Contract Enforcement, Fairness, and Involuntary Unemployment†

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Abstract

We analyze the impact of contract enforcement problems on the emergence of (involuntary) unemployment. In an experimental labor market where the trading parties can form long-term relationships, we compare a work environment where contracts are implicit in the sense that effort is observable, but not verifiable to a situation where contracts are "complete" and effort is enforced exogenously. In both treatments, firms can employ no, one or two workers. Efficiency is maximized when all firms employ two workers and all employees provide full effort. Our findings are as follows: unemployment is much higher in the treatment without third-party contract enforcement. More importantly, unemployment in this treatment is involuntary, being caused by the firms' employment and contracting policy. Firms pay high wages but offer fewer vacancies than possible and (technologically) efficient. This policy, however, succeeds in eliciting high efforts from the employed workers. When complete contracts can be written, wages are close to the market clearing level, firms do not ration jobs, and unemployment is mostly voluntary.

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1 Introduction

Many labor relationships are characterized by contractual incompleteness, in particular since employment contracts often specify employees' obligations only imprecisely. Probably the most important reason for leaving contracts incomplete is the difficulty to monitor and verify employee performance or work effort. When this is the case, firms cannot stipulate fully contingent contracts but have to rely on other, implicit means to elicit work effort. Several such implicit contract enforcement mechanisms have been discussed in the literature, ranging from voluntary bonus payments to self-enforcing, relational contracts based on an implicit threat to dismiss workers who have been caught shirking (e.g., MacLeod and Malcomson 1989, **?**, MacLeod and Malcomson 1998). Other papers have argued that social preferences could help to overcome moral hazard problems. Workers who feel treated fairly, e.g., because their employer generously shares the rents from production, might voluntarily provide high work effort in return (Akerlof 1982, Fehr, Kirchsteiger, and Riedl 1993).

While implicit contracts can provide strong performance incentives, they could have less desirable consequences for other labor market outcomes. In particular, some of the instruments of implicit contract enforcement could give rise to involuntary unemployment. For instance, when fairness concerns are important, it could be optimal for firms to dismiss workers rather than cut wages in times of economic downturns (Bewley 1999). More generally, firms might ration jobs because the requirement to pay fair wages could render less productive jobs unprofitable. Finally, the presence of unemployed workers could itself be a prerequisite to elicit effort of those employed. Higher unemployment levels increase the cost of job losses since, c.p., the job acquisition rate for unemployed workers decreases. Thus, unemployment might be necessary to provide sufficient performance incentives for employed workers who want to avoid losing their jobs (Shapiro and Stiglitz 1984, MacLeod and Malcomson 1989).

In this paper, we empirically analyze the relationship between contract enforcement and the emergence of unemployment. We address the following questions: Does the absence of third party contract enforcement have a direct impact on the level of involuntary unemployment? Is this influence due to the implicit contract enforcement instruments used by firms? For instance, do firms ration jobs when effort is not verifiable although full employment would be (technologically) efficient? Do they engage in repeated, long-run work relationships and do they pay "fair" wages? How does unemployment influence workers' effort provision?

We study these questions in an experimental labor market where we exogenously vary the verifiability of work effort. In the market, firms and workers interact during multiple market periods. All firms share the same production technology which exhibits decreasing returns to scale from labor, but ensures that full employment is technologically efficient. In each market period, firms can hire up to two workers whereas workers can accept exactly one contract offer. We concentrate on simple, but frequently observed employment contracts which stipulate a fixed, non-contingent wage payment and a desired level of work effort. In order to study rent-sharing as well as the determinants of dismissal or re-employment in relational contracts, we allow firms and workers to interact repeatedly and build up long-term work relationships.

Our two treatment conditions only differ in the degree to which work effort is verifiable and, hence, explicitly enforceable. In a control treatment, concluded contracts are explicitly enforced, i.e., a worker's effort has to be equal to the contractually agreed upon effort level (*C treatment*). By contrast, in our main treatment (*IC treatment*) effort is observable to firms and workers, but not verifiable. Firms therefore have to rely on implicit contracts. Backward induction together with the assumptions of standard neoclassical labor market models predicts that treatments will differ in terms of workers' performance (i.e., first best work effort will be elicited in the C treatment, whereas effort will be minimal in the IC treatment), but that maximum employment will be achieved in both treatments.

