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Shocking gift exchange

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A B S T R A C T

We study how a gift exchange labor market reacts to the occurrence of negative shocks. One-round shocks may hit either workers' wages or employers' earnings (via worker productivity). In our model, other-regarding preferences suffice to predict gift exchange and wages above the competitive level. Wage rigidity is predicted if we add wage illusion and loss aversion. Using a real-effort laboratory experiment, we find support for the model. When there are no shocks, there is gift exchange. After a wage shock we see strong nominal wage rigidity and no impact on workers' effort, as predicted. Rigidity is also observed after a productivity shock, but here we do observe increases in effort, especially at low wages. The latter is contrary to the model predictions and suggests that productivity shocks alter gift-exchange patterns. We conclude that the wage rigidity often observed in the field can be explained by boundedly rational workers with social preferences.

1. Introduction

Labor markets are often considered *rigid*; wages do not adjust quickly to changes in market conditions, particularly if there is downward pressure to cut them (Bewley 1999, Dickens et al. 2007). Rigidity can be harmful when it stops markets from clearing, which, for example, can bring about involuntary unemployment. Rigidity would not occur if market forces determined wages in the labor market. Labor relations, however, are often characterized by incomplete contracts on the one hand (Milgrom and Roberts, 1992), and trust and reciprocity on the other. There are many examples of how the effects of moral hazard are mitigated by trust and reciprocity between employers and workers and mutual regard for each other's well being, rather than by attempts to reach more complete contracts (Fehr et al. 1997; Gächter and Fehr 2002). This may be partly attributed to psychological reactions to market forces. For example, workers often perceive wage cuts as unfair and demotivating (Bewley 1999; Kahneman et al. 1986). Fairness and motivation are concepts that are deemed to play a central role in labor relations. Indeed, experiments have shown that cuts to nominal wages are considered unfair and lead to lower effort exerted by the worker (e.g., Hannan 2005, Kube et al. 2013, Cohn et al. 2015, and Koch 2021).

If labor relations are not purely market interactions, they might not follow the conventional rules of supply and demand when adjusting to shocks. A seminal and simple theory to explain why this might occur was presented as the 'fair

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wage-effort hypothesis' by Akerlof and Yellen (1990). The basic idea is that workers have a notion of a wage level that is deemed 'fair'. They will respond negatively (by reducing effort) to wages below this level. The effect is, however, asymmetric; there is no effort response to wages above the fair level. The fair wage is thus defined as the point at which a positive relationship between wage and effort levels out. Empirical support for such a kink in the effort-wage relationship is provided by, among others, Mas (2006), Gächter and Thöni (2010), Kube et al. (2013), Cohn et al. (2015), and Sliwka and Werner (2017). The existence of such a fair wage level may induce employers to offer wages that are higher than the market-clearing level. They then trust that workers will reciprocate with their effort levels. Note, however, that it is not a priori obvious at what wage level the kink will occur (that is, what constitutes a fair wage). Moreover, it remains unknown if and how such fair-wage reference points adjust to shocks in a gift exchange market. We explore these issues in this paper.

This paper applies the accumulated knowledge about labor relations with incomplete contracts in an attempt to better understand wage rigidity; it studies how one-time negative shocks in earnings are absorbed in a gift exchange labor market. Gift exchange describes a two-player interaction where the first mover offers a benefit ('gift') to a second mover without any certainty that the second mover will honor the expectation of a counter-gift. In the labor market context with moral hazard, this means that a wage above the market-clearing wage is offered while expecting this to be responded to with higher than minimal effort. Under the fair wage-effort hypothesis, this gift exchange is observed only for wages below the fair-wage level (Gächter and Thöni, 2010). Gift exchange is thus based on social relations, such as the above-mentioned trust and reciprocity or the other-regarding preferences that we use later in our model. It can improve moral hazard situations in which standard rational behavior would cause the market to fail (Akerlof 1982, Mauss 2002). We refer to the observed relationship between wages and effort in a setting of moral hazard as the "gift-exchange pattern'.

Gift-exchange patterns point to the possible advantages of wage rigidity. In preventing wage cuts, rigidity could simultaneously prevent subsequent drops in labor productivity that would occur in response to wages that are lower than those deemed fair. Indeed, depending on the specific pattern, rigidity may even be an optimal strategy for employers (Fehr et al. 1993). Thus, we are interested here in the gift exchange patterns that occur, and specifically in the extent to which these can explain the observed wage rigidity after negative shocks. Importantly, we do not consider the gift-exchange pattern as given; we recognize that shocks may affect the pattern itself. Note that in studying this, we abstract away from institutional factors that prevent wage adjustments, such as unions, collective bargaining or binding contracts. This allows us to isolate gift exchange patterns, and more specifically the role they play in wage rigidity.

We derive predictions from a simple model of gift exchange with a fair-wage reference point. These predictions are subsequently tested in a laboratory experiment. The structure of the model and the experimental design build on the seminal experiment by Fehr et al. (1993). It adds to the original by using a real-effort task to measure workers" productivity and, in particular, by adding one-time negative shocks. A novelty of this paper is also to vary the side of the market that receives the negative shock in the gift exchange labor market. The random shocks come in two types, a cut in (all) workers' wages and a reduction in (all) workers' productivity. The wage shock causes a real wage cut that keeps the nominal (gross) wages intact but reduces the net wages for all workers. The productivity shock reduces all employers' earnings for any given effort level. These two shocks allow us to alternate who benefits most from maintaining the status quo. Note that our interest lies in temporary shocks that affect either net wages or productivity for one round only. This is because we see the labor market that we create as matching workers to employers for a length of time (e.g., a year) in which shocks (like a pandemic) may happen that will have faded away by the time the next round starts.[1]

The earlier non-experimental literature shows that real wage cuts through inflation are not perceived to be as unfair and demotivating as nominal wage cuts are (e.g., Kahneman et al. 1986, Kaur 2019). This is observed even when the economic consequences are equal, that is, when the achievable bundle of consumption goods is equally reduced. Related experimental literature has studied the effects of nominal wage changes while holding real wages constant, the opposite case to ours. For instance, a real-effort experiment by Fochmann et al. (2013) finds that subjects work harder and longer, the higher the nominal wage is, even when this higher wage is accompanied by a change in the tax rate that keeps the real wage constant. This is referred to as 'net wage illusion'. One extension of our model will allow for net wage illusion.

Our paper is not the first to study wage rigidity in the laboratory. In a gift-exchange context, strong wage rigidity in response to shocks is not a common experimental result. For example, Koch (2021) finds that the average wage is lower after a shock has occurred than when there is no shock, although some rigidity remains as wages do not adjust fully. Gerhards and Heinz (2017) use a two-round laboratory market where the employer might be hit by an external shock in the second round. In their experiment, employers pay on average lower second-round wages if a shock is realized and workers do not subsequently reduce effort in response to the lower wages. They also observe that the mere possibility of a second-round shock makes both first-round wage and effort adjust upwards. We will see, however, that our results over time show strong learning effects in the first two rounds. Reference points (and rigidity) require time to develop, but once so, they remain stable. This casts some doubt on the external validity of previous studies that rely on only one or two rounds. Last, Buchanan and Houser (2020) find that about half of the employers cut wages, and they are punished for it by reduced effort. With hindsight, they estimate that rigidity is the optimal policy for employers.

[1] As an anonymous reviewer pointed out, one could also consider permanent shocks, which may be seen as a regime change. We leave this for future research.

In two related experiments, by Rubin and Sheremeta (2015) and Davis et al. (2017), a gift exchange market is shocked with on-average neutral events that vary how well effort translates to output. Both papers find that such shocks reduce wages. Rubin and Sheremeta (2015) conclude that welfare is reduced by these shocks despite the fact that they have zero impact on average productivity. Davis et al. (2017) speculate that the reason underlying the lower welfare is not the shocks themselves but the history of shocks that in some cases triggers hysteresis. Our data do not allow us to study the role of hysteresis.

Finally, the experimental literature on shocks to employers' earnings has established that workers' effort is sensitive to the surplus of the employer (e.g. Hannan 2005, Hennig-Schmidt et al. 2010, Koch 2021). This is what we also observe. Interesting here is the asymmetry: our results show that wages are not 'required' to adjust after the workers have been hit by a shock, yet the workers do adjust to the shocks experienced by the employer. To our knowledge, we are the first to observe this. Moreover, from the welfare comparisons between treatments, we find a clear indication that 'shock-fairness' matters; welfare is highest in the setup where either party can experience a shock.

Our paper aims to contribute to the literature on how labor markets adjust to shocks in various ways. What we have in common with the above-mentioned studies is that we study this in a gift-exchange context, building on the work of Fehr et al. (1993) and Fehr et al. (1997). While Rubin and Sheremeta (2015) and Davis et al. (2017) add (on-average neutral) shocks to labor productivity and conclude that these reduce gift exchange, Koch (2021), Gerhards and Heinz (2017), and Buchanan and Houser (2020) introduce purely negative shocks (in the latter two studies these shocks are permanent). Our work differs from these other studies in various important ways. First, we believe to be the first to consider equivalent (temporary) shocks on both sides of the labor market. Second, to the best of our knowledge, our paper is the first to experimentally study the effects of real wage cuts while keeping nominal wages and employer profits constant.[2] Third, in order to make the effects of shocks more salient we use a real effort task instead of stated effort. Real effort allows one to also capture subconscious effort responses, such as reductions in motivation that might negatively affect prolonged concentration; it also allows for an intrinsic motivation to work. In the world outside the laboratory, effort is real and workers typically desire this to be recognized by their employer. It is unclear whether such elements can be captured in a stated-effort design. Finally, we stay close to the original Fehr et al. (1993) design by matching participants anonymously through a market with excess supply of labor. These other studies are based on pre-determined pairs and often on repeated within-pair interactions. While this makes those studies relevant for principal-agent relationships within firms, ours aims at studying the effects of shocks on gift exchange patterns in the labor market more generally, where periods of unemployment and relative inactivity are also possible.

Our theoretical model starts with a simplified version of the Charness and Rabin (2002) framework. It allows individuals to derive disutility from inequality in payoffs, similar to the approach of Benjamin (2015). We then introduce loss aversion and net wage illusion (as explained below). This is in contrast to Dickson and Fongoni (2019), who model gift exchange based on *work morale* and reference points. Their model does not provide much rationale for how and why effort would react to shocks. We are interested in such predictions, which our approach provides. When there are no shocks on either side of the market, the model predicts wages above the competitive level together with gift exchange. A wage shock is predicted to have no effect on wages or effort. In this way, the model predicts wage rigidity. Wage rigidity is also predicted if a productivity shock occurs, but this also leads to a reduction in effort for the simple economic reason that effort is less productive.

Our experimental results in the absence of shocks confirm previous findings on gift exchange. The fact that we do so in a real-effort experiment is evidence of the robustness of the traditional results. Our experimental treatments with shocks show three main findings. First, we confirm the model's predictions on wages as we observe strong wage rigidity. Wages do not react systematically to realized shocks. Second, although we do not find that wages are significantly higher when shocks *might* occur, neither do we find that the shocks significantly reduce welfare in ex-ante terms. The market seems to adjust to the risk of shocks in a way that largely stabilizes welfare. Our third main finding is that gift exchange (the workers' effort responses to wages) is not affected by real wage cuts. Productivity shocks, however, lead to increases in effort (where decreases were predicted), especially at lower wage levels. This suggests that productivity shocks cause a shift in workers' fairness standards.

The remainder of this paper is organized in the traditional way. Our model is presented and analyzed in Section 2. Section 3 presents the experimental design and procedures. The results are presented and discussed in Section 4 and a concluding discussion is in Section 5.

2. Theory

In this section, we present a model of gift exchange to analyze the interaction between a worker and an employer when both (may) have social preferences. We will subsequently use this model to predict the effects of shocks. The basic setup is a simple one-shot, two-player gift exchange game between an employer and a worker.[3] A minimum wage level applies, which we normalize to zero.

[2] Buchanan and Houser (2020) do consider the case of real wage cuts when there are permanent shocks.

[3] In the experiment, employers are linked to workers via an anonymous hiring market. For simplicity, we assume here that the two are already linked. We think of the equilibrium wage in our model as the wage offered (and accepted) on the market.

The game consists of two-stages:

- In the *first stage* the employer sets a wage $w \geq 0$ for the worker.
- In the *second stage* the worker observes w and chooses effort $e \geq 0$; that is, effort is non-contractible.

We will start with a model of gift exchange in which actors exhibit other-regarding preferences and then discuss the effects of the two shocks. Then we introduce well-established elements of bounded rationality into the model and study how they change the way the shocks are absorbed. We conclude with a set of theoretical predictions derived from the models.

2.1. A Model of gift exchange

Following the logic of backward induction, we first consider how workers in the second stage respond with effort to a given wage, which is independent of the effort. We then model how employers set the wage in the first stage, given the workers' best response function. At this point, we are not yet considering shocks.

Worker's Effort Choice

Utility. The worker's utility, denoted by u^W, is captured by the expression:

$$u^W = (1 - \beta(e))w + \beta(e)(f(e) - w) - c(e). \tag{1}$$

Utility thus depends on the worker's monetary payoff (wage, w); the (utility) costs of exerting effort, $c(e)$, and a social preference term reflecting the difference between the employer's monetary earnings and the wage. Employers' earnings consist of the (monetary) benefits that the worker's effort generates, depicted by $f(e)$, minus the wage. We interpret that $f(e)$ captures worker productivity, which depends on the effort that she exerts.

The function β is derived from a simplified version of the Charness and Rabin (2002) model. This allows one to capture various types of social preferences in a single framework.[4] For example, it allows individuals to derive a disutility from an inequality in payoffs. The reaction to the inequality may differ, depending on whether they are earning more or less than the employer. Inequality here is simply defined by the monetary earnings.[5] An often-made assumption introduced by Fehr and Schmidt (1999) is that individuals dislike disadvantageous inequality more than they dislike advantageous inequality. When the worker earns less than the employer, $w < f(e) - w$, the preference in the Fehr and Schmidt (1999) model is captured by a parameter $\sigma < 0$; when the worker earns more than the employer, $w > f(e) - w$, the preference is captured by parameter $\rho > 0$. We follow Charness and Rabin (2002), however, and allow for a more general class of other-regarding preferences by not restricting σ to be negative and only assume $\rho > \sigma$ and $\rho > 0$.[6] In summary,

$$\beta(e) = \begin{cases} \sigma, & \text{if } w < \dfrac{f(e)}{2} \\[2ex] 0, & \text{if } w = \dfrac{f(e)}{2} \\[2ex] \rho, & \text{if } w > \dfrac{f(e)}{2}. \end{cases} \tag{2}$$

Before we derive a best response function for a worker, we make some functional assumptions. The costs of effort are assumed to be a strictly convex function of the effort exerted, $c'(e) > 0$ and $c''(e) > 0$. In addition, we assume $c(0) = 0$. The benefit that effort generates is assumed in turn to be a concave function of the effort, $f'(e) > 0$ and $f''(e) \leq 0$, while no effort means no benefits, $f(0) = 0$. To ensure that a positive level of effort is efficient, we assume $\lim_{x \downarrow 0} f'(0) > \lim_{x \downarrow 0} c'(0)$.

