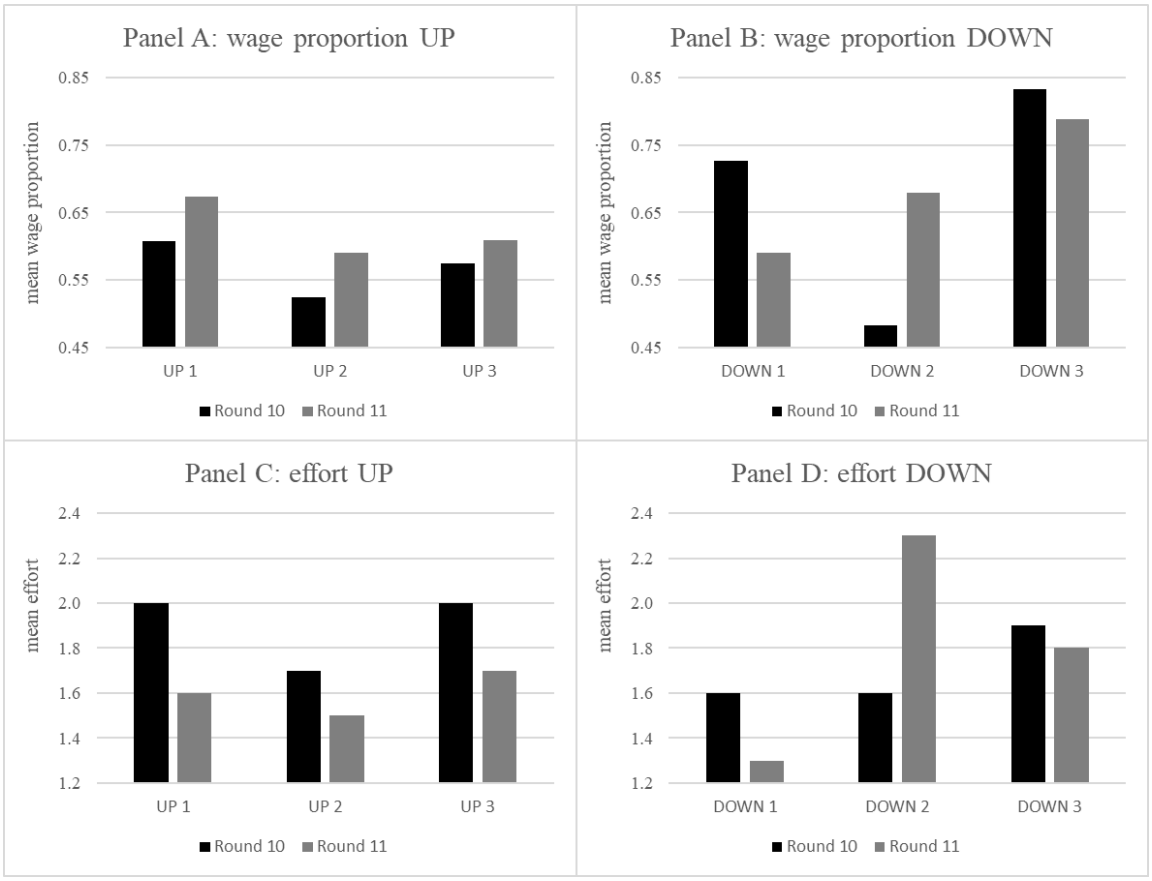
Figure 8 shows the evolution of wage proportions and effort for each session of treatments UP and DOWN separately. Panel A displays the adjustment of nominal wage proportions between round 10 and round 11 for each of the sessions of treatment UP. The figure shows that wage proportions increase in the round of the shock in all sessions, thus exhibiting fairly consistent behaviour in all sessions of treatment UP. Panel C displays employees' reactions to the shock and shows that effort decreases in all sessions. Session differences thus do not seem to be able to explain the surprising result that effort decreases in response to wage increases after the shock in treatment UP.