However, when workers' performance depends on whether they feel treated fairly by their employer (i.e., when workers have social preferences), firms in the IC treatment might find it profitable to ration jobs, rely on repeated interaction with specific workers, and pay strictly positive rents to those workers. This could lead to market outcomes where firms succeed in eliciting above minimum effort levels also in the IC treatment. However, this efficiency increase in terms of effort might come at the cost of involuntary unemployment. High wage payments and job rationing in the IC treatment could lead to higher unemployment as compared to the treatment with explicit contract enforcement.

Our experiment yields the following findings. First, unemployment is indeed much higher when third party contract enforcement is not feasible. More importantly, unemployment in this treatment is involuntary, being caused by the firms' employment and contracting policy. Most firms indeed pay high wages but offer fewer vacancies than possible. By contrast, wages are close to the market clearing level when effort is explicitly enforced. Firms do not ration jobs, and unemployment is very low. Moreover, unemployment in this treatment is mostly voluntary, being caused by workers who do not accept existing contract offers.

The firms' employment policy in the IC treatment, however, succeeds in eliciting high efforts from the employed workers: more than 50% of workers choose effort levels close to the maximum and only 12% of workers shirk and provide minimum work effort. We observe that many firms employ a specific worker over several periods when effort is not explicitly enforced. These long-term work relationships are characterized by high wages and high effort levels. Providing high efforts in response to high wages is profitable for the worker since firms do not rehire workers who were caught shirking in previous periods. At the same time, being unemployed entails considerable costs for workers. Due to firms' job rationing, the prevalence of long-term work relationship, and the high level of unemployment, the job acquisition rate for unemployed workers is very low.

The IC treatment also allows us to deeper analyze the determinants of firms' success in an environment where contracts are not explicitly enforceable. Interestingly, profits are initially higher for firms who ration jobs, but do not depend on firm size in later periods of the IC treatment. As more and more firms decide to ration jobs, unemployment rises, and therefore the pressure to perform increases for employed workers. Ultimately, work effort (and therefore firm profits) also increases in firms that employ more than one worker. However, we find that employment relationships in these firms differ strongly from the ones in successful one-worker firms. While one-worker firms are characterized by long-term employment relationships, high wages and high worker rents, the successful two-worker firms offer low wages and positive, but lower rents to the workers. Moreover, fluctuation in two-worker firms is much higher (i.e., there are essentially no long-term employment relations). The result resembles an "endogenously segmented" labor market with two forms of employment relationships which are equally successful from the firms' perspective but differ strongly for workers.

Efficiency wage theory have long postulated that the absence of explicit contract enforcement could lead to involuntary unemployment (Shapiro and Stiglitz 1984, MacLeod and Malcomson 1989, Akerlof and Yellen 1990). To the best of our knowledge, this paper is the first which empirically shows a direct, causal link between contract enforcement and the emergence of unemployment. So far, there has been only indirect evidence which suggested that this link might exist. For instance, it has been shown in surveys as well as in economic experiments that fairness concerns in environments characterized by contractual incompleteness can be the cause of wage rigidities (Campbell III and Kamlani 1997, Bewley 1999, Fehr and Falk 1999). In a setup similar to ours, Brown, Falk, and Fehr (2004) have shown that the absence of third party contract enforcement leads to a "bilateralization" of trade, where interaction between firms and workers is characterized by long-term employment relationships with high wages and high effort. Unemployment, however, is exogenously given in their experiments and firms had no option to ration jobs.

The paper most closely related to ours is the work by Fehr, Kirchsteiger, and Riedl (1996) who also study the emergence of unemployment in a market where effort is not perfectly verifiable. However, their experimental design differs from ours in a variety of important aspects. First, they concentrate on one-shot interactions between firms and workers while our focus is on the emergence of unemployment through fairness concerns and relational contracting. Second, as a shortcut for implementing a threat of dismissal, Fehr, Kirchsteiger, and Riedl (1996) introduce an exogenously given, strictly positive probability that workers who shirk will be caught and have to pay a penalty to their firm. In contrast, we can directly observe dismissal and re-employment decisions by firms. Finally, workers' productivity in their experiment was private knowledge to firms and productivity of some firms was so low that these firms could not profitably offer incentive compatible contracts. In our setup, we observe job rationing *although* it is possible for firms to offer an incentive compatible contract that is profitable.

Complementary evidence to our paper that also suggests the importance of efficiency wages comes from the literature on non-compensating intra- and inter-industry wage differentials (e.g., Krueger and Summers 1988, Blanchflower, Oswald, and Sanfrey 1996, Abowd, Kramarz, and Margolis 1999, Goux and Maurin 1999). The earlier papers in this literature have observed persistent interindustry heterogeneity in wages for workers with identical observable characteristics which rejects classical competitive theories of wage determination. More recently, Abowd, Kramarz, and Margolis (1999) and Goux and Maurin (1999) have found that unobserved worker heterogeneity explains a considerable fraction of interindustry wage differentials. However, strong interfirm wage differentials within a given industry persist.