Best Response. A worker maximizes u^W in Eq. (1), that is, for any given w she chooses e such that

$$\frac{c'(e)}{f'(e)} = \beta(e). \tag{3}$$

The best response of a worker, $\hat{e}$, thus depends on her social preferences. Note that $\hat{e}$ varies with w because $\beta(e)$ depends on w (Eq. (2)). Denote by $\hat{e}_\sigma$ the solution to Eq. (3) for $\beta(e) = \sigma$, and by $\hat{e}_\rho$ the solution for $\beta(e) = \rho$. For $\sigma < 0$ we have a corner solution $\hat{e}_\sigma = 0$. Beyond this corner solution, the solution is increasing in β because $\partial(\frac{c'(e)}{f'(e)})/\partial e > 0$. Thus,

[4] We do not include reciprocal preferences, which are also part of the Charness and Rabin (2002) model.

[5] We assume that workers do not take into account social preferences that the employer may have, nor do they account for their own social preferences or effort costs when comparing themselves to the employers. This is grounded in the so-called availability heuristic (Kahneman et al. 1982), as payoffs are the only comparative metric readily available in the experiment. While this assumption simplifies the analysis, extending the model by, for example, including effort costs to the inequality comparison does not qualitatively change the predictions.

[6] When the payoffs are equal ($w = \frac{f(e)}{2}$), the weight β is assumed equal to zero. This does not mean that the employer's income plays no role; as long as the earnings remain equal, changes in one's own payoff are perfectly aligned with changes in the employer's. Of course, as soon as a change causes differences in the earnings, the worker will attribute a non-zero weight to the employer's earnings.

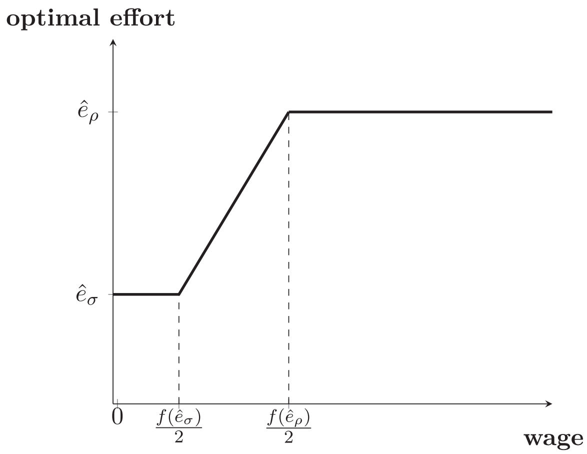

Fig. 1. Worker's response curve e(w) as a function of wage. *Notes:* The optimal effort (vertical axis) is shown as a function of the wage (horizontal axis). $\hat{e}_\rho$ ($\hat{e}_\sigma$) depicts the solution to the first order condition (4) in case the worker faces (dis)advantageous inequality. In this example, $\sigma > 0$.

$\sigma < \rho$ together with $\rho > 0$ implies that $\hat{e}_\sigma < \hat{e}_\rho$; that is, optimal effort is lower with disadvantageous inequality than with advantageous inequality. Finally, denote by $\hat{e}_0(w)$ the effort level that equalizes earnings between worker and employer; this is implicitly defined by $w = \frac{f(\hat{e}_0)}{2}$.[7]

Result 1. The worker's best response function is given by

$$\hat{e}(w) = \begin{cases} \hat{e}_\sigma, & \text{if } w < \dfrac{f(\hat{e}_\sigma)}{2} \\ \hat{e}_0(w), & \text{if } \dfrac{f(\hat{e}_\sigma)}{2} \leq w \leq \dfrac{f(\hat{e}_\rho)}{2} \\ \hat{e}_\rho, & \text{if } w > \dfrac{f(\hat{e}_\rho)}{2}. \end{cases} \tag{4}$$

Eq. (4) implies that effort is non-decreasing in wage.[8] Moreover, the second line on the r.h.s. shows that (because $\hat{e}_\sigma < \hat{e}_\rho$) there is a range of wages for which workers choose an effort level that equalizes earnings. Fig. 1 illustrates this best response function.[9]

The effort function is non-decreasing in wage and is reminiscent of the fair wage-effort hypothesis mentioned in the introduction (Akerlof and Yellen, 1990) that argues that effort responds positively to wages up to a wage level that is deemed 'fair'. Above the fair wage, workers are assumed to provide a constant effort level that Akerlof and Yellen call "normal". The kink in the response at a wage of $\frac{f(\hat{e}_\rho)}{2}$ defines the *objectively fair wage* in our model. The characteristics of this fair wage depend on the worker's disutility parameter ρ and the assumptions we make for the unobservable functions $c(e)$ and $f(e)$.[10]

Employer's Wage Setting

Utility. Employers choose a wage at the first stage of the interaction. Their utility, denoted by u^F (where "F" stands for "firm'), is assumed to be given by

$$u^F = (1-\alpha)(E[f(e(w))] - w) + \alpha w. \tag{5}$$

The utility thus consists of the expected monetary earnings (expected revenue $E[f(e(w))]$ minus the wage) plus a social preference term reflecting concern for the worker, and in particular, the worker's wage (weighted by α).[11] In a Subgame

[7] To avoid further corner solutions, we assume that there exists an $\hat{e}_0$ for which this equality holds. For ease of notation, we further assume that $\sigma < \frac{c'(\hat{e}_0(w))}{f'(\hat{e}_0(w))} < \rho, \forall w$. This assures that $\hat{e}_\sigma < \hat{e}_0(w) < \hat{e}_\rho, \forall w$, thus avoiding cumbersome notations.

[8] We note that although the discontinuity of the beta function (2) shapes the gift exchange function $e(w)$, it does not drive the predictions of this paper. Our predictions only require that for some positive levels of wages, optimal effort increases in wage with diminishing returns $f(e)$. The latter ensures that there is a local maximum in employer's utility. We choose the discontinuous Charness and Rabin (2002) function because of its prominent place in the literature.

[9] For presentational purposes, $f(e)$ is assumed to be linear. A non-linear $f(e)$ would add curvature to the intermediate segment of the best response function.

[10] For similar patterns, see Benjamin (2015) (using a model based on other-regarding preferences) and Dickson and Fongoni (2019) (a model of 'worker morale').

[11] As with the worker, we assume that the employer's other-regarding preferences are fully based on monetary earnings. The employer does not take into account the worker's other-regarding preferences or her effort costs.

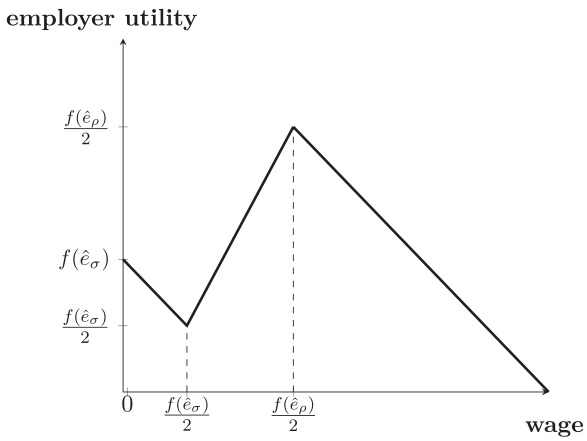

Fig. 2. Employer's utility as a function of wage. *Notes:* The employer's utility is shown as a function of the wage (horizontal axis), assuming $\alpha < 0.5$. $\hat{e}_\sigma$ ($\hat{e}_\rho$) depicts the solution to the first order condition (4) in case the worker faces (dis)advantageous inequality.

Perfect Equilibrium (SPE), employers expect the workers to best respond to the wage offered, that is, $E[f(e(w))]$ is determined by Eq. (4). In other words, $E[f(e(w))] = f(\hat{e}(w))$.

We first consider the role of α. Recall from worker's best response, Eq. (4), that for the low and high wage ranges, effort does not respond to changes in the wage. A wage increase within either of these ranges then raises the worker's earnings without affecting her productivity, $f(e)$. The utility-maximizing wage for the employer in each of these wage ranges is then a corner solution of either the lowest wage (in case the employer cares more for her own payoff, $\alpha < 0.5$) or the highest wage (when the employer cares more for the worker's payoff ($\alpha > 0.5$). From here onward, we will assume the former scenario, that is, the employer cares more for her own payoff than that of the worker.

In the intermediate wage range, the worker responds with effort in a way that equalizes the net monetary benefits. Substituting $w = E[f(e(w))] - w$ in (5) gives $u^F = E[f(e(w))] - w$. This means that the other-regarding preferences drop out. For this intermediate range, we thus set $\alpha = 0$ without loss of generality. The utility maximizing wage is then the wage that maximizes the employer's monetary earnings.

Optimal Wage Setting. Fig. 2 summarizes the discussion above and shows how the employer earnings, given by $f(\hat{e}(w)) - w$, vary with the wage offered in the SPE. Increasing low wages (below $\frac{f(\hat{e}_\sigma)}{2}$) does not affect the worker's chosen effort level (which stays at the low $\hat{e}_\sigma$), so the employer's earnings drop linearly in w.[12] A wage equal to zero then yields a local maximum in the employer's utility. Similarly, the linear negative relation between this utility and wages above $\frac{f(\hat{e}_\rho)}{2}$ follows from workers not responding to increased wages with higher effort. Only the intermediate range provides an opportunity for further gift exchange, that is, a marginal increase in effort in response to a wage increase. In this range, a wage increase leads to higher effort that benefits the employer. Revenue can rise up to a level of $\frac{f(\hat{e}_\rho)}{2}$ for a wage of $\frac{f(\hat{e}_\rho)}{2}$. This provides a second local maximum of the employer's utility. A comparison of the two local maxima yields our next result.

Result 2. The utility maximizing wage for an employer is

$$\hat{w} = \begin{cases} 0, & \text{if } \frac{f(\hat{e}_\rho)}{2} < f(\hat{e}_\sigma) \\ \frac{f(\hat{e}_\rho)}{2}, & \text{if } f(\hat{e}_\sigma) \leq \frac{f(\hat{e}_\rho)}{2}, \end{cases} \tag{6}$$

where we assume that an employer chooses the higher wage whenever indifferent.

Recall that we call $w = \frac{f(\hat{e}_\rho)}{2}$ the objectively fair wage. Result 2 shows that whether the employer prefers the minimum wage of zero or the objectively fair wage depends on σ and ρ, which are the worker's social preference parameters. This is because the employer's optimal action depends on the extent to which she can stimulate sufficient gift exchange from the worker's side. We conclude that whenever ρ is large enough relative to σ, the SPE involves gift exchange: employers set wages above the minimum and workers respond with an effort level that equalizes earnings. Note that this gift exchange model does not require workers to have reciprocal preferences, which would yield even higher wages and effort levels. Moreover, gift exchange is observed in equilibrium even if employers have selfish preferences. All that is needed for gift exchange is that the worker cares about the employer's earnings.

[12] If $\sigma < 0$ then $f(\hat{e}_\sigma) = 0$.

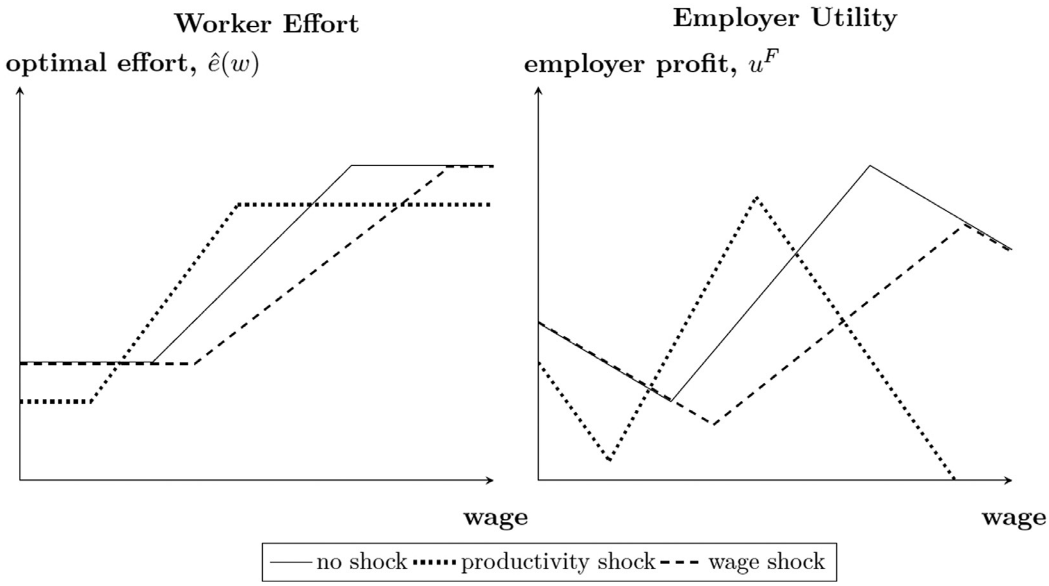

Fig. 3. The Effects of Shocks. *Notes:* The left panel shows optimal effort (vertical axis) as a function of the nominal wage (horizontal axis). The right panel shows employer's utility as a function of the nominal wage (horizontal axis).

Incomplete Information

Thus far, we have assumed that this is a game of complete information. In particular, this assumes that employers know the workers' preference parameters σ and ρ. In practice, workers' preferences will be heterogeneous with respect to these parameters and employers will update their beliefs about workers' (social) preferences based on experienced effort choices. Our goal, however, is not to provide a full-fledged analysis of this game. Instead, our aim is to derive directional predictions with respect to the effects of shocks on gift exchange. The complete-information SPE derived here suffices to do so.

2.2. The impact of shocks

We now consider shocks in monetary earnings. These may occur randomly with known probability. When a shock occurs, it reduces the monetary income of either all workers or all employers, thus affecting one side of the market. Think for example of an externally enforced tax. We consider two potential common shocks:

Wage shock: reduces the wage (w) received by the workers, leaving employer earnings unaffected.

Productivity shock: reduces the employers' revenues ($f(e)$), leaving worker earnings unaffected.

A detailed description of the model with shocks is presented in Appendix A. Here we provide an overview of the model's implications.

Fig. 3 illustrates the effects of shocks on the worker's best response function (left panel) and the employer's utility (right panel). For presentational purposes, we again assume a linear $f(e)$ (cf. fn. 9).

Observe that a wage shock (dashed line) shifts the worker's best response to the right because a higher wage is needed to equalize earnings (left panel). Moreover, the upper bound shifts further to the right than the lower bound (cf. Appendix A). As a consequence, the intermediate wage area with gift exchange is larger than without the shock. There is no vertical shift of the response function, because this is determined by the f.o.c. (3), which is not affected by a wage shock. Because the wage shock does not affect effort levels at low wages and because it does not reduce employers' revenues for given effort, employer utility (right panel) at the minimum wage is the same with and without wage shock. As wages increase, u^F develops in the same way in both cases. However, it takes a higher wage for the worker to start equalizing earnings as effort does not increase until the net wage is equal to the (minimum) employer profit. This occurs at a higher wage than when there is no shock. The employer's utility subsequently reaches its maximum at a higher objectively fair wage and lower level of utility due to the increased wage expenses.