Panel B displays adjustments of wage proportions in treatment DOWN and panel D shows adjustments of effort. The graph exhibits substantial differences between sessions. In DOWN 1, employers reduce the wage proportion in response to the shock, and employees reduce effort. In DOWN 2, employers increase wage proportions in line with our model's predictions, and employees reciprocate by increasing effort. In DOWN 3, we find slight decreases in wage proportions and effort. This shows that treatment DOWN is marked by considerable differences between the sessions, which can act as an explanation for the unexpected results. It appears that within separate sessions, subjects seem to have acted more in line with the predictions of our model.

Running the regressions in table 3, which capture only data from before the shock, separately for each session renders results that are consistent with the pooled data for both treatments (see table A.1 in the appendix). All coefficients for the nominal wage are positive. They are not in all cases significant, but this is likely to be explained by the reduced number of observations. Thus, up until the shock, behaviour seems to have been consistent over sessions. Running the regressions in tables 4-8 for each session separately, shows that behaviour is in most cases consistent over sessions in treatment UP, which is in line with figure 8. In treatment DOWN, separate regressions for each session in most cases do not deliver results consistent with the pooled data. This is especially pronounced for adjustments of wage proportions and effort to the shock (see tables A.2 and A.3 in the

appendix), which is again in line with figure 8. It must be kept in mind though that running the regressions separately for each session decreases the power, as it reduces the observations substantially and conclusions can thus only be tentative.

Fig. 8– wage proportions and effort for each session of treatments UP and DOWN



Implications for experimental design

Our data is marked by substantial differences between the three sessions of treatment DOWN. We had not expected these differences, and they have implications for our experimental design. It appears that some of the most interesting and important reactions to the shocks can be observed between sessions. Given these unexpected results, our power test (see appendix) is no longer adequate. We only have three sessions per treatment and therefore not enough observations. This makes it necessary to adapt the design to create smaller units of observation. In the current design, employers and employees are randomly re-matched into pairs *i* and groups *g* every round. This means that session-specific reactions to the shock are likely to have influenced all subjects in the session over the course of the rounds.

An improved design could employ smaller groups *g,* and keep these groups fixed throughout the session. Groups could, for example, include three employers and three employees. This would give us three completely independent groups within one session, with the downside of less variation in the wages paid by others. Another possibility would be to keep the design as it is in respect to groups, but adapt it in order to run it on classEx (Giamattei and Lambsdorff 2019) or MTurk, thus being able to easily gather many more observations than in the lab. To do this, we would, however, have to reduce the number of rounds per wage range substantially. Alternatively, we could run the experiment in the lab with reduced number of rounds per wage range but let subjects play the entire experiment several times. This would allow for learning effects and would give us several observations per group *g*, which we could control for in the regressions. In any case, a larger number of observations would allow us to classify groups into different adjustment types, depending on whether they adapt wage proportions upwards, downwards or keep them constant in reaction to a shock. Differences between groups might then provide a better starting point for analysing nominal wage rigidity and the exploitability of a positively sloped Phillips curve by policy makers.

Extension: Partner treatments

We also tried out running treatments UP and DOWN with a partner matching, with the aim of investigating whether downward nominal wage rigidity would be more likely to occur within a stable relation between employer and employee. This was not the case, as can be seen in table A.4 in the appendix. Nevertheless, we can check whether there are also strong differences between sessions in the partner treatments. In these two treatments, employers play with the same employee in all rounds and the groups for determining the wages of others are also constant during the entire experiment. This means that we have six independent groups in each treatment (2 per session) that do not influence each other through random re-matching. We can thus analyse whether these groups exhibited similar behaviour in response to the shock or were marked by substantial differences like in the random treatments.