The results reported in Goux and Maurin (1999) indicate that wages strongly increase in firm size and firms' capital intensity and, to a lower extent, in productivity or profitability. Our results for the IC treatment show that, overall, higher wages are paid by firms who ration jobs and employ only one worker. This is, however, only seemingly contradictory. According to Goux and Maurin (1999), it is likely that larger firms in their sample face more difficulties to monitor employee performance. Therefore, their findings are in line both with efficiency wage theories and with our results. Comparison of wages *across* our treatment conditions strongly suggests that it is indeed the difference in the verifiability of effort and not firm size per se that matters for differences in wages. Holding contract enforcement constant—i.e., comparing wages *within* the IC treatment—it is the more productive and, under decreasing returns to scale, smaller firms that pay higher wages.

Our finding of an endogenous segmentation of the labor market in the IC treatment also provides interesting new insights into the debate on dual labor markets. It has long been acknowledged that dual labor markets can be an implication of contract enforcement problems and efficiency wages. However, in these models, dual labor markets typically arise as a consequence of differences in monitoring costs across firms (Bulow and Summers 1986) or due to differences in adjustment costs to demand fluctuations (Saint-Paul 1996, ch. 4). In our experiment, segmentation occurs in the IC treatment even though all firms face the same technological constraints. Rather, segmentation is the result of market interactions when third party contract enforcement is not feasible. In response to the non-verifiability of effort, many firms ration jobs, pay high wages and employ specific workers over a long time horizon. As a result, unemployment increases. This allows other firms to successfully employ a "secondary-sector" contracting strategy, involving lower wage payments and tighter conditions for contract renewal. High unemployment disproportionally helps these firms, since they are more likely to hire previously unemployed workers. For a given wage, these workers tend to shirk particularly little—unlike in classical shirking models where unemployment disciplines all workers similarly. The "secondary sector" firms are therefore able to pay lower wages to elicit a certain level of work effort.

The remainder of the paper is organized as follows: the following section describes our experimental setup. Section 3 derives behavioral predictions and Section 4 presents the empirical results. Section 5 concludes.

2 Experimental Design and Procedures

To study the impact of contractual incompleteness on unemployment, we implemented an experimental labor market where we exogenously varied the verifiability of work effort. In the market, firms and workers interacted during 18 market periods. Each of the 18 periods consisted of two stages: a market phase where firms offered employment contracts and hired workers, and a work phase where work effort of employed workers was determined. The experimental treatments differed only in the degree to which work effort in the second phase was third party enforceable. In our main treatment, henceforth called *Incomplete Contracts Treatment* (or *IC treatment*), third party contract enforcement was absent and workers thus could depart from the contractually agreed upon effort level. By contrast, the effort level stipulated in the employment contract was explicitly enforced in our control treatment, henceforth called *Complete Contracts Treatment* (or *C treatment*).

2.1 The Market Phase

Firms were the contract makers in the market phase. When offering a contract, firms stipulated a non-contingent wage payment w and a desired level of effort $\hat{e}$. To study the relevance of long-term employment relations under the different treatment conditions, firms could make two different types of contract offers: public offers which were available to all workers and could also be observed by all other firms, or private contract offers that were only available to one specific worker. The latter type of contract offers allowed firms to rehire certain workers and interact repeatedly with them. To enable the formation of long-term relations, in the beginning of the experiment each worker and each firm received an identification number (ID) which was held constant throughout the whole experimental session. If an employer wanted to (re)hire a specific worker via a private contract offer, she had to specify the ID of the worker in addition to the wage and desired effort level when entering the contract offer. In this case, only the selected worker was informed about the contract offer, and only this worker could accept the offer.

In a certain market period, each employer could hire up to two workers. As long as none of her contract offers had been accepted in a given period, an employer could make as many private and public offers as she wanted. A worker could accept all contract offers available to him, i.e., all public offers that were not yet accepted and private offers that firms had addressed to him. Once a worker accepted a contract offer, the contract between this worker and the respective firm was concluded. After agreeing on one contract, the worker was not allowed to accept further contract offers in this period. Additionally, all other outstanding offers of the respective employer were removed from the list of available contracts in the moment where one of her contract offers was accepted. The employer could then decide to hire a second worker by entering new contract offers. This market feature was implemented to prevent that an employer who wanted to employ only one worker but entered multiple contract offers had two offers accepted before being able to withdraw her remaining contract offers.