A productivity shock (dotted line) shifts the area of wages where the worker wants to equalize earnings to the left. Moreover, it shifts the upper bound further to the left than the lower bound (cf. Appendix A), yielding a smaller range of wages where gift exchange is observed. The productivity shock also shifts the worker's best response curve downward. This is because the worker recognizes that each unit of effort gives less return to the employer and internalizes this by lowering the provided effort such that the marginal cost of effort matches the lowered marginal benefit to the employer. As a consequence, a productivity shock reduces employer's utility (right panel) at the minimal wage (here normalized to $w = 0$). Utility then declines linearly until the worker starts to respond to wage increases by equalizing earnings. This gift exchange takes place up to the objectively fair wage, but this is lower than the objectively fair wage in the case without shocks. As wages increase beyond this level, employer's payoff decreases linearly because effort no longer increases in response to higher wages.

One will observe gift exchange in the SPE if the utility achieved at the objectively fair wage is higher than the utility achieved at the minimum wage. Appendix A derives precise conditions for this to occur.[13] The theoretical predictions in the following subsection are based on the assumptions that these conditions for the occurrence of gift exchange are met.

2.3. Theoretical predictions

We start with the employer-worker interaction when there are no shocks. The possibility of gift exchange in the SPE gives the following theoretical predictions. As discussed above, these have found support in numerous laboratory and field experiments.

Theoretical Prediction 1: (*Wages*) Employers offer wages above the minimum level.

Theoretical Prediction 2: (*Gift Exchange*) The relationship between wages and effort is positive up to a fair wage level. No relation is expected at wages above the fair wage level.

Based on the subgame-perfect equilibria depicted in Fig. 3 and the analysis of Appendix A, we derive the following comparative static predictions for the effects of shocks.

Theoretical Prediction 3: (*Wage shock*) Compared to the case without shocks, a negative wage shock yields higher wages and does not affect (equilibrium) effort.

Theoretical Prediction 4: (*Productivity shock*) Compared to the case without shocks, a negative productivity shock yields lower wages and lower (equilibrium) effort.

Note that these hypotheses do not predict wage rigidity. This is because the objectively fair wage, based on equity and cost-benefit calculations, varies with the shocks. In the next subsection we discuss alternative behavioral models that do predict wage rigidity.[14]

2.4. Alternative behavioral models

Net wage illusion

Various experimental studies on labor market responses to taxes observe that workers respond more to gross wages than to net (after-tax) wages (Fochmann et al. 2013; Weber and Schram 2017). In an environment of shocks, this would mean that a worker neglects the effects of a shock on her real wage (if it leaves the nominal wage unchanged) and therefore does not change her effort. As a consequence, the effort response function and the employer's utility in Fig. 3 do not shift after a wage shock compared to the no-shock case.

Loss aversion

Our static model assumes that the worker responds to wages independently of any prior expectations she might have had about a 'reasonable' wage level. Instead, a worker might consider a wage that is lower than what she expected to be a 'loss', irrespective of whether this lower wage might be justified by a shock. We rationalize this by applying the Kőszegi and Rabin (2006) notion of reference-dependent preferences. Utility is measured against some reference point. If the outcome falls short of the expected, the individual experiences a loss even if the outcome is positive in absolute terms. It is worth noting that this formulation of loss aversion is closely related to the formulation of a negative reciprocity term in Charness and Rabin (2002). Here, 'misbehaving' is essentially understood as setting a wage below the relevant reference point.

We assume that for a worker the objectively fair wage in the no-shock case serves as a reference.[15] We now denote this by $\tilde{w}$. Recall that $\tilde{w} = \frac{f(\hat{e}_\rho)}{2}$. The worker then experiences a loss if the current wage falls short of this reference point. In our model, we capture this by adding a loss term to the social preference function $\beta(e)$ in the worker's utility function (1).

[13] We also show in the appendix, that if worker preferences yield an SPE with gift exchange when there is a wage shock, then there is also gift exchange in the equilibrium for the case without a shock.

[14] The asymmetry in the Predictions 3 and 4 with respect to the effects on effort stems from the fact that optimal effort is given by an equilibrium condition on which a productivity shock has an impact, but a wage shock does not. This asymmetry will also be observed in the model extensions discussed below.

[15] We make this assumption to stay within the realm of our model. All that is needed for the effects described in what follows is that people have some idea of what is a 'fair' wage in the absence of shocks.

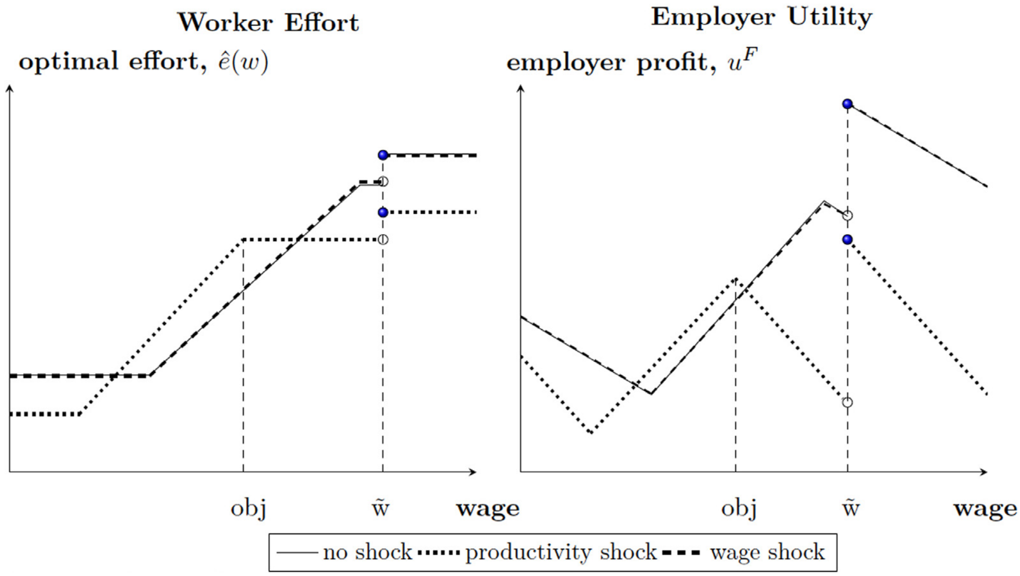

Fig. 4. The Effects of Net Wage Illusion and Loss Aversion. *Notes:* The left panel shows optimal effort (vertical axis) as a function of the nominal wage (horizontal axis). The right panel shows employer's utility as a function of the wage (horizontal axis). $\tilde{w}$ depicts the subjectively fair wage, which is defined as the objectively fair wage in the no-shock case and which serves as a reference point for the worker. *obj* is the objectively fair wage when there is a productivity shock.

Once again, we set $\beta = 0$ for the range of wages where the worker equalizes earnings (cf. fn. 6).

$$\beta(e) = \begin{cases} \sigma - \lambda, & \text{if } w < \frac{f(e)}{2} \wedge w < \tilde{w} \\ 0, & \text{if } w = \frac{f(e)}{2} \wedge w < \tilde{w} \\ \rho - \lambda, & \text{if } w > \frac{f(e)}{2} \wedge w < \tilde{w} \\ \rho, & \text{if } w > \frac{f(e)}{2} \wedge w \geq \tilde{w}, \end{cases} \tag{2'}$$

where parameter λ measures the degree of loss aversion. In the first line of (2'), the worker faces disadvantageous inequality and a wage that is lower than the reference point. In the second, earnings between the worker and employer are equal, but the wage is still below the reference. The latter also holds in the third line, but here the worker is earning more than the employer. Finally, the fourth line covers the situation where the worker faces advantageous inequality and at the same time a wage that is larger than or equal to the reference point.

Without shock, the parameter λ shifts the worker's best response function downward (because $\hat{e}_{\sigma-\lambda} < \hat{e}_\sigma$ and $\hat{e}_{\rho-\lambda} < \hat{e}_\rho$) and to the left (because $f(\hat{e}_{\sigma-\lambda}) < f(\hat{e}_\sigma)$ and $f(\hat{e}_{\rho-\lambda}) < f(\hat{e}_\rho)$). Otherwise, the predictions of the static model remain unaltered. When there is a productivity shock the *objectively fair wage* diminishes (cf. Fig. 3). With loss aversion we assume that the worker does not adjust her reference point accordingly. We provide more details in Appendix B. Here, we summarize the combined effects of net wage illusion and loss aversion.

Combined effects

Fig. 4 shows the best response and employer utility functions when there is both net wage illusion and loss aversion. Note the discontinuity in both graphs at $\tilde{w}$. The 'jump' at this reference point is caused by loss aversion (measured by λ) no longer playing a role in the worker's effort decision (left panel). This has direct consequences for the employer's utility (right panel). We call the point at which this occurs the 'subjectively fair wage'. Note that when there is a productivity shock, this subjectively fair wage $\tilde{w}$ is larger than the objectively fair wage, which is determined by the upper kink in the worker's effort function. When there is a wage shock, the two are equal, due to the net wage illusion.

The right panel of Fig. 4 shows that when there is a productivity shock there are three local maxima in the employer's utility. They are at the minimum wage (0), the objectively fair wage (the peak in utility for $w = obj < \tilde{w}$) and the subjectively fair wage ($\tilde{w}$). Assuming that the objectively fair wage yields higher utility than the minimum wage, it is straightforward to formulate conditions under which the employer will prefer to keep wages at the subjectively fair level (cf. Appendix B). In the right panel of Fig. 4, utility is higher for the subjectively fair wage than for the objectively fair wage. If this holds, the model predicts wage rigidity, that is, employers prefer to hold wages constant even if they face a shock on their income. With a productivity shock, wage rigidity arises from loss aversion; if employers were to cut wages, workers would retaliate by cutting effort, making the wage adjustment unprofitable. The model also predicts wage rigidity for wage shocks as the objective fair wage is the same as the subjective one when there is both nominal illusions and loss aversion.

2.5. Alternative theoretical predictions

Based on the relationships illustrated in Fig. 4 and the elaboration in Appendix B, we can formulate alternatives to Hypotheses 3 and 4, for the case where workers exhibit net wage illusion and loss aversion that is strong enough to cause wage rigidity.

Theoretical Prediction 3A: (*Wage shock under net wage illusion*) A negative wage shock has no effect on wages or effort.

Theoretical Prediction 4A: (*Productivity shock under loss aversion*) A negative productivity shock has no effect on wages and yields lower effort.

Off the equilibrium path

Note that the behavioral model predicts no effects of a wage shock, on or off the equilibrium path (cf. Fig. 4). The case is different with a productivity shock, where equilibrium effort is lower with than without shock (Theoretical Prediction 4A). Out of equilibrium, however, one might observe the opposite. Consider the upward sloping part of the gift exchange curve for the no-shock and productivity shock cases. The worker's best response to a wage in this range (out of equilibrium) yields higher effort after a shock than when there is none. This is because the worker equalizes payoffs on this part of the curve. As the return on effort is lower, a higher level is needed to achieve balance.

3. Experimental design and procedures

3.1. Design

The design builds on Fehr et al. (1993). In contrast to their seminal paper, we use a computerized experiment and implement a real-effort task to measure productivity. The experiment is framed as a labor market and consists of eight rounds. Shocks are framed as one-round taxes. Each round consists of the following stages, which are elaborated below.

1. If tax shocks are possible, the (common) tax scheme (or the lack thereof) is announced
2. Employers hire workers in an auction
3. Workers conduct a real effort task
4. Payoffs are determined and reported

We start with a description of the hiring stage. Hiring happens in real time, via a one-sided auction. Employers post wage offers between 30 and 100 points, in intervals of 5, on a public platform observable by all employers and workers in the market. Offers can be updated while not yet accepted. Once a worker accepts an offer, the offer is removed and the worker is hired by the employer in question. The market consists of five employers and seven workers and each participant can have only one hiring contract per round.[16] As a consequence, at least two workers are unemployed in each round. The hiring stage lasts at most two minutes and finishes as soon as all five employers have hired a worker. After the auction, anonymized information is provided to all market participants about the number of hired workers and the realized wages (wages are given in random order).

At the start of the second stage, each hired worker thus knows her wage and whether or not a shock has occurred. She then works for five minutes on a real effort task. For the task (introduced by Weber and Schram 2017), two 10x10 matrices appear on the computer monitor. Each matrix cell contains a two-digit number. The worker needs to find the highest number in each matrix and add these two up. A correct answer yields a reward of 20 points to the employer (part of which may be taxed, as explained below). Whether the answer is correct or incorrect, a new pair of matrices appears. The maximum number of tasks that can be attempted is limited to ten.[17]

In some rounds, one-round shocks might be implemented. These are framed as "taxes", which are announced before the hiring auction and are known to hold for all workers or employers in that round. Note that this means that all participants are fully informed before they make any decisions in a round. The taxes impact participants' earnings. We distinguish between (1) a wage tax; this reduces the wage that the worker receives from the employer in that round by 20%; and (2) a productivity tax; this reduces the revenue that the employer receives from the hired worker's correctly solved tasks in that round by 20% (from 20 to 16 points). Tax revenues are not returned to participants in any way; proceeds are returned to the experimenter.

The experiment consist of four treatments that are varied between subjects. These differ in the type of tax that *might* occur. The four treatment options are 1) no tax (denoted by NT), 2) productivity tax (ET, for 'Employer Tax'), 3) wage tax (WT) and 4) employer or wage tax (AT, for "All Taxes'). In treatments where taxes are possible, they happen in any round with an probability equal to $\frac{1}{3}$. When both taxes are possible, each tax is equally likely but they cannot occur simultaneously.

[16] Following the original design of Fehr et al. (1993), the market consists of 7 workers and 5 employers. Brandts and Charness (2004) show that the market conditions (whether labor is in excess supply or demand) do not matter for the occurrence of gift exchange.

[17] This limit is set to discourage a strategy of guessing one answer and repeatedly entering this number at a very high pace. The limit is not binding; from previous projects, we know that even when incentivized with piece-rate rewards, fewer than 1% of the subject pool is able to reach this limit.

Table 1
Treatments and outcomes

Treatment	NT	ET	WT	AT
possible tax outcomes	nt	nt, et	nt, wt	nt, et, wt

Notes: NT/nt = ‘no tax’; ET/et = ‘productivity tax’; WT/wt = ‘wage tax’; AT = ‘all taxes’.

Table 2
Payoffs.

	employer payoff	worker payoff
no tax (nt)	$40 - w + 20 * e$	w
productivity tax (et)	$40 - w + 16 * e$	w
wage tax (wt)	$40 - w + 20 * e$	$0.8 * w$
outside option (no contract)	0	20

Notes: Cells show payoffs in points for employers and workers, depending on the outcome of the tax shock.