For sake of parsimony, figure 9 only displays the direction of employers' adjustments of nominal wage proportions and employees' effort reactions between rounds 10 and 11.[6] An upward facing arrow means that wage proportions or effort were adjusted upwards. A downwards facing arrow implies negative adjustments and a right facing arrow means no adjustment. The table shows that in treatment UP, three groups adjusted wage proportions upwards in face of the shock and three downwards. In treatment DOWN, two groups adjusted upwards and four groups adjusted downwards. Effort increases in nearly all groups in UP and shows no consistent pattern in DOWN. We again observe substantial differences between groups, supporting our findings on session heterogeneities from the random treatments. This strengthens the conclusion that a redesign of the experiment might promise more insights.

Fig. 9 – direction of adjustment of nominal wage proportions and effort in partner treatments

Partner Treatments			
Session	Group	**Wage proportion**	**Effort**
UP 1	UP 1.1	↑	↑
	UP 1.2	↓	↓
UP 2	UP 2.1	↓	↑
	UP 2.2	↑	↑
UP 3	UP 3.1	↓	↑
	UP 3.2	↑	↑
DOWN 1	DOWN 1.1	↓	↓
	DOWN 1.2	↓	↑
DOWN 2	DOWN 2.1	↑	↑
	DOWN 2.2	↓	↓
DOWN 3	DOWN 3.1	↓	→
	DOWN 3.2	↑	↓

7 Conclusion

We created an experimental gift-exchange game with employers and employees under conditions of monetary neutrality. In the first 10 rounds, employees reciprocate high nominal wages despite monetary neutrality, due to the kind intentions that high nominal wages signal. We introduce exogenous monetary shocks in round 11 and examine the reactions of wages and effort. In reaction to an expansionary shock, employers adjust wages upwards slightly over-proportionally to the new wage range. In response, they

[6] Table A.5 in the appendix displays values for the size of nominal wage proportions and effort in rounds 10 and 11 for all groups.

expect positive reactions of effort, in line with a positively sloped Phillips curve. Surprisingly, employees instead reduce effort. As a potential explanation for these results, we find that the shock seems to have blurred the signal of intentions conveyed by nominal wages to a certain extent, such that nominal wages no longer exert a strong effect on effort. The shock and the resulting necessity of adapting the assessment of the kindness of the nominal wage from the old wage range to the new range might have proved cognitively challenging. Employers and employees thus might have adjusted their perception of a fair nominal wage differently, which might have induced a mismatch after the shock. Also, it appears that the shock might have destroyed the recognition of intentions to a certain extent. The tendency to value nominal wages appears to prevail only as long as policy makers do not seek to exploit it. Once they try to, it seems to break down.

In reaction to a contractionary shock, employers adjust wages downwards flexibly (and even slightly more than would be proportional), but neither do employers expect reductions in effort, nor do employees reduce effort. Several factors might have contributed to these findings. Employers also expected all other employers to reduce wages in response to the shock. This might have prompted them to reduce wages themselves, too. This finding is in contrast to recent approaches by Angeletos and Lian (2016; 2018) and García-Schmidt and Woodford (2019), who argue that limited rationality leads to a positively sloped Phillips curve. Instead, it appears to be more in line with the view by Lucas (1976), who assumes a vertical Phillips curve under conditions of complete information like in our experiment, such that effort and output are constant. However, as already mentioned above, we also find that the relation between nominal wages and effort breaks down in face of the shock. This would imply a different reason for downward wage flexibility than the approach by Lucas: employers may recognise the disruption of the relationship between intentions and effort and thus implement flexible nominal wage adjustments without fearing negative reciprocal reactions.

Finally, we encounter substantial session differences, such that adjustments of nominal wages and effort are not consistent over sessions. These differences are very likely to have biased our main results and thus limit the reliability of our findings. Therefore, we must be cautious with the interpretation of our main results, which are only to be seen as an exploration of possible effects.

Further, the gender composition of our subjects is very biased, with 84.2 percent of subjects being female. Given that several studies find that women tend to be less reciprocal than men (Lambsdorff and Frank 2011, Cox 2002), the gender composition might also have biased our results. Therefore, this study may be seen as an exploratory study and a first attempt to tackle the puzzle of downward nominal wage rigidity in a situation in which intentions contribute to a positively sloped Phillips Curve. A refined experimental design with a more balanced gender composition of participants will be able to offer further insights.