The market phase ended when the maximum number of contracts had been concluded or when all firms had indicated that they did not want to make additional contract offers.[1] At the end of the market period, the worker(s) of a given firm were informed about the contracts concluded by their firm, i.e., each worker received a summary of his own contract terms as well as information on whether and under which conditions his firm had employed a second worker. Providing information on the size of the firm in which a worker is employed can be crucial for workers when contracts are not third party enforceable (IC treatment). If some workers base their work effort on the extent to which their firm shares production rents, e.g., because they respond to "fair" wage payments, knowledge of offered rents, productivity, and firm size is of high importance for workers (see section 2.3 and section 3).

[1] We also implemented a maximum trading time of 200 seconds for each market phase. This constraint was, however, only binding in few occasions (mostly in the C treatment). The impact of the time constraint on the level of unemployment and other market outcomes reported below is therefore limited and confined to the control treatment with explicit contract enforcement (see section 4.1).

2.2 The Work Phase

After the end of the market phase, the employed workers entered the second stage of a market period—the work phase. In this stage, actual work effort e was determined. Since effort was contractible in the complete contracts treatment, workers who had accepted a contract offer in this treatment had to comply with the contract terms. The desired effort level $\hat{e}$ stipulated in their contract was thus explicitly enforced, i.e., $e = \hat{e}$ was exogenously implemented by the experimenter. By contrast, work effort was observable, but not verifiable in our main treatment (IC treatment). Therefore, a worker could choose any feasible level of effort in the work phase, i.e., he could also exert less or more effort than stipulated in his employment contract. Workers' effort choices, together with firms' wage payments, determined material payoffs of firms and workers. Before the next period started, a firm and its worker(s) were informed about actual work efforts and the resulting payoffs for the firm and the workers employed by this firm.

2.3 Parameters and Procedures

The participants' roles were randomly assigned at the beginning of the experiment and kept constant throughout all market periods. In every market, we had 17 workers and 7 firms. Since firms could employ at most two workers, this implies that three workers were "exogenously" unemployed in each period (see section 3). A worker's material payoff π_W was given by

$$\pi_W = \begin{cases} w - c(e) & \text{if worker accepted a contract } [w, \hat{e}] \\ 0 & \text{if unemployed} \end{cases}$$

A worker who remained unemployed in a given period received a payoff of 0 points. An employed worker received the wage w specified in his contract and had to bear the cost of the work effort he provided, $c(e)$. The set of feasible efforts and wages was given by $e \in \{1, 2, ..., 10\}$ and $w \in \{0, 1, 2, ..., 100\}$. Effort costs $c(e)$ increased convexly in the level of actual work effort (see Table 1).

Effort level e	1	2	3	4	5	6	7	8	9	10
Cost of effort $c(e)$	0	1	2	4	6	8	10	12	15	18

Table 1: *Schedule of effort costs.*

A firm's material payoff depended on the number of workers hired, the wage(s) paid, and the effort exerted by the worker(s). Firms' production technology was characterized by decreasing returns to scale. Specifically, each unit of effort by a worker increased production (and the firm's payoff) by 10 points if only one worker was employed by the firm. If two workers were employed, each unit of effort increased the firm's payoff by only 7 points. Additionally, firms had to pay the wages specified in their contracts. The material payoff of a firm, π_F, can therefore be summarized as follows:

$$\pi_F = \begin{cases} 10e_1 - w_1 & \text{if one worker employed} \\ 7(e_1 + e_2) - w_1 - w_2 & \text{if two workers employed} \\ 0 & \text{else} \end{cases}$$

e_1 (e_2) denotes the effort provided by the first (second) worker, and w_1 (w_2) is the wage paid to the first (second) worker employed by the firm. Note that this specification of the production technology implies that efficiency is maximized when two workers are employed and maximum effort is exerted: the second worker's marginal productivity per unit of effort is 4 whereas the marginal cost of effort lies between 1 and 3 points. Payoff functions π_F and π_W, workers' cost schedule $c(e)$ as well as the number of firms and workers in the market were common knowledge.