All of this is common knowledge. The sequence of taxes was drawn randomly beforehand and was fixed in order for all sessions to have a directly comparable history.[18]

It is important to distinguish between tax *treatments* (tax environments) and the tax *outcomes*. Throughout this paper, we indicate treatments with capital letters; they define which tax shocks (outcomes) are possible. Tax outcomes are realized per round; we indicate these with lower case letters. Table 1 summarizes all possible cases.

Each round ends with a payoff report for that round. Participants learn their own payoffs and if hired or hiring, the payoff of the partner to which they had been linked, as well as the number of tasks attempted and the number of tasks correctly solved. Payoffs depend on the hiring status and the tax outcome and are summarized in Table 2. If an employer hires a worker, the employer receives 40 points and all of the revenue from the task but must pay the worker’s wage from this income. A worker’s payoff consists entirely of the wage. If unmatched, employers earn nothing and unemployed workers receive an unemployment benefit of 20 points, regardless of the tax outcome. When taxes apply, they directly affect only one side, either the employer or the worker. The productivity tax is collected from the revenue that the employer receives, which means that when taxed, instead of the usual 20 points, the employer receives only 16 points for each task correctly completed by the worker. When the wage tax applies, the workers receive only 80% of the wages paid by their employer.[19]

At the end of the experiment, two rounds are randomly selected for payment.[20] The exchange rate used is one euro for every ten points earned in those two rounds. Note that for employers negative earnings in a round are possible. Because two rounds are paid, this can be compensated. In the end, only very few participants had negative earnings, and everyone who did was able to cover these with the show-up fee.

3.2. Procedures

The experiment was run at the BLESS laboratory of the University of Bologna, in 2017 - 2018. Participants were primarily students and recruited using ORSEE (Greiner, 2004). The experimental software was programmed in oTree (Chen et al., 2016). We had 312 participants in 13 sessions. Each session had 2 groups (each consisting of 5 employers and 7 workers).[21] Average earnings (including a five euro show up fee) were 14.5 euros.

Reading the instructions and getting familiar with the software took approximately 20 minutes and the main experiment lasted about one hour. A translation of the instructions is presented in Appendix C. During the software tutorial, the participants did the real effort task for five minutes to get acquainted with it. At the end of the instructions, the participants had a comprehension test (cf. Appendix C).

3.3. Testable hypotheses for the experimental design

We apply our theoretical predictions to this experimental environment. Note that – as is common when using laboratory data to test hypotheses – our predictions are concerned with the comparative statics that follow from the theoretical

[18] The shocks occur in rounds 2, 4, and 5. In *AT*, half of the sessions had a one-round productivity tax in round 2 and a one-round wage tax in rounds 4 and 5; the remaining sessions had the reverse. Note that the productivity tax is an example of the productivity shock that we modeled above, while the wage tax is a wage shock.

[19] It follows from the payoffs in Table 2 that (if one does not consider effort costs) equal payoffs are not possible for odd wages (35, 45, ...). We nevertheless chose to restrict the set of possible wages to the set with intervals of five to avoid employers signaling their identity by repeatedly making the same “unusual” offer (like 41).

[20] In the first three sessions, due to computational errors the incentive scheme rewarded three rounds instead of two (which was only known to the participants ex post) and a shock occurred in fewer rounds than intended (which is not expected to affect choices because the occurrence of a shock is common knowledge before any decision is made).

[21] For three groups we have 11 participants instead of 12, due to recruitment failures. In these cases, the experiment proceeded with six workers and five employers in the group. Our conclusions do not change if we drop these groups from the analyses.

discussion in the previous section. We keep the same order and start with the baseline in which no shock is realized (note that the occurrence of a shock is common knowledge at the start of a round). Recall that our first theoretical prediction is that employers will offer wages above the minimum level. We test this against a null hypothesis based on the rational choice equilibrium of no gift exchange. This involves employers offering a minimum wage and workers exerting no effort.

Hypothesis 1: **No Tax: Wages**

- H_0^1: In no shock (nt) rounds, employers offer the minimum wage of 30 points.
- H_1^1: In no shock (nt) rounds, employers offer wages above the minimum level of 30 points.

Closely related to this is the second theoretical prediction that the relationship between wages and effort is positive up to a fair wage level. For our environment, this gives

Hypothesis 2: **No Tax: Effort**

- H_0^2: In nt rounds, there is no relationship between wages and effort.
- H_1^2: In nt rounds, there is a positive relationship between wage and effort up to the objectively fair wage and no relationship beyond that.

For the reactions to shocks we have two sets of hypotheses, depending on whether or not the model includes net wage illusion and loss aversion. For wages, a model without net wage illusion predicts that a wage shock will yield an increase while net wage illusion predicts wages that do not respond to such shocks.[22] The latter is also predicted by the rational model with selfish preferences.

Hypothesis 3: **Wage Tax: Wages**

- H_0^3: *Rational-selfish model and social preferences with net wage illusion.* Wages are the same in wt rounds as in nt rounds.
- H_1^3: *Social preferences without net wage illusion.* Wages are higher in wt rounds than in nt rounds.

For effort, we focus on the equilibrium case where wages are as predicted. When analyzing the data, we will also consider the wage-effort relationship more generally (that is, including out-of-equilibrium wages), but our hypotheses are derived from the equilibrium predictions. Recall that none of our models predict that equilibrium effort will be affected by a wage shock. For the model with net wage illusion, this is trivial (workers do not “recognize” the change in net wage).

Hypothesis 4: **Wage Tax: Effort**

- H_0^4: Effort is the same in wt rounds as in nt rounds.

The predictions for a productivity shock again depend on the model. As with a wage shock, the rational-selfish model predicts no effects on wages or effort. The same holds for the model with loss aversion. The model with social preferences (but without loss aversion), however, predicts that the productivity tax will yield lower wages. Thus,

Hypothesis 5: **Productivity Tax: Wages**

- H_0^5: *Rational-selfish model and social preferences with loss aversion.* Wages are the same in et rounds as in nt rounds.
- H_1^5: *Social preferences without loss aversion.* Wages are lower in et rounds than in nt rounds.

Finally the productivity shock is predicted to reduce equilibrium effort by the social preference models with and without loss aversion.

Hypothesis 6: **Productivity Tax: Effort**

- H_0^6: *Rational-selfish model.* Effort is the same in et rounds as in nt rounds.
- H_1^6: *Social preferences (with and without loss aversion).* Effort is lower in et rounds than in nt rounds.

4. Results

We have data for a total of 130 employers, 179 workers, and 934 employer-worker matchings. These matchings include, however, eight rounds of observations for each worker and employer (though an observation may consist of nothing more than not having a contract in a round). To correct for such multiple observations, we treat – unless specified otherwise – the average observation for an employer over the rounds as the unit of observation. We choose to aggregate over the employers because they cannot be selected out of a round to the same extent that workers can. This gives us 30 observations each for NT, ET, and WT, and 40 for AT, though not every employer has an observation in every round.[23]

[22] It might seem counterintuitive that net wage illusion takes away the effect of wage shock. The underlying mechanism is that the burden of the shock is shared equally when the shock is noticed. When there is net wage illusion, no effect is expected as the illusion “hides” the changed market situation.

[23] In rare occasions, an employer did not succeed in hiring a worker before the two-minute auction deadline. In early sessions, we also lost some of the late-round data and the post-experiment survey results due to technical problems.

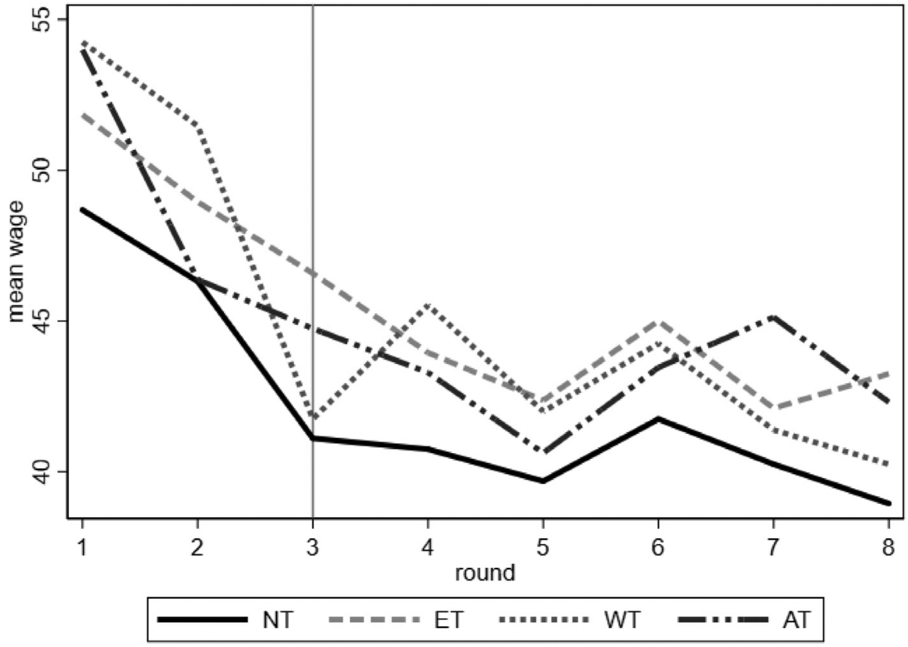

Fig. 5. Average wage. *Notes*: Lines show average realized wage over the eight rounds of the experiment. The minimum wage is 30. *NT*: no taxes possible; *WT*: wage tax possible; *ET*: productivity tax possible; *AT*: both taxes possible. Tax shocks occurred in rounds 2, 4, and 5.

Unless indicated otherwise, test results are based on non-parametric permutation t-tests (cf. Schram et al. 2018), here referred to as PtT. In order to obtain an impression of the power of our statistical tests, we use information from a different experiment we ran where wages could be changed after the initial contract (more information about this experiment is available upon request). The mean wage observed there in *NT* was 41.7, with a standard deviation of approximately 10. An underlying treatment effect of 15% (observed in the other experiment) would then give us a power of 66% for a standard *t*-test with 30 observations per treatment. We nevertheless expect our tests to be sufficiently powered, because (i) the PtT is a higher-powered test than the standard *t*-test (Moir 1998, Schram et al. 2018)[24]; and (ii) we expect the standard deviation to be lower in sessions where the wage cannot be altered within a round.

We organize the discussion around two key elements in our data, the realized wages and the exerted effort. For the latter, much of our focus will be on the occurrence of gift exchange (that is, the relationship between realized wage and exerted effort). We distinguish between treatments and shocks. As before, treatments (indicated by capital letters) are environments in which shocks (lower-case letters) may occur (see Fig. 5).

4.1. Realized wages

In all treatments, the average wage starts relatively high and drops over the first two rounds, stabilizing around a level of 40–45 points from round 3 onward.[25] Our interpretation of the wage drop in the first two rounds is learning; employers adjust their wage offers quickly once they experience the workers" responses and the behavior of the other employers. Interestingly, this learning period casts some doubt on the results in previous papers that draw conclusions about wage rigidity based on only one or two rounds (e.g., Gerhards and Heinz 2017).

Because our predictions are based on equilibria, we lay aside the learning effects in the first rounds and focus our analysis on rounds 3–8. As a consequence there are two rounds (4 and 5) with realized shocks in our analysis of treatments *ET*, *WT*, and *AT*. For completeness, Appendix D presents the analysis using data from all rounds; the results are very similar. Throughout the experiment, almost all wage offers were accepted. The acceptance rate of the first offer made by an employer in rounds 3–8 varies across treatments between 85% and 93%. This means that variations that we observe in realized wages can by-and-large be attributed to variations in wage offers. To start, Table 3 shows average wages per treatment and tax shock. In this table, we use the fact that *AT* consists of two sub treatments that are mirror images of each other. This was

[24] We know of no method to directly calculate the power of a PtT.

[25] In all treatments, the wage of round 1 is significantly higher than that of round 8. The $p-$values for the null of no difference are for *NT*: PtT, $p = .001$ ($N = 16$); *ET*: PtT, $p = .025$ ($N = 18$); *WT*: $p < .001$ ($N = 30$) and *AT*: PtT, $p =< 0.001$ ($N = 39$). The wage is not significantly different in round 3 from that in round 8 in any treatment. The $p-$values are for *NT*: PtT, p = 0.850 ($N = 16$); *ET*: PtT, $p = .094$ ($N = 18$); *WT*: PtT, $p = .104$ ($N = 30$); and *AT*: PtT, $p = .340$ ($N = 39$). For these comparisons, note that rounds 1, 3, and 8 are all without shock. Also, recall that we have some missing values for round 8, due to technical problems in early sessions.

Table 3
Wages, treatments, and shocks.

tax outcome	*NT*	*ET*	*WT*	AT_{et}	AT_{wt}	pooled
nt	**40.8**	**43.6**	**42.3**	**47.4**	**40.5**	**42.8**
obs.	30	30	30	20	20	130
et		**42.4**		**44.6**		**43.4**
obs.		25		20		45
wt			**43.5**		**38.8**	**41.1**
obs.			20		20	40
PtT (p-values)						
nt vs et	-	*0.434*	-	*0.034*	-	
nt vs wt	-	-	*0.325*	-	*0.117*	

Notes: Results are for rounds 3–8. Tax shocks occurred in rounds 4 and 5. The unit of observation is the mean wage paid by an employer across rounds. Paired tests between shock and no-shock rounds are reported. We do not conduct tests for the pooled data because these combine paired with unpaired comparisons. Mean wages across employers are in bold. "obs." shows the number of employers. *NT*: no taxes possible; *nt*: no tax shock realized; *WT*: wage tax possible; *wt*: wage tax shock realized; *ET*: productivity tax possible; *et*: productivity tax shock realized; AT_{et}: both taxes possible, only *et* realized; AT_{wt}: both taxes possible, only *wt* realized. "pooled" combines treatments. PtT: permutation *t*-test.

Table 4
Wages and treatments.

	NT	ET	WT	AT
all	**40.8**	**43.0**	**42.6**	**43.2**
obs.	30	30	30	40
PtT for differences against *NT*				
p-value	na	*0.427*	*0.475*	*0.364*

Notes: Results are for rounds 3–8. The unit of observation is the mean wage of an employer across rounds (presented in bold). *NT*: no taxes possible; *WT*: wage tax possible; *ET*: productivity tax possible and *AT*: both taxes possible. PtT: (unpaired) permutation *t*-test.

done to balance the number of observations under each shock. AT_{et} has one *wt* shock in round 2 followed by two *et* shocks in rounds 4 and 5, while AT_{wt} has one *et* shock in round 2 followed by two *wt* shocks in rounds 4 and 5.[26]

The results show that average wages within a treatment vary little with realized tax shocks. Results of the PtT (shown in the lower panel of Table 3) indicate that shocks have no significant effect on the wages in *ET*, *WT* or AT_{wt}. Though the effect on wage in AT_{et} is relatively small (6%), it is statistically significant. In this treatment, employers that face a productivity shock manage to pay lower wages. Note, however that in the pooled data average wages are even higher after a productivity shock than without shock. A comparison between *ET* and AT_{et} shows that in the latter case the apparent negative effect of a shock on wages is not caused by low wages after *et*, but that, instead, average wages in *nt* are relatively high.[27] All in all, we find little evidence that the wage systematically adjusts to tax shocks. Note also that in all treatments the mean wages are far from the minimum level of 30 points. The 95% confidence intervals for outcome *nt* are (36.9, 44.6), (39.4., 47.8), (38.7, 46.0), (40.5, 54.3), and (36.7, 44.2) for *NT*, *ET*, *WT*, AT_{et}, and AT_{wt}, respectively.