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Appendix

Further details regarding the experiment

Power test

In order to determine the necessary sample size, we ran a power-test using conventional values for β (0.2) and α (0.05). Our model in section 4 allows us to derive an equitable payoff for the low range of 6 and for the high range of 9. In Grundmann, Giamattei and Lambsdorff (2019), the effect of an increase by 4 Taler (from 4 to 8) on effort was about 0.5. This suggests that by changing the nominal wage by 3 we should expect an effect of $\frac{3}{4}0.5 = 0.375$. We test for a more conservative effect size of 0.25. The standard deviation in Grundmann, Giamattei and Lambsdorff (2019) amounted to 0.9. Since we collect 10 observations prior and after the shock, the standard error of the measured effort is $\frac{0.9}{\sqrt{10}} = 0.285$ and the sampling ratio is 1. The power-test prescribes a minimum sample size of 21. We thus expect that with 30 employees per treatment, our experiment is sufficiently powered.

Procedures

After all rounds had finished, employers were asked whether they had adjusted the nominal wages after the shock and why and whether they felt they had been treated more fairly or more unfairly by their employee after the shock. Employees were also asked whether they felt they had been treated more (un)fairly and whether they adjusted their effort after the shock.

At the end of the experiment, participants filled in a demographic questionnaire regarding their age, gender and fields of study. Subjects were paid the sum of round payoffs for 10 randomly determined rounds plus any payoff for belief elicitations and comprehension questions. Paying out 10 of 20 rounds ensured an adequate hourly salary for our subjects. A person not involved in the experiment disbursed the payments and could not infer subjects' behaviour from their payoff.

Further tables

Table A.1
Random effects regressions for each session (corresponds to table 3)

	Before Shock					
Effort	UP 1	UP 2	UP 3	DOWN 1	DOWN 2	DOWN 3
Nominal wage	0.18***	0.12	0.067	0.050	0.11**	0.17***
	(0.07)	(0.08)	(0.08)	(0.04)	(0.05)	(0.05)
Real wage	0.26	0.52	0.85**	1.04**	0.51	0.096
	(0.22)	(0.36)	(0.43)	(0.43)	(0.35)	(0.52)
Round	-0.028	0.0037	0.015	-0.054*	-0.028	-0.058
	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)
Constant	0.96**	0.52*	0.54	0.59*	0.68**	0.29
	(0.43)	(0.29)	(0.33)	(0.32)	(0.34)	(0.43)
N	100	100	100	100	100	100
Rounds	1-10	1-10	1-10	1-10	1-10	1-10
Within R^2	0.285	0.374	0.321	0.304	0.359	0.308
Between R^2	0.413	0.231	0.003	0.290	0.338	0.014
Overall R^2	0.291	0.346	0.249	0.301	0.346	0.248

Standard errors (clustered by employees) in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table A.2
Random effects regressions for each session of DOWN (corresponds to table 5)

Nominal wage proportion	DOWN 1	DOWN 1	DOWN 2	DOWN 2	DOWN 3	DOWN 3
Post-shock	-22.3***	-24.5***	15.6*	6.53	-7.77	-4.35
	(7.78)	(7.16)	(8.62)	(6.80)	(6.20)	(4.56)
Round	2.10***	-0.34	-0.68	0.019	2.12***	0.53
	(0.76)	(0.61)	(0.84)	(0.66)	(0.58)	(0.48)
Constant	58.2***	71.6***	59.9***	56.0***	63.3***	72.0***
	(5.19)	(6.49)	(3.59)	(5.63)	(3.17)	(1.82)
N	110	200	110	200	110	200
Rounds	1-11	1-20	1-11	1-20	1-11	1-20
Within R^2	0.000	0.000	0.000	0.000	0.000	0.000
Between R^2	0.000	0.000	0.000	0.000	0.000	0.000
Overall R^2	0.083	0.030	0.096	0.298	0.021	0.006