These results can be directly applied to our hypotheses regarding wages. The confidence intervals for *nt* indicate that wage offers are not at the minimum, which rejects H_0^1 in favor of H_1^1. This leads us to reject the standard rational model with selfish preferences. The result that wages are not significantly different after a wage shock (*wt*) than in *nt* means that we cannot reject H_0^3 in favor of H_1^3. Given our support (from the first hypothesis) for social preferences over the standard model, the difference between H_0^3 and H_1^3 is that the former assumes net wage illusion while the latter does not. This suggests that net wage illusion affects decisions in this environment. Finally, we conclude that loss aversion also plays a role, because we cannot systematically reject H_0^5 in favor of H_1^5 (wages are not different in *et* than in *nt*). We will summarize the results for all hypotheses below.

Our results provide evidence of nominal wage rigidity. We therefore pool the wage results across the tax shock outcomes. Table 4 shows the mean wages per treatment that this gives.

We observe higher wages in the treatments where tax shocks are possible (*AT*, *ET*, and *WT*) than in *NT*, but none of the differences are statistically significant. If we pool the three treatments with possible shocks, the difference with *NT*

[26] As we are only considering rounds 3–8, this means we have observations of *et* shocks only under AT_{et} and observations of *wt* shocks only under AT_{wt}. Because we are using the mean wage per employer as the unit of observation, we use paired-sample permutation tests in Table 3 (the mean wage paid in rounds without shock is paired with the mean wage in rounds with a shock). This requires doing the tests for AT_{et} and AT_{wt} separately.

[27] As explained in the table footnote, no pairwise test can be performed for the data pooled across all treatments. We can, however, pool only *ET* and AT_{et}. This gives mean wages of 45.3 for *nt* and 43.4 for *et*, a marginally significant difference (PtT, $p = .062$, $N = 45$). In a similar vein, pooling *WT* and AT_{wt} gives mean wages of 41.1 (*nt*) and 41.3 (*wt*). The difference is insignificant (PtT, $p = .818$, $N = 40$).

Table 5
Effort, treatments, and shocks.

tax outcome	NT	ET	WT	AT_{et}	AT_{wt}	pooled
nt	**2.8**	**2.8**	**2.7**	**3.3**	**3.0**	**2.9**
obs.	30	30	30	20	20	130
et		**3.1**		**3.8**		**3.4**
obs.		25		20		45
wt			**2.6**		**3.2**	**2.9**
obs.			20		20	40
PtT (p-values)						
nt vs et	-	*0.170*	-	*0.021*	-	
nt vs wt	-	-	*0.502*	-	*0.588*	

Notes: Results are for rounds 3–8. Tax shocks occurred in rounds 4 and 5. The unit of observation is the mean effort received by an employer across rounds. We do not conduct tests for the pooled data because these combine paired with unpaired observations. "obs." shows the number of employers. NT: no taxes possible; nt: no tax shock realized; ET: productivity tax possible; et: productivity tax shock realized; WT: wage tax possible; wt: wage tax shock realized; AT_{et}: both taxes possible, only et realized; AT_{wt}: both taxes possible, only wt realized. "pooled" combines treatments. PtT: permutation t-test.

is still insignificant (PtT, $p = .322$). Whereas the results in Table 3 show wage rigidity in response to shocks, the results here indicate that the *possibility* of tax shocks also does not lead to an increase in wages. Before turning to possible effort responses to shocks, we summarize our results on wages.

Result 1: Realized wages are systematically higher than the minimum wage (30 points) in all treatments.

Result 2: The occurrence of a tax shock does not systematically affect wages.

Result 3: The possibility of a tax shock does not systematically affect wages.

4.2. Effort and gift exchange

We measure effort by the number of correct summations in the real-effort task.[28] To start, Table 5 summarizes the mean realized effort across treatments and shocks (again using the employer as the unit of observation). Note that this averages effort across distinct wage levels. Below, we investigate the relationship between wage and effort.

In neither of the treatments with wage shocks (wt) is the effort significantly different in rounds with a shock than in rounds without. This means that we do not reject the null hypothesis H_0^4 (for which none of our models predicted an alternative). Formally, H_0^4 predicts a null effect. The PtT in Table 5, however, only show that we cannot reject a null effect. This in itself does not provide evidence in favor of the hypothesis. To test H_0^4, we therefore resort to a Bayesian analysis. We base our analysis on linear regressions of effort (the number of correct summations) on a constant term and a dummy indicating that a shock took place (with robust standard errors clustered at the group level). We do this separately for cases where wt and et were possible. The former gives no significant effect of wt, while the coefficient for et is 0.607, which is significant with $p = .002$.

The Bayesian analysis for H_0^4 requires an assumption about the prior distribution of the effect of wt on effort (as measured by the regression coefficient) in the cases where wt is possible. To formulate a null hypothesis for wt, we use the results for et and assume a normal distribution for the coefficient with mean and standard deviation determined by the corresponding et regression. This basically assumes that wt's effect on effort has the same distribution as et's effect on effort. We use an alternative hypothesis that the effect of wt centers around 0 (no effect), assuming a normal prior distribution for the coefficient with standard deviation 1 (our conclusions are robust to choosing standard deviation 0.1 instead). This setup allows us to calculate the posterior odds ratio of the alternative hypothesis (no effect of wt) being correct to the null hypothesis (same effect as of et) being correct. Assuming that both models are equally likely a priori, this posterior ratio is more than 2:1. We therefore conclude that a model where a shock wt has the same effect as a shock et is rejected in favor of one where the shock has no effect.

The results in Table 5 for productivity shocks (et) are far from the predictions. With ET, we cannot reject the null of no effect (H_0^6). In fact, effort is higher in et than in nt, which is opposite to H_1^6. The difference is, however, insignificant. In AT_{et}, effort is also higher in et; here the difference of 0.6 units is significant. Although this result is contrary to the prediction,

[28] Of course, this "performance" is determined by a combination of effort and ability. Because of our randomization of participants (and therefore their ability) across treatments, we attribute any treatment differences to effort. Note that we do not provide a graph depicting performance over time. Performance may differ across rounds because wages vary or because the response to given wages changes. To correct for the former, we checked the effort-wage ratio, measured as the number of correct sums, divided by the wage. Given that employer's earnings increase by 20 for each additional unit of effort, any ratio higher than 0.05 reflects a profitable mean earnings increase to the employer. The observed effort-wage ratio over time reveals that for each treatment, the margin within which the ratio moves is small (roughly between 0.055 and 0.085; that is, all values are above the break-even point). Importantly, there is no discernible trend for any of the treatments.

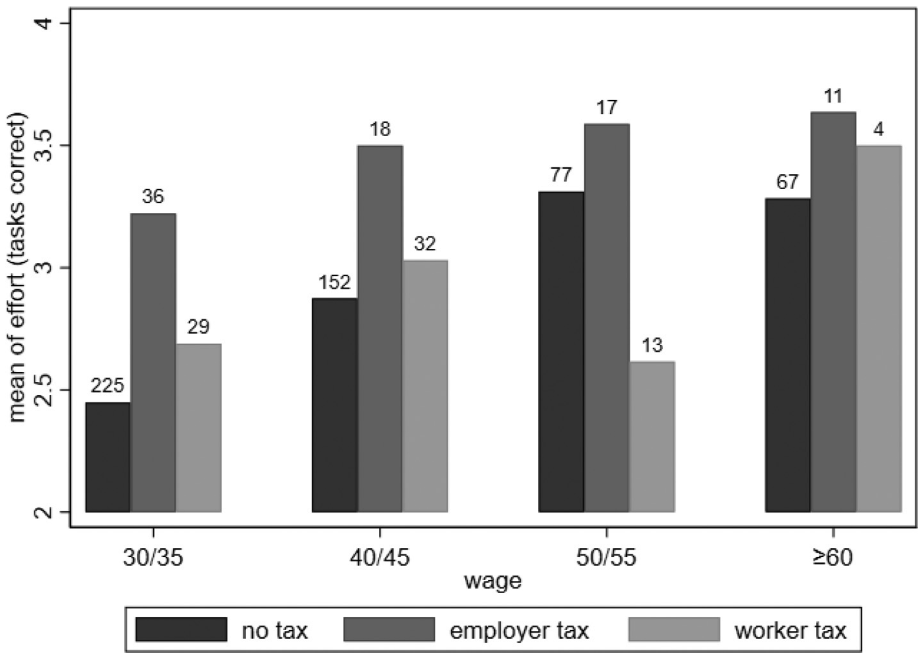

Fig. 6. Gift Exchange. *Notes*: The number of observations in each bin is reported above each bar.

it does not reject the social preference model per se, particularly if one allows for behavior off the equilibrium path. As argued at the end of Section 2.5, one may expect to see higher effort in *et* if the wage is below the equilibrium level. More generally, a positive reaction of effort to a productivity shock seems to indicate that fairness considerations play a role in the effort decision.

The only hypothesis that we have not yet formally tested is Hypothesis 2, where H_1^2 predicts a positive relationship between wage and effort up to a fair wage level. To get a first impression, Fig. 6 relates effort to nominal wages.[29]

The baseline *nt* is represented by the black bars. It has the shape predicted by the fair wage-effort hypothesis; at lower wage levels we observe clear evidence of gift exchange (effort increasing in wage) but no further increase is observed beyond the 50/55 wage bin. We interpret 50 as the fair wage level. Indeed, in the 50/55 bin mean earnings of workers (52.1) and employers (53.9) are more or less equal; employers earn more than workers at lower wages and vice versa for higher wages. Note that the gift exchange up to this wage level is substantial. At a wage of 30 or 35, the mean effort is 2.45, while it is 3.31 for wages of 50 or 55. This is an increase of 35%. The effort increases from the 30/35 bin to the 40/45 bin and from the 40/45 bin to the 50/55 bin are both (marginally) statistically significant (PtT, $p = .017$, $p = .054$, respectively). The slight decrease from 50/55 to 60–100 is insignificant (PtT, $p = .914$).[30] Together, this allows us to reject H_0^2 in favor of H_1^2. Without shocks, effort increases with wages (only) up to a fair wage level, which provides support for a model with other-regarding preferences. This result adds to the empirical support that has been found for fair wage-effort hypothesis (e.g., Mas 2006, Gächter and Thöni 2010, Kube et al. 2013, Sliwka and Werner 2017, Cohn et al. 2015).

Recall that we observed in Fig. 5 that it took two periods for wages to “settle in'. To see whether a similar learning period is observed for gift exchange, we consider the equivalent of Fig. 6 – that is, the effort per wage bin – in *nt*, in rounds 1 and 2. In these rounds, the average effort for wages in the 30/35 bin is 2.95. This increases to 3.40 for the 40/45 bin and 3.58 for wages of 50/55. For wages of 60 or more, the average effort is 3.54. The increase from 30/35 to 50/55 is 21%. Thus, the gift exchange is weaker in early rounds than thereafter. None of the differences between adjacent bins is statistically significant (PtT, all $p > .216$). Moreover, the difference between the 30/35 and 50/55 bins is also statistically insignificant (PtT, $p = .108$). We conclude that it indeed takes time for gift exchange patterns to develop.

Observations for *et* are represented by the dark gray bars. The productivity tax shock has a positive effect on the effort provided at low wages (30/35), where effort under the productivity tax is 31% higher than when no shock has occurred. The difference is statistically significant (PtT, $p = .011$). This difference is +22% (PtT, $p = .109$), +8% (PtT, $p = .543$) and +11% (PtT, $p = .549$) for wages 40/45, 50/55, and 60–100, respectively (all are statistically insignificant). The graph suggests that, as in

[29] For this analysis, we do not use the employer as the unit of observation but the labor contract. This is because effort is assumed to respond non-linearly to realized wage (and therefore not to average wage). Moreover, we pool wages over 60 because we have few high wage observations.

[30] Considering all wages (as opposed to wage bins), we observe that the correlation between wages and effort between wages 30 and 55 is 0.21. This is statistically significant (Pearson correlation test, $p < .001$). For wages 55 and above, the correlation of 0.09 is statistically insignificant (Pearson correlation test, $p = .461$).

nt, there might be gift exchange up to a fair wage level. None of the steps between adjacent bins, however, is statistically significant (PtT, $p = .505$, $p = .902$, $p > .999$, respectively).[31] We conclude that in rounds with a productivity tax, increased worker effort compensates the loss for employers. There is no evidence, however, of further gift exchange.

Finally, the wage tax does not seem to have any systematic effect on the effort compared to *nt*, though this might be related to the low number of relatively high wages observed. At wages 30/35 and 40/45, effort is, respectively, 10% and 5% higher in *wt*, but the differences are insignificant (PtT, $p = .499$ for 30/35; $p = .632$ for 40/45). At wages 50/55 average effort is about 21% lower in *wt* (PtT, $p = .135$), while the low number of very high wages in *wt* (4) makes a comparison with *nt* meaningless. None of the three pairwise comparisons between adjacent bins is statistically significant (PtT, $p = .458$, $p = .449$, $p = .135$, respectively).[32] We conclude that gift exchange in not observed when a wage tax occurs.

In summary, there is clear evidence of gift exchange in *nt*, which confirms many results in the previous literature. When there is a shock on employers" earnings, workers compensate by exerting more effort (especially for low wages), but this diminishes the pattern of gift exchange. A tax on the worker's wage, on the other hand, does not effect mean effort, but it does seem to eliminate gift exchange. This gives the following results.[33]

Result 4: Without shocks, there is gift exchange.

Result 5: A productivity shock yields an increase in worker effort for low wages and crowds out gift exchange.

Result 6: There is no gift exchange when there is a wage shock.

4.3. Overview of results

The big picture is that we reject the nulls of the Hypotheses 1 and 2 concerning the rounds without shocks, *nt*. This confirms the results in the existing literature that gift exchange occurs when there are no shocks. We add to this previous literature by showing that gift exchange also occurs when workers conduct a real-effort task.

We cannot reject the null of Hypothesis 3 (*wt*), but our Bayesian analysis does provide support for the null prediction of Hypothesis 4 (*wt*). We find no support for Hypotheses 5 or 6 (*et*). Considering the underlying theories used to develop the hypotheses in Section 3.3, these non-rejections suggest that the behavioral elements of our model in Section 2 play an important role in the interaction between employer and worker. Indeed, net wage illusion (H_0^3), loss aversion (H_0^5) and social preferences (H_0^6) underlie the null hypotheses that we fail to reject.