Standard errors (clustered by employers) in parentheses, * p<0.10, ** p<0.05, *** p<0.01
Notes: Nominal wage proportion multiplied by 100 before entering the regressions

Table A.3
Random effects regressions for each session of DOWN (corresponds to table 7)

Effort	DOWN 1	DOWN 1	DOWN 2	DOWN 2	DOWN 3	DOWN 3
Post-shock	-0.19	-0.081	0.34	0.31	0.013	-0.21
	(0.17)	(0.19)	(0.24)	(0.22)	(0.11)	(0.14)
Nominal wage proportion	0.91	0.51	1.42	0.53	2.83***	0.82**
	(0.67)	(0.45)	(0.87)	(0.61)	(0.80)	(0.40)
Real wage	0.74	0.73**	0.59	0.99***	-0.034	1.08***
	(0.50)	(0.32)	(0.38)	(0.20)	(0.48)	(0.38)
Round	-0.057*	-0.025	-0.030	-0.042**	-0.063*	-0.0043
	(0.03)	(0.02)	(0.04)	(0.02)	(0.04)	(0.02)
Constant	0.80**	0.91***	0.69*	0.85**	0.28	0.33
	(0.33)	(0.25)	(0.38)	(0.34)	(0.42)	(0.35)
N	110	200	110	200	110	200
Rounds	1-11	1-20	1-11	1-20	1-11	1-20
Within R^2	0.292	0.353	0.368	0.387	0.322	0.352
Between R^2	0.163	0.190	0.502	0.266	0.005	0.164
Overall R^2	0.280	0.322	0.370	0.368	0.248	0.307

Standard errors (clustered by employees) in parentheses, * p<0.10, ** p<0.05, *** p<0.01

Table A.4
Random effects regressions, partner treatments

	UP		DOWN	
Nominal wage proportion	1	2	3	4
Shock	-0.66	0.28	-5.21	-1.84
	(4.87)	(3.84)	(3.36)	(2.88)
Round	1.10*	0. 46	1.31***	0.82**
	(0.65)	(0.35)	(0.49)	(0.36)
Constant	59.85***	60.87***	60.89***	64.09***
	(6.48)	(6.16)	(4.02)	(3.76)
N	330	600	330	600
Rounds	1-11	1-20	1-11	1-20
Session Dummies	yes	yes	yes	yes
Within R^2	0.025	0.015	0.042	0.035
Between R^2	0.014	0.008	0.053	0.105
Overall R^2	0.021	0.013	0.046	0.057

Standard errors (clustered by employers) in parentheses, * p<0.10, ** p<0.05, *** p<0.01
Notes: Nominal wage proportion multiplied by 100 before entering the regressions

Table A.5
Wage proportions and effort in round 10 and round 11 in partner treatments

Partner Treatments					
		Wage proportion		**Effort**	
Session	Group	Round 10	Round 11	10	11
UP 1	UP 1.1	0.56	0.69	2.20	2.40
	UP 1.2	0.83	0.71	2.60	2.00
UP 2	UP 2.1	0.84	0.75	2.00	2.20
	UP 2.2	0.62	0.73	2.60	2.80
UP 3	UP 3.1	0.60	0.57	2.20	2.60
	UP 3.2	0.75	0.78	1.80	2.20
DOWN 1	DOWN 1.1	0.83	0.78	2.20	1.80
	DOWN 1.2	0.69	0.64	2.00	2.20
DOWN 2	DOWN 2.1	0.47	0.48	2.00	2.20
	DOWN 2.2	0.69	0.68	2.60	2.40
DOWN 3	DOWN 3.1	0.73	0.68	2.20	2.20
	DOWN 3.2	0.73	0.74	2.40	1.60

Oral instructions (translated from German)

[Oral instructions were read out loud and recorded by one of the experimenters prior to conducting the experiment. The recorded instructions will be played in all sessions and are thus the same for all roles, sessions and treatments]

Welcome to the experiment! Before the experiment starts, you will receive some general instructions: Please listen carefully and don't click on the button "Start Experiment" until the end of these instructions. The experiment aims at gaining insights on human behaviour. All participants are here in this room and are participating in the same experiment. You can earn money in this experiment. The amount depends on your decisions as well as the decisions of the other participants. In any case, you will receive at least 3.50€. All participants are anonymous and cannot communicate with one another. The decisions you make and the information you provide will not be traced to you personally. The disbursement of payoffs will also be carried out anonymously: no other participant will be able to see how much money you receive and the experimenters will not find this out either. The person who will pay out the money at the end of the experiment cannot infer your behaviour from your payoff.

The experiment will be explained to you on the printed instructions. Please read all information carefully as soon as you are asked to do so on your screen. Please note that you may have to wait for other participants during the experiment. Please remain seated

quietly at your desk during the entire course of the experiment and do not talk to other participants. If you do not comply with these rules, you may be excluded from the further participation in this experiment. As this experiment is conducted on several days, we inform you that any communication about the content of this experiment, for example via Jodel *[a popular social media app]*, is prohibited. Such communication may have the consequence that experiments cannot be conducted in the future.

If you have any questions please raise your hand. Someone will then come to your desk.

Please click on "Start Experiment" now.

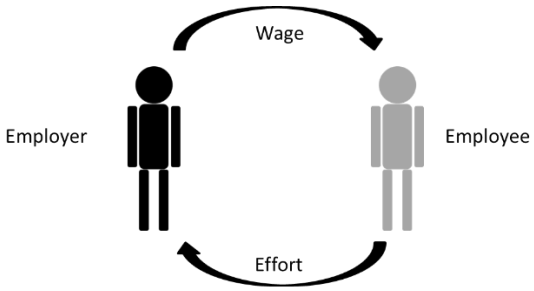
[End of oral instructions]

Written instructions – employee (translated from German)

Written instructions are provided for treatment DOWN. Differences treatment UP are marked.

General instructions

At the beginning of this experiment, 20 participants will randomly receive the roles of employers and employees, so that 10 employers and 10 employees will participate in this experiment. The experiment consists of 20 rounds. In each round, the employer chooses a wage for his employee and the employee then chooses his work effort.



You are an employee. You will keep this role throughout the entire experiment. You will be randomly re-matched with an employer at the beginning of each round. You thus interact with different employers during the experiment.

The round payoff for the employee and the employer is determined as follows:

Round payoff employer = benefit of work effort – wage

Round payoff employee = wage – costs of effort

At the end of the experiment, 10 of the 20 rounds will be randomly drawn. The round payoffs of these 10 rounds will be summed up. You will be paid out this sum at the end of the experiment.

Procedure of the rounds

A round consists of two steps. There are two currencies, Taler and euros.

Step 1: Employers choose Taler wage

Your employer chooses a wage for you in the currency Taler. The wage can be between 3 and 15 Talers. *[Treatment UP: The wage can be between 2 and 10 Talers.]* At the same time as your employer, all other employers also set a wage for the other employees. Just like your employer, they can choose a wage between 3 and 10 Talers. *[Treatment UP: Just like your employer, they can also choose a wage between 2 and 10 Talers.]*

Calculation of euro wage

The employer sets the wage in the currency Taler. The wage is converted into euros as follows:

Euro wage = Taler wage / Average of 4 other Taler wages

The higher the Taler wage you receive, the higher your euro wage. The euro wage is higher, the smaller the Taler wage that 4 randomly chosen other employers pay their employees. The euro wage is lower, the higher the Taler wage that 4 other randomly chosen employers pay their employees. Following notion clarifies this: In reality, higher wages lead to higher prices for goods. This means that you can buy less of these goods than other employees with higher wages can buy. Your Taler wage is therefore worth less if other employers pay their employees high Taler wages. This leads to the following:

If the Taler wage that you receive from your employer is lower than the average of 4 other Taler wages, the euro wage that your employer pays you is smaller than 1€.

If the Taler wage that you receive from your employer is the same as the average of 4 other Taler wages, the euro wage that your employer pays you equals 1€.