4.4. Welfare consequences

Our results suggest that effort responds more strongly to shocks than wages do. The strength of gift exchange depends, however, on which shocks occur. Realized productivity shocks lead to increased effort, while realized wage shocks have no effect on effort provision. To investigate the net effects of this complex employer-worker interaction, Table 6 summarizes the earnings of hiring employers (left panel) and hired workers (right panel) in each treatment and tax outcome. As before, we take for each tax outcome the average earnings across rounds 3–8 as the unit of observation for the employer. Similarly, for worker earnings we use the average (across rounds) earning per worker (and per tax outcome) as the unit of observation.

In all cases, employers earn more on average than workers. This might be partially explained by the fact that the employers are on the short side of the market. Furthermore, employers bare more risks. Indeed, their payoffs vary more[34] and unlike workers' payoffs employers' earnings in a round may be negative.

We calculate theoretical ex-ante payoffs per treatment as the average payoffs in rounds with and without shocks weighted by the probability of each shock occurring. These theoretical before-tax-announcement payoffs are reported in the lower panel of Table 6. None of the differences for employers are significantly different when shocks are possible than when they are not (PtT, $p = .250$, $p = .560$, $p = .327$, for *ET*, *WT*, *AT*, respectively). This result is surprising given that the productivity shock directly reduces employers" payoffs. We know from our results on gift exchange, however, that workers respond to the productivity shocks by increasing effort. Ex-ante worker earnings show that they are not significantly worse off in tax treatments than in *NT*. In fact, workers earn slightly more when employers can be taxed (*ET*) but the difference is insignificant (PtT, $p = .183$); the other two comparisons to *NT* yield $p = .381$ for *WT* and $p = .916$ for *AT*.

[31] The correlation is positive (0.12) for wages up to 55, but this is statistically insignificant (Pearson correlation test, $p = .336$). For wages of 55 and above, there is a negative (0.06), but statistically insignificant (Pearson correlation test, $p = .857$) correlation with effort.

[32] Though there is a positive correlation between wages and effort up to a wage of 55, and also for wages above 55 (0.01 and 0.58, respectively), neither is statistically significant (Pearson correlation test, $p = .904$, $p = .423$, respectively).

[33] It is noteworthy that a productivity shock has a stronger impact on effort than a wage shock. Both shocks are exogenous, that is, neither party can be "blamed" for them. A possible explanation is that the wage-effort relationship is more complicated than assumed here. In separate analyses we regress effort on wages and find that the effects of the tax shocks are robust to various non-linear relationships between the two. More information is available upon request.

[34] The standard deviation of average (across rounds) employer payoffs is 18.6 points while it is only 9.1 points for workers.

Table 6
After tax earnings by treatment and tax outcome.

	Panel A: Employer earnings					Panel B: Worker earnings			
	NT	**ET**	**WT**	**AT**		**NT**	**ET**	**WT**	**AT**
nt	55.1	52.1	51.8	58.6	*nt*	40.7	43.7	41.3	42.6
obs	30	30	30	40	*obs*	41	38	42	54
et		47.2		55.4	*et*		42.8		44.0
obs		25		20	*obs*		30		26
wt			47.5	65.8	*wt*			34.8	31.5
obs			20	20	*obs*			25	28
	Ex-ante payoffs					Ex-ante payoffs			
	55.1	48.9	51.4	59.2		40.7	43.6	38.9	40.9
se	(3.93)	(3.41)	(5.07)	(2.20)	*se*	(1.45)	(1.73)	(1.22)	(1.33)

Notes: Unit of observation is the employer (averaged across rounds 3–8) in the left panel and the worker (averaged across rounds 3–8) in the right panel. Cells show mean earnings. Ex-ante payoffs are determined by weighting realized earnings with the probability of a shock. Standard errors are in parenthesis.

By combining the numbers in the two panels of Table 6, we obtain a measure of aggregate surplus. This varies between 93.3 in WT and 100.6 in AT.[35] This difference is marginally significant (PtT, $p = .062$); all other pairwise differences in aggregate surplus are statistically insignificant (PtT, all $p > .21$). Tax revenues also differ across treatments. They are higher with a productivity tax (12.3 in ET and 15.2 in AT) than for a wage tax (8.7 in WT and 7.8 in AT). In AT, this gives an average tax revenue of 11.5. Together with the measured aggregate surplus, this suggests that due to gift exchange, a tax system with only wage taxes is less efficient than one with taxes on both sides of the labor market.

5. Concluding discussion

We study gift exchange in a market where one-round negative shocks may occur. The predictions of our gift exchange model depend on whether we allow for other-regarding preferences, net wage illusion, or loss aversion. We test these predictions in a laboratory experiment. Our data for the case without shocks allow us to conclude that wages are set above the minimal level and that gift exchange takes place. This replicates the traditional gift exchange results in a real-effort environment. Our model shows that such gift exchange can take place even in the absence of reciprocal motives (cf. Charness and Rabin 2002). This result is reminiscent of models by Benjamin (2015) and Dickson and Fongoni (2019) who also predict gift exchange without reciprocity. The former, however, relies on previous transactions to determine the fairness of current choices. The latter introduces the notion of 'worker morale', which forms a ground for gift exchange. In contrast to both, gift exchange in our model is the result of other regarding preference even when these affect only current decisions and without the need to introduce novel concepts. Instead, our model applies well-established behavioral regularities. When we introduce wage or productivity shocks, the pattern of behavior we observe allows us to conclude that social preferences, net wage illusion and loss aversion all play a role in workers' decision making.

Though somewhat speculative, we can attempt to compare the three behavioral elements that we distinguish between. To start, given the broad literature on gift exchange, it should not come as a surprise that gift exchange is observed in the no-shock treatment. This shows that other-regarding preferences play an important role here, like they have been shown to play in many environments. Moreover, the occurrence of a wage shock has little effect on effort for low wage bins. This suggests that net wage illusion is also a strong force (which is also in line with much of the literature referred to above). The precise role of loss aversion is less clear. Though the results of our hypothesis testing show support for a model that includes loss aversion, it is not directly clear (or measurable) how strong the effect is when wage rigidity occurs. One interesting pattern in our data is that workers increase effort at low wages when their employers are hit by a shock. This might mean that workers have an aversion to their employer's losses. Whether such "other-regarding loss aversion exists and plays a role seems an interesting topic for future research. Finally, we can compare our approach to Dickson and Fongoni (2019)'s worker morale function. Our view is that the social preferences and the worker morale function play largely similar roles in the models as both bring about the fair wage-effort hypothesis. While in the worker morale case, loss aversion is a key assumption needed for creating the kink at the reference point, in our setting this kink arises already from the other-regarding preferences. Loss aversion's role is then to explain why tension arises in response to shocks, as is captured by the difference between the objective and the subjective fair wage. Adding worker morale to our model would, therefore, not change the results concerning wage rigidity.

Our results highlight how involved the interaction between shocks, wages, and effort responses can be. In rounds where no shock is realized we observe strong gift exchange, that is, a strong response of effort to wage levels. If a shock is actually

[35] This aggregate is slightly different than the sums of averages for employers and workers in Table 6. This is because we need to change the unit of observation to enable testing. Specifically, we determine here per employer for each contract the sum of her and the worker's earnings. We then use the mean per employer across rounds 3–8 as the unit of observation.

realized, its effect on this effort response depends on which side of the market it hits. A negative wage shock has very little effect, while a negative productivity shock – which affects employers" earnings – makes workers exert much more effort (especially at low wages), compared to when no shock is realized. Employers do not appear to take these effort responses into account when setting a wage. They do not adjust their wage offers to the realization of a shock. This causes wage rigidity when shocks appear. For the wage shock, this is rationalizable because workers do not adjust their efforts. With a productivity shock, the workers compensate the employers by increased effort, and the latter have no reason to adjust the wages downward to compensate the shock. In fact, if they did reduce wages to cushion the shock, workers might not be as generous.

All in all, our results show that an understanding of the complexities of the labor market goes beyond the simple rational choice model with selfish preferences and requires more than simply allowing for gift exchange. Wage rigidity has been observed in the field (Kaur 2019) and we observe it in the laboratory. Additional insights from behavioral economics are needed to reconcile such data patterns even if one allows for other-regarding preferences. Nevertheless, the effects seem to evolve around a pattern of gift exchange and employers' expectation of this pattern. Our study hopes to contribute to a better understanding of the interactions involved.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

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Appendix A. Shocks

In this appendix we discuss the effects of shocks in the model. The size of a shock is captured by parameter δ^j, $j \in \{W, F\}$ such that $0 < \delta^j < 1$. In our experimental design, shocks are realized before wages are set, so all effects are known before the employer and worker interact. δ^W then reduces the worker's payoff to $(1-\delta^W)w$ while leaving the employer's earnings unchanged at $f(e) - w$. δ^F reduces the employer's payoff to $(1-\delta^F)f(e) - w$ and leaves the worker's earnings at w. We call the latter a productivity shock.

A1. Worker effort choice

First consider a productivity shock on the employer side, which changes the second term in the worker's utility Eq. (1) to $\beta((1-\delta^F)f(e) - w)$. This affects both the f.o.c. (3), where the r.h.s. is replaced by $\beta(1-\delta^F)$ and the inequalities in (2), where $f(e)$ is replaced by $(1-\delta^F)f(e)$. Denote by $\hat{e}^\delta_\sigma$ ($\hat{e}^\delta_\rho$) the solution to the f.o.c. for $\beta = \sigma$ ($\beta = \rho$).[36] Because $\frac{c'(e)}{f'(e)}$ is increasing in e, it holds that $\hat{e}^\delta_\sigma < \hat{e}_\sigma$ and $\hat{e}^\delta_\rho < \hat{e}_\rho$. For equal earnings ($\beta = 0$), we have optimal effort $\hat{e}^\delta_0$ implicitly determined by $w = \frac{(1-\delta^F)f(\hat{e}^\delta_0)}{2}$, with $\hat{e}^\delta_0 < \hat{e}_0$. For the worker's best response to wage w when a productivity shock δ^F occurs, this gives

$$\hat{e}^\delta(w) = \begin{cases} \hat{e}^\delta_\sigma, & \text{if } w < \dfrac{(1-\delta^F)f(\hat{e}^\delta_\sigma)}{2} \\ \hat{e}^\delta_0(w), & \text{if } \dfrac{(1-\delta^F)f(\hat{e}^\delta_\sigma)}{2} \le w \le \dfrac{(1-\delta^F)f(\hat{e}^\delta_\rho)}{2} \\ \hat{e}^\delta_\rho, & \text{if } w > \dfrac{(1-\delta^F)f(\hat{e}^\delta_\rho)}{2}. \end{cases} \tag{1}$$

With a wage shock δ^W, on the other hand, the first term on the r.h.s. of utility Eq. (1) is replaced by $(1-\beta)(1-\delta^W)w$. Because the wage the worker receives is sunk when she makes the effort decision, this shock does not affect f.o.c. (3). It does, however, affect the inequality conditions in Eq. (2), where w is replaced by $(1-\delta^W)w$.

Fig. A.1 illustrates the effects of shocks on either side of the market on the worker's best response function. For presentational purposes, we again assume a linear $f(e)$ (cf. fn. 9 in the main text). Observe that a shock at the employer side (dotted line) shifts the area of wages where the worker wants to equalize earnings to the left. Moreover, it shifts the upper bound ($\frac{(1-\delta^F)f(\hat{e}^\delta_\rho)}{2}$) further to the left than the lower bound ($\frac{(1-\delta^F)f(\hat{e}^\delta_\sigma)}{2}$), because $\hat{e}^\delta_\rho > \hat{e}^\delta_\sigma$ and f is monotonically increasing. As a

[36] The optimal effort level $\hat{e}$ is only affected by a shock on the employer side, not by a wage shock (as explained below); a superscript δ for the optimal effort therefore always refers to δ^F.

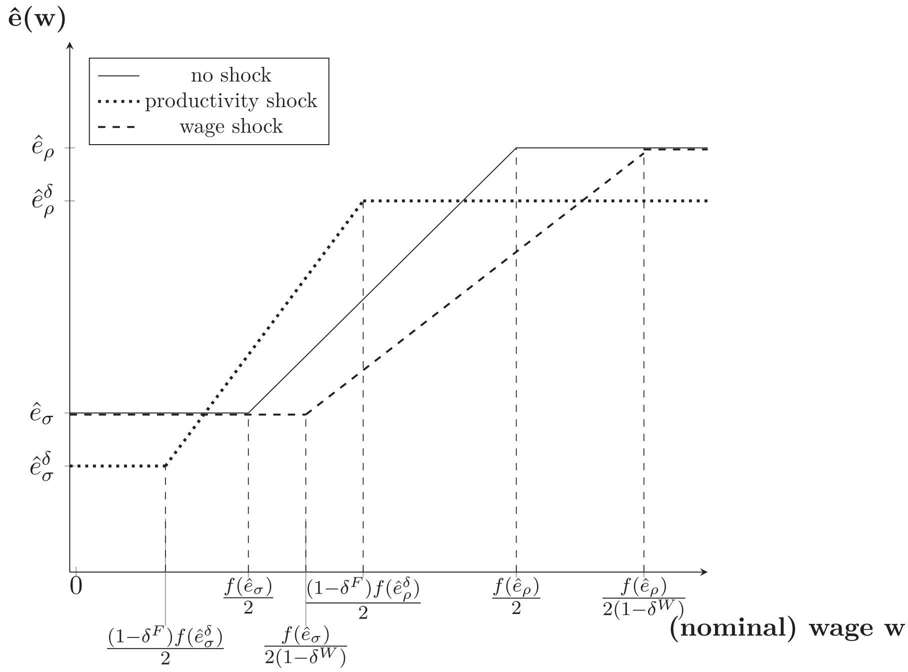

Fig. A.1. Worker's best response with shocks.

consequence, the intermediate wage area where earnings are equalized is smaller with the shock than when $\delta^F = 0$. Moreover, the productivity shock shifts the worker's best response curve downward. This is because the effect of effort on the employer's income is diminished, which the worker internalizes through the social preferences that enter worker's utility.

A shock to worker's wages (dashed line), on the other hand, shifts the best response to the right because a higher wage is needed to equalize earnings. Here, the upper bound ($\frac{f(\hat{e}_\rho)}{2(1-\delta^W)}$) shifts further to the right than the lower bound ($\frac{f(\hat{e}_\sigma)}{2(1-\delta^W)}$) because $\hat{e}_\sigma < \hat{e}_\rho$ and f is monotonically increasing. With a wage shock, there is no vertical shift of the response function, because this is determined by the f.o.c. (3), which is not affected by δ^W.

A2. Employer wage setting

The effects of shocks on wage setting at stage 1 are illustrated in Fig. A.2.