If the Taler wage that you receive from your employer is higher than the average of 4 other Taler wages, the euro wage that your employer pays you is larger than 1€.

Step 2: employees choose their effort level

You are informed about your wage in Taler. You are also informed about the average wage in Taler that 4 other randomly chosen employers pay their employees and which determines your wage in euros. You then choose your effort level. You choose an effort level between 1 and 4.

With your effort level, you determine your employer's benefit in euros for this round. Your effort incurs costs for you that increase with your effort level. Following table gives you an overview of benefits and costs of effort.

Benefit of work effort for employer	1 €	2 €	3 €	4 €
Cost of work effort for employee	0 €	0.1 €	0.3 €	0.6 €

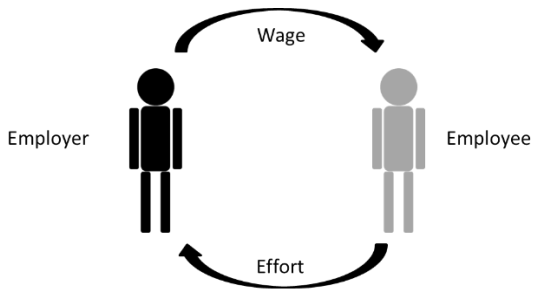
At the end of the round, you will receive information on the decisions and payoffs for this round. As already mentioned, your round payoff is determined as follows: Round payoff = euro wage – costs of effort.

Written instructions – employer (translated from German)

Written instructions are provided for treatment DOWN. Differences for treatment UP are marked.

General instructions

At the beginning of this experiment, 20 participants will randomly receive the roles of employers and employees, so that 10 employers and 10 employees will participate in this experiment. The experiment consists of 20 rounds. In each round, the employer chooses a wage for his employee and the employee then chooses his work effort.



You are an employer. You will keep this role throughout the entire experiment. You will be randomly re-matched with an employee at the beginning of each round. You thus interact with different employees during the experiment.

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Round payoff employer = benefit of work effort – wage

Round payoff employee = wage – costs of effort

At the end of the experiment, 10 of the 20 rounds will be randomly drawn. The round payoffs of these 10 rounds will be summed up. You will be paid out this sum at the end of the experiment.

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Calculation of euro wage

You set the wage in the currency Taler. The wage is converted into euros as follows:

Euro wage = Taler wage / Average of 4 other Taler wages

The higher the Taler wage you pay, the higher your employee's euro wage. The euro wage is higher, the smaller the Taler wage that 4 randomly chosen other employers pay their employees. The euro wage is lower, the higher the Taler wage that 4 other randomly chosen employers pay their employees. Following notion clarifies this: In reality, higher wages lead to higher prices for goods. This means that your employee can buy less of these goods than other employees with higher wages can buy. The wage you pay is therefore cheaper for you than the wage other employers pay their employees. This leads to the following:

If the Taler wage that you pay your employee is lower than the average of 4 other Taler wages, the euro wage that you pay your employee is smaller than 1€.

If the Taler wage that you pay your employee is the same as the average of 4 other Taler wages, the euro wage that you pay your employee equals 1€.

If the Taler wage that you pay your employee is higher than the average of 4 other Taler wages, the euro wage that you pay your employer is larger than 1€.

Step 2: employees choose their effort level

The employees are informed about their wage in Taler. They are also informed about the average wage in Taler that 4 other randomly chosen employers pay their employees and which determines their wage in euros. The employees then choose their effort levels between 1 and 4. With his effort level, your employee determines your benefit in euros for this round. Your employee's effort incurs costs for him that increase with his effort level. Following table gives you an overview of benefits and costs of effort.

Benefit of work effort for employer	1 €	2 €	3 €	4 €
Cost of work effort for employee	0 €	0.1 €	0.3 €	0.6 €

At the end of the round, you will receive information on the decisions and payoffs for this round. As already mentioned, your round payoff is determined as follows: Round payoff = benefit of work effort – euro wage.

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