Following a productivity shock at the employer side and the expected best response by the worker, employer's utility is given by $u^F = (1-\delta^F)f(\hat{e}^\delta(w)) - w$. At the minimal wage (here normalized to $w = 0$), this gives $u^F = (1-\delta^F)f(\hat{e}_\sigma^\delta)$. Utility then declines linearly until $w = \frac{(1-\delta^F)f(\hat{e}_\sigma^\delta)}{2}$, after which the worker responds by equalizing earnings. This gift exchange takes place up to the objectively fair wage $w = \frac{(1-\delta^F)f(\hat{e}_\rho^\delta)}{2}$. At this point, the employer obtains $u^F = (1-\delta^F)f(\hat{e}_\rho^\delta) - \frac{(1-\delta^F)f(\hat{e}_\rho^\delta)}{2} = (1-\delta^F)\frac{f(\hat{e}_\rho^\delta)}{2}$. As wages increase beyond this level, employer's payoff decreases linearly because no further gift exchange takes place.

A wage shock yields employer utility $u^F = f(\hat{e}((1-\delta^W)w)) - w$. At the minimum wage $w = 0$, optimal effort is $\hat{e}_\sigma$ and as wages increase, the u^F develops as with $\delta^W = 0$. It takes a higher wage for the worker to start equalizing earnings, however, as effort does not increase until the net wage reaches the minimum employer profit, which is a higher wage than when $\delta^W = 0$ (cf. Fig. A.1). The employer's utility subsequently reaches its maximum at a higher (objectively fair) wage ($\frac{f(\hat{e}_\rho)}{2(1-\delta^W)}$), at a lower level of utility at $\frac{f(\hat{e}_\rho)}{2} - \frac{f(\hat{e}_\rho)}{2(1-\delta^W)} = \frac{f(\hat{e}_\rho)(1-2\delta^W)}{2(1-\delta^W)}$ due to the increased wage expenses.

Note that one will observe gift exchange in the SPE if the utility achieved at the objectively fair wage is higher than the utility achieved at the minimum wage. With a productivity shock this requires $(1-\delta^F)\frac{f(\hat{e}_\rho^\delta)}{2} > (1-\delta^F)f(\hat{e}_\sigma^\delta)$, which occurs iff $\frac{f(\hat{e}_\rho^\delta)}{2} > f(\hat{e}_\sigma^\delta)$. In case of a wage shock, the objectively fair wage yields higher employer utility than the minimum wage if $\frac{1-2\delta^W}{1-\delta^W}\frac{f(\hat{e}_\rho)}{2} > f(\hat{e}_\sigma)$. Because $\frac{1-2\delta^W}{1-\delta^W} < 1$, this condition also implies $\frac{f(\hat{e}_\rho)}{2} > f(\hat{e}_\sigma)$. Thus, if worker preferences yield an SPE with gift exchange when there is a wage shock, then there is also gift exchange in the equilibrium for the case without a shock.

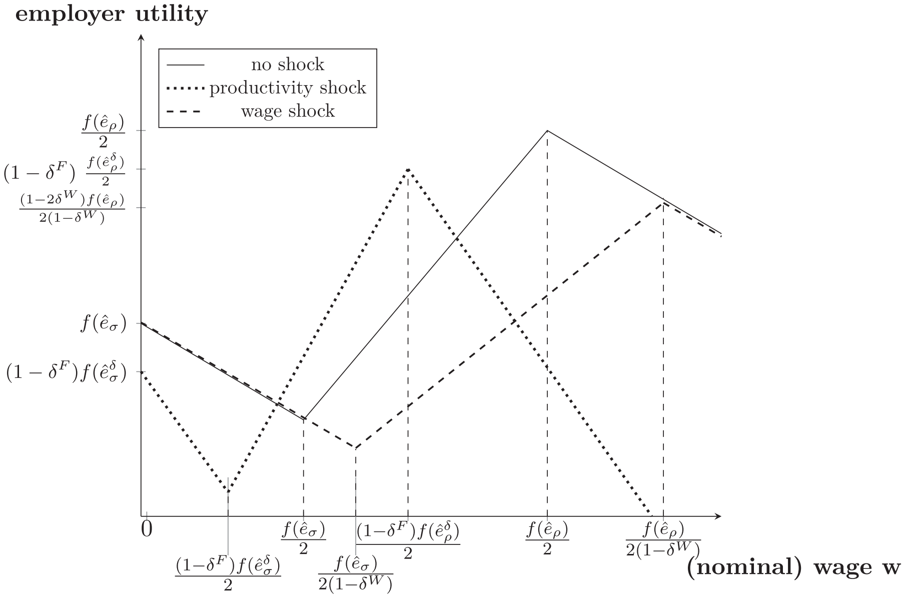

Fig. A.2. Employer's utility with shocks.

Appendix B. Loss Aversion

In this appendix, we adapt the model to allow for loss aversion. Recall from the main text that the subjectively fair wage is the objectively fair wage in the absence of shocks, that is, $\tilde{w} = \frac{f(\hat{e}_\rho)}{2}$.[37] The best response function $\hat{e}^\delta(w)$ now becomes:

$$\hat{e}^\delta(w) = \begin{cases} \hat{e}^\delta_{\sigma-\lambda}, & \text{if } \; w < \dfrac{(1-\delta^F)f(\hat{e}^\delta_{\sigma-\lambda})}{2}(<\tilde{w}) \\ \hat{e}^\delta_0(w), & \text{if } \; \dfrac{(1-\delta^F)f(\hat{e}^\delta_{\sigma-\lambda})}{2} \le w \le \dfrac{(1-\delta^F)f(\hat{e}^\delta_{\rho-\lambda})}{2}(<\tilde{w}) \\ \hat{e}^\delta_{\rho-\lambda}, & \text{if } \; \dfrac{(1-\delta^F)f(\hat{e}^\delta_{\rho-\lambda})}{2} < w < \tilde{w} \\ \hat{e}^\delta_\rho, & \text{if } \; w \ge \tilde{w}\left(> \dfrac{(1-\delta^F)f(\hat{e}^\delta_\rho)}{2}\right). \end{cases} \tag{9'}$$

The first line in the r.h.s. of eq. (9') describes the case where the current wage is lower than the subjectively fair wage and lower than the employer payoff; this is responded to in a way that gives minimal effort while accounting for loss aversion. In the second line, the worker equalizes earnings for the current wage, which is lower than the subjectively fair wage. In the third line, the current wage is lower than subjectively fair wage, but the optimal response creates advantageous inequality for the worker, as wage is above the *objectively fair wage*. In the final line, the subjectively fair wage is such that the optimal effort response creates higher earnings for the worker than for the employer, while the actual wage is even higher.

Fig. B.1 demonstrates the best response functions $\hat{e}(w)$ when there is both net wage illusion and loss aversion.

Note the discontinuity at the subjectively fair wage $w = \frac{f(\hat{e}_\rho)}{2}$. The 'jump' at this wage level equals λ in all three cases. Because of the jump in the effort response at the subjectively fair wage, a similar discontinuity occurs for the employer's utility. This is illustrated in Fig. B.2.

Now there are potentially three local maxima in the employer's utility. They are at the minimum wage (0), the objectively fair wage ($\frac{(1-\delta^F)f(\hat{e}^\delta_{\rho-\lambda})}{2}$) and the subjectively fair wage ($w_{t-1} = \frac{f(\hat{e}_\rho)}{2}$). Assuming that the objectively fair wage yields higher utility than the minimum wage (which holds if $f(\hat{e}_{\rho-\lambda}) > 2f(\hat{e}_{\sigma-\lambda})$), the employer will prefer to keep wages at the

[37] Note that $\tilde{w} = \frac{f(\hat{e}_\rho)}{2} > \frac{f((1-\delta^F)\hat{e}^\delta_\rho)}{2} > \frac{f((1-\delta^F)\hat{e}^\delta_{\rho-\lambda})}{2}$. The first inequality is illustrated in Fig. A.1, the second follows because the worker puts less weight on the employer's earnings and therefore exerts less effort. As a consequence, $w < \frac{f((1-\delta^F)\hat{e}^\delta_{\rho-\lambda})}{2}$) implies $w < \tilde{w}$.

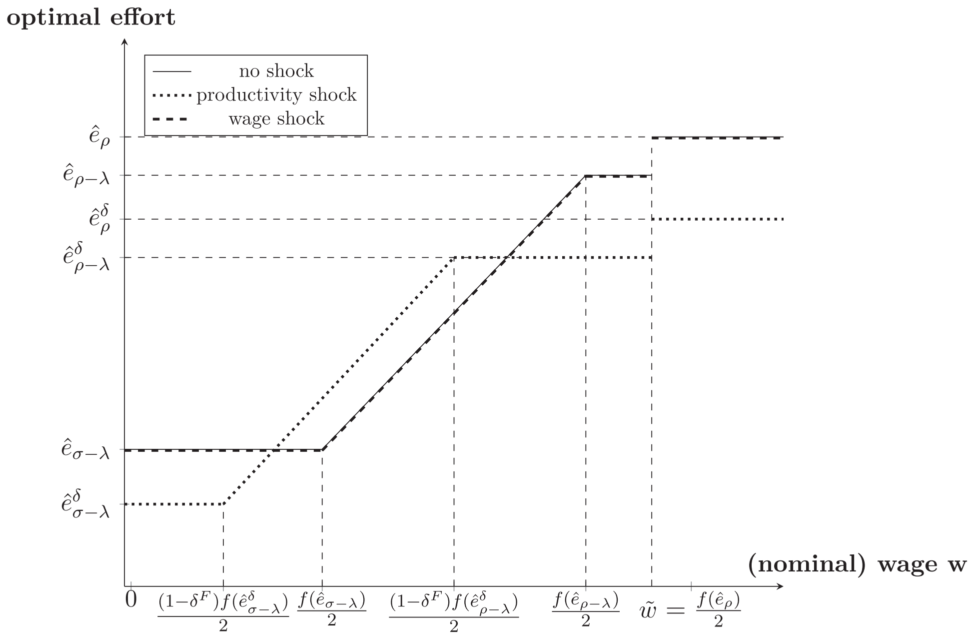

Fig. B.1. Optimal response with net wage illusion and loss aversion.

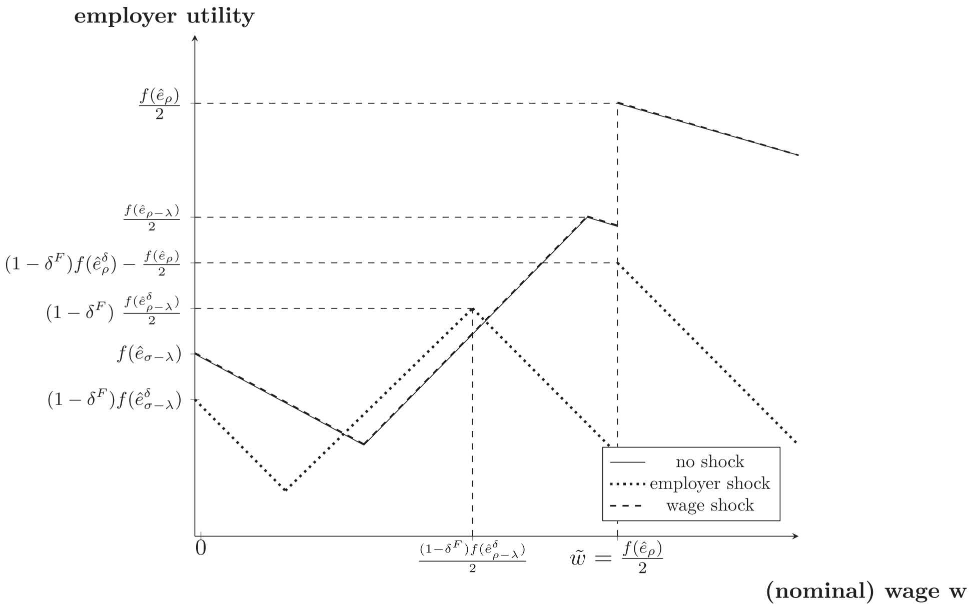

Fig. B.2. Employer's utility with net wage illusion and loss aversion.

subjectively fair level if and only if

$$(1-\delta^F)\frac{f(\hat{e}^{\delta}_{\rho})}{2}-\frac{f(\hat{e}_{\rho})}{2}\geq(1-\delta^F)\frac{f(\hat{e}^{\delta}_{\rho-\lambda})}{2}, \tag{2}$$

where we assume that the wages will be unchanged if the employer is indifferent. Eq. (2) is a condition for wage rigidity. If it holds, then employers will prefer to hold wages constant, even if they face a shock on their income.

Appendix C. Experimental Instructions [original in Italian]

The instructions differ for each treatments. When appropriate, we indicate additional texts by the following system. "When taxes" refers to all treatments that allow taxes: AT, ET, and WT. "In AT" refers to the tax treatment with all taxes, "ET" refers to the tax treatment with only employer taxes and "WT" refers to the tax treatment with only wage taxes.

Welcome to the experiment!

From now on, please, do not talk with the other participants. If you have any questions, please, raise your hand. Place your phone in your bag: you are not allowed to use it during the experiment. In case you want to revisit the instructions after the software tutorial, you can use the paper version on your desk where you also find a pen and a paper.

Your payoff from the experiment will consist of two parts: the 5 euro show-up fee and the earnings (or losses) from 2 rounds out of the 8 rounds in total. These 2 rounds will be chosen at random.

Role

You participate in a labor market that has 5 employers and 7 employees. After the tutorial and a questionnaire on the instructions, you will be randomly assigned to either the role of an employer or the role of a worker, and you will keep the same role for the entire duration of the experiment.

Overall structure

The experiment consists of 8 rounds.

[When taxes: *In the beginning of each round, the taxation scheme of the round will be announced. After the announcement,***]** each round will have the following stages:

1st Stage: Hiring

Each employer can make a wage offer on a public platform, and each worker can accept one of these offers. Once an offer becomes accepted, the hired worker will work that round for the employer that made the offer. All the hiring results of the round will be made public.

2nd Stage: Work

Each hired worker has 5 minutes to work on the tasks. After the 5 minutes, the work results will be communicated to the respective worker and employer, and the earnings are calculated.

Detailed instructions

Hiring Stage

[When taxes: *Before the hiring stage begins, there will be a 10 second announcement that reveals the taxation scheme that is effective during the round (more information on the possible taxation schemes in the next page of instructions).***]**

The hiring stage lasts at most for 2 minutes. There are 5 employers and 7 workers in the market. Each employer can announce a wage offer on a public platform. The offer must be between 30 and 100 points, in steps of 5 points, and it can be modified while not yet accepted, but cannot be withdrawn entirely once made.

A worker can accept one of the available offers. Once accepted, the worker is immediately hired by the employer for the reminder of the round and the offer is removed from the platform. If more than one worker attempts to accept the same offer, it is granted to the fastest. All of the offers and subsequent modifications are updated to the platform in real time and published in a random order.

If an offer is not accepted within the 2 minutes, the employer is not able to hire anyone. In the same way, if a worker does not accept an offer within the 2 minutes or if all of the 5 offers made have been accepted by other workers, the market closes and these workers will be unemployed for the round. Out of the 7 workers, at least 2 will be unemployed every round.

Without a contract, the workers and employers will not participate in the remaining stages of the round: an employer earns 0 points and a worker earns 20 points as an unemployment benefit. Both will resume the experiment again in the beginning of the next round.

If an employer hires a worker, the employer receives 40 points and any earnings from the work of the hired worker. The worker's wage will then be subtracted from these earnings. The worker's earnings consist of the wage. **[When taxes:** *AT: Both payoffs/ET: employer's payoff/ WT: worker's payoff may be subject to taxes, as explained in the next part.***]**

The experiment is anonymous: the worker will not know the identity of the employer, and likewise, the employer will not know the identity of the worker.

After the hiring stage, all of the participants see the overall results of the hiring stage: how many workers were hired and at what wages.

[When taxes:] Taxes

[The options and probabilities depend on which taxes are possible. The following section is written for AT unless otherwise specified]

The taxation scheme is announced before the hiring stage, it is randomly chosen by a computer, and it can be one of 3 ***[In ET or WT: 2]*** *possibilities:*

- ***No taxes****(probability 4/6 = 66.7) %* ***[In ET or WT: 1/3 = 66.7%]***
- ***Tax****of 20% on the revenues of the employer (probability 1/6 = 16,7%)* ***[In ET 1/3 = 66.7%, not mentioned in WT]***
- ***Tax****of 20% on the wage of the worker (probability 1/6 = 16,7%)* ***[In WT 1/3 = 66.7%, not mentioned in ET]***

In total, there is a 33% probability that a tax is applied, and a 67% probability that there are no taxes; on average, 1 in 3 rounds has taxes. ***[In AT only:*** *The type of the tax is randomly chosen by computer, each type being equally likely.* **]**

[In AT and ET only: *The tax on the revenues of the employer reduces the earnings from the worker tasks: each correctly completed task is worth 16 points, instead of the 20 points when there is no tax. The tax does not impact the 40 points received from hiring.***]**

[In AT and WT only: *The tax on the earnings of the worker reduces the amount of wages received by 20%. Each employer however pays the full salary.***]**

The collected taxes will be returned to the experimenter.

Work Stage

The hired workers have 5 minutes to work, during which they can attempt at most 10 tasks in total. Each task consists of two boxes, each containing 100 numbers: the task is to find the largest number in each box and then sum them together.

Each correctly completed task will give the employer 20 points **[In AT and ET:***if there are no taxes on the employer's taxes, in which case, each correctly complete task is worth 16 points***]**. Wrong answers do not affect payoffs but count as 'attempted tasks'. The workers can submit only one answer per task.

Example: The largest number in the left box is 99 and the largest number in the right box is 65, both are circled with red. Summed together they give 99 + 65 = 164: **164** is the correct answer to be submitted!

Riquadro 1									
63	53	85	38	92	67	13	88	75	13
29	63	84	60	13	54	45	59	83	15
82	91	29	93	66	22	97	21	27	27
70	35	89	61	40	33	29	52	77	20
30	90	95	57	31	19	80	77	96	79
36	51	33	85	62	39	95	58	45	15
60	26	41	52	29	72	57	16	77	40
79	27	20	89	32	90	60	43	81	89
94	93	55	13	95	55	65	93	11	82
28	91	74	77	71	11	99	72	45	64

Riquadro 2									
26	62	53	10	14	18	11	25	23	64
43	16	22	36	31	59	63	24	40	51
12	35	46	55	14	19	55	33	57	17
30	53	52	23	20	24	58	41	64	43
18	28	13	46	29	57	15	50	33	13
17	10	36	19	28	41	20	22	45	21
35	45	48	64	14	63	11	53	10	64
19	34	63	39	45	53	25	25	45	42
38	13	11	60	11	47	45	31	17	52
22	32	22	52	57	18	16	65	49	18

The Payoffs

After 5 minutes or after having tried all 10 tasks, all of the participants are directed to a results page. The worker and the employer who has hired the worker get to know the number of correct and attempted tasks, and the resulting payoffs of both, but will not get to know the results of the other participants.

Scenario A:

If the participant does not have a contract:

- Employer's payoff = **0 points**
- Worker's payoff = **20 points**

Scenario B:

If the participant has a contract [When taxes: *and there are no taxes***]***:*

- Employer's payoff = **40 - wage + 20 * number of tasks correct**
- Worker's payoff = **wage**

In other words, the employer receives 40 points when hiring a worker, pays the wage and receives the revenues from each correctly completed task. What remains is the earnings of the employer, and note that this can also be negative. Conversely, the earnings of the worker consists of the wage.

[Only in AT and WT: ***Scenario C:***

If the participant has a contract and there is a 20% tax on the earnings of the employer *, the payoff from each correctly completed task is reduced to 16 (from 20) and thus the payoffs are given as:*

- Employer's payoff = **40 - wage + 16 * number of tasks correct**

The worker's payoff is the same as under Scenario B. **]**

[Only in AT] ***Scenario D:*** **[OR Only in ET]** ***Scenario C;***

If the participant has a contract and there is a 20% tax on the earnings of the worker **, the payoff of the worker is given by the salary less the taxes:**

- Worker's payoff = **wage - 20% of the wage**

The employer's payoff is the same as under scenario B. **]**

[Only in AT] *The two taxation systems are alternatives, they can never apply simultaneously.*

The points earned in the laboratory will be converted into Euros with the following exchange rate: **10 points = 1 euro**. On top of the 5 euro show-up fee, the participants are remunerated for only two rounds (out of the 8 in total) that are randomly selected in the end of the experiment.

Comprehension test

The comprehension test consisted of 12 true or false statements. The first 10 questions were the same for all tax treatments. The correct answer is reported in the parenthesis.

1. If a worker is unemployed for a round, she or he does earns nothing. (FALSE)
2. If an employer does not manage to hire a worker for a round, the employer earns nothing. (TRUE)
3. Accepting an offer, the worker commits to work for that employer for that round. (TRUE)
4. An employer who has hired someone earns 40 points. (TRUE)
5. In general, the salary is deducted from the earnings of the employer and given to the worker. (TRUE)
6. The number of tasks that a worker can try is unlimited. (FALSE)
7. The workers obtain a higher salary if they complete more tasks. (FALSE)
8. Other than the worker himself/herself, only the employer will get to know how many tasks were completed. (TRUE)
9. You will be compensated for all of the 8 rounds. (FALSE)
10. There are always unemployed workers. (TRUE)

The last two questions depend on what taxes are possible. When no taxes are possible (NT):

11. Your earnings will depend on your decisions and those of the other participants. (TRUE)
12. The earnings of an employer cannot be negative for a round. (FALSE)

If only productivity taxes are possible (ET)

11. 20% of 20 points is 4 points. Thus, when we have taxes on the employers, the earnings per each correct task is 16 instead of 20 points. (TRUE)
12. The earnings of an employer cannot be negative for a round. (FALSE)

If only worker taxes are possible (WT)

11. The earnings of an employer can be negative for a round. (TRUE)
12. The taxes on the worker's earnings are always 20 points. (FALSE)

If both taxes are positive (AT)

11. 20% of 20 points is 4 points. Thus, when we have taxes on the employers, the earnings per each correct task is 16 instead of 20 points. (TRUE)
12. The taxes on the worker's earnings are always 20 points. (FALSE)

Table D.1
Wages, treatments and shocks, all rounds.

tax outcome	*NT*	*ET*	*WT*	AT_{et}	AT_{wt}	pooled
nt	**42.6**	**46.6**	**44.6**	**48.7**	**43.2**	**45.0**
obs.	30	30	30	20	20	130
et		**43.6**		**44.6**	**42.0**	**43.4**
obs.		25		20	20	65
wt			**48.2**	**50.8**	**38.8**	**46.2**
obs.			30	20	20	70
PtT (p-values)						
nt vs et	-	*0.093*	-	*0.003*	*0.208*	
nt vs wt	-	-	*0.073*	*0.153*	*0.001*	

Notes: Results are for rounds 1–8. Tax shocks occurred in rounds 2, 4, and 5. The unit of observation is the mean wage paid by an employer across rounds. Paired tests between shock- and no-shock rounds are reported. We do not conduct tests for the pooled data because these combine paired with unpaired comparisons. Mean wages across employers are in bold. 'obs.' shows the number of employers. *NT*: no taxes possible; *nt*: no tax shock realized; *WT*: wage tax possible; *wt*: wage tax shock realized; *ET*: productivity tax possible; *et*: productivity tax shock realized; AT_{et}: *wt* realized in round 2, *et* realized in rounds 4 and 5; AT_{wt}: *et* realized in round 2, *wt* realized in rounds 4 and 5. 'pooled' combines treatments. PtT: permutation *t*-test.

Table D.2
Wages and treatments.

	NT	ET	WT	AT
all tax outcomes	**42.6**	**45.9**	**45.2**	**45.0**
obs.	30	30	30	40
PtT for differences against NT				
p-value (p=c/n)		0.247	0.350	0.397

The unit of observation is the mean wage of an employer across rounds (presented in bold). *NT*: no taxes possible; *WT*: wage tax possible; *ET*: productivity tax possible and *AT*: both taxes possible. PtT: (unpaired) permutation *t*-test.

Appendix D. All Rounds

In this appendix, we provide the most important results of the main text when using data from all eight rounds.[38] We start by investigating how wages respond to shocks. Table D.1 shows average wages per treatment and tax shock.

The results are similar to those observed for rounds 3–8 in Table 3, but somewhat statistically stronger.[39] An exception is that now a wage shock *wt* yields higher wages in *WT* (and also in AT_{wt}). It appears that wage shocks in the second round (before wages in general have settled) are compensated by higher wages. In all treatments the mean wages are again far from the minimum level of 30 points (which is not surprising, because wages in the first two rounds are higher than in subsequent rounds). For comparison to Table 4, Table D.2 shows the mean wages per treatment. As we found for rounds 3–8, we observe no treatment differences.

D.1. Effort and gift exchange

To start, Table D.3 summarizes the mean realized effort across treatments and shocks.

Again, the results are similar to those reported in the main text. At this level of aggregation (across wages) there is little variation of effort across shocks.

Finally, Fig. D.1 relates effort to wages. This shows the same pattern of gift exchange as observed in Fig. 6 of the main text. In *nt*, the effort increases from bin 30/35 to 40/45 and 40/45 to 50/55 are both statistically significant (PtT, $p = .005$ and $p = .018$, respectively) while the step from 50/55 to higher wages is not (PtT, $p = .967$). In *et* and *wt* we observe no gift exchange; none of the differences between adjacent wage bins is statistically significant (PtT, all $p > .37$). Comparing the effects of shocks on effort within wage bins shows for *et* that effort is significantly higher than in *nt* for the lowest wages (PtT, $p = .024$) while the differences in the other three bins are all insignificant (PtT, all $p > .22$). For *wt*, none of the differences with *nt* is statistically significant (PtT, all $p > .18$). All of these results are qualitatively the same as those reported in the main text for rounds 3–8.

[38] Unless indicated otherwise, we use the same methods as in the main text.

[39] Combining *ET* and *AT*, the mean wages are 46.1 (*nt*) and 43.4 (*et*); the difference is significant (PtT, $p = .001$, $N = 65$). Pooling *WT* and *AT*, mean wages are 45.4 (*nt*) and 46.2 (*wt*) and differ insignificantly (PtT, $p = .488$, $N = 70$).

Table D.3
Effort, treatments, and shocks.

tax outcome	*NT*	*ET*	*WT*	AT_{et}	AT_{wt}	pooled
nt	**2.9**	**3.1**	**2.9**	**3.3**	**3.1**	**3.0**
obs.	30	30	30	20	20	130
et		**3.1**		**3.8**	**3.0**	**3.3**
obs.		25		20	20	65
wt			**2.8**	**3.4**	**3.2**	**3.1**
obs.			30	20	20	70
PtT (p-values)						
nt vs et	-	*0.334*	-	*0.017*	*0.733*	
nt vs wt	-	-	*0.854*	*0.668*	*0.700*	

Notes: Results are for rounds 1–8. Tax shocks occurred in rounds 4 and 5. The unit of observation is the mean effort received by an employer across rounds. We do not conduct tests for the pooled data because these combine paired with unpaired observations. 'obs.' shows the number of employers. *NT*: no taxes possible; *nt*: no tax shock realized; *ET*: productivity tax possible; *et*: productivity tax shock realized; *WT*: wage tax possible; *wt*: wage tax shock realized; AT_{et}: *wt* realized in round 2, *et* realized in rounds 4 and 5; AT_{wt}: *et* realized in round 2, *wt* realized in rounds 4 and 5. 'pooled' combines treatments. PtT: permutation *t*-test.

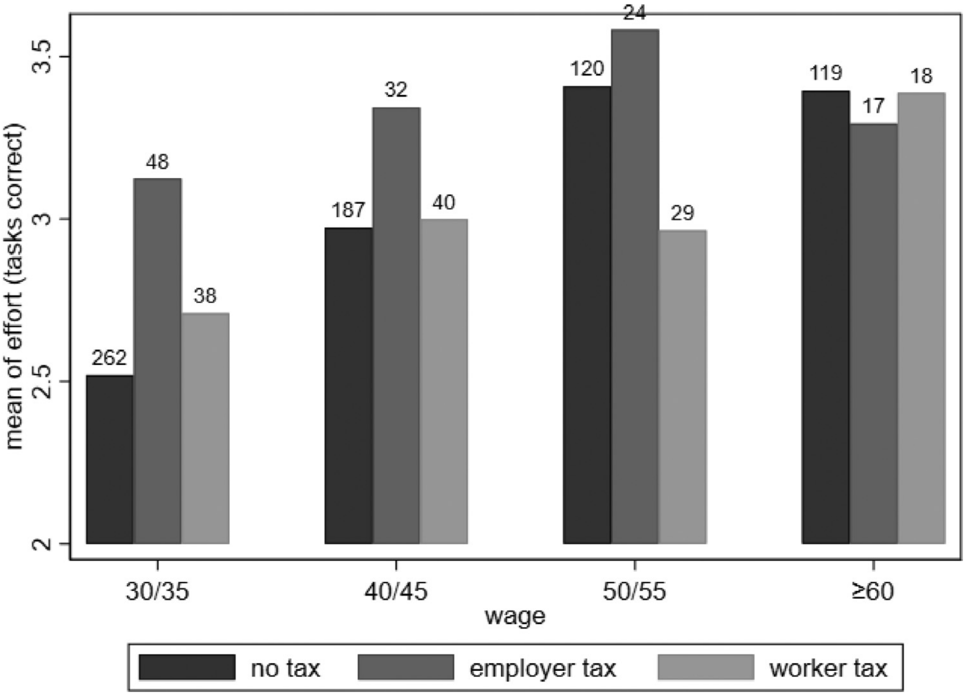

Fig. D.1. Average effort across wages. Note: The number of observations in each bin is reported above the bar.

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