The experiment was carried out between June and November 2007 in the BonnEconLab, the laboratory for economic experiments at the University of Bonn. We conducted five sessions each for the IC treatment and the C treatment. A total of 240 subjects, mainly undergraduate university students from all majors, took part in the experiments. Every subject participated only in one on the treatment conditions. At the beginning of an experimental session, participants received detailed information about the rules and structure of the experiment.[2] The experiment started only after all participants had answered several control questions correctly. In addition, subjects played one trial period of the market phase to ensure that they understood how to use the computer program. Sessions lasted about 110 minutes and subjects earned on average 25.49 Euro (about 35 USD at the time of the experiment), including a showup fee of 8 Euro. The experiments were computerized using the software "z-Tree" (Fischbacher 2007); subjects were recruited using the online recruitment system by Greiner (2003).

[2]A translation of the instructions can be found in the appendix. In order to rule out that participants' fairness concerns from their labor relations outside the laboratory play a prominent role, instructions were framed in a neutral goods-market language.

3 Behavioral Predictions

3.1 Money-maximizing behavior of all players

As indicated in section 2, efficiency is maximized when all firms employ two workers and all workers exert full effort. If players are rational and selfish, and if effort is contractible (C treatment), we should expect that profit-maximizing firms implement the first best outcome and reap all gains from trade: in each period, firms will employ two workers, offering contracts which ask for maximum effort ($\hat{e} = e = 10$) and pay the minimum acceptable wage. As unemployed workers receive zero unemployment benefits, this wage is equal to the cost of the implemented effort, i.e., $w = c(10) = 18$ points. Since there are 7 firms and 17 workers in each market, three workers will remain unemployed by design of the experiment. As we are interested in unemployment which is arising *endogenously* through the market interaction between firms and workers, we will refer to the situation where the maximum number of workers is employed and only three workers remain "exogenously" unemployed as *full employment* in what follows.

Which market outcomes should we expect in the IC treatment under the assumptions of standard neoclassical labor market models, i.e., rationality, money-maximizing behavior of all players and common knowledge thereof? All players know that the market operates for exactly 18 periods—our setup thus constitutes a repeated game of finite length which is solvable by backward induction. Since effort is costly, but not verifiable, workers will choose the minimum effort $e = 1$ in the final period of the IC treatment, irrespective of the wage and desired effort level stipulated in their contract. Anticipating this, money-maximizing firms will pay the minimum acceptable wage for an effort of 1 in this period. This amounts to a wage payment $w = c(1) = 0$ since, again, workers' outside option is to remain unemployed and receive zero payoff.[3] Through backward induction, the outcome of minimal effort (and minimal wage) will also hold in all pre-final periods of the IC treatment.

In sum, predictions differ strongly in terms of contracts offered and effort implemented in the two different market environments. Lower efforts in the IC treatment directly translate into lower market efficiency in this treatment. Importantly, however, the two treatments should *not* differ in the second dimension of market efficiency—the level of unemployment. In particular, under the assumption of money-maximizing behavior of all players we should expect full employment also if contracts are not third party enforceable. To see this, note that—given our assump-

[3]Assuming that workers reject contract offers with net payoffs equal to their outside option yields $[w, \hat{e}] = [1, 1]$ in IC and $[w, \hat{e}] = [19, 10]$ in C.

tions on production technology and payoff functions—it is more profitable for a firm to employ two workers at the minimum possible wage ($w = 0$) who exert minimum effort ($e = 1$) compared to employing just one worker at the same wage rate who exerts the same level of effort.

3.2 Fair-minded workers

There is mounting evidence both from laboratory (e.g., Fehr and Gächter 2000, Brown, Falk, and Fehr 2004) and field studies (e.g., Bewley 1999, Cohn, Fehr, and Götte 2008) which suggests that workers' performance in markets characterized by contractual incompleteness depends on whether they feel treated fairly by their employer (see also Akerlof 1982 and Akerlof and Yellen 1990 for an early theoretical assessment on how fairness preferences can impact labor market outcomes). In this section, we will sketch how workers' fairness preferences could influence the results of our experiment. In particular, we will argue that the presence of fair-minded workers can lead to market outcomes where higher efforts are observed in the IC treatment, but where the level of unemployment is also higher compared to the subgame perfect equilibrium outlined in the previous paragraph.

Brown, Falk, and Fehr (2004) have shown that the presence of fair-minded players in markets similar to our IC treatment gives firms incentives to build up long-term employment relationships and pay high wages to their workers. Workers in such long-term relations will adhere to the contract and provide non-minimal levels of work effort in most periods of the game. This outcome is profitable both for firms and workers: if there are sufficiently many fair-minded workers, it is profitable for firms to pay strictly positive rents even in the final period of the game, since fair workers reciprocate high wages by providing high efforts. If firms in addition re-employ only workers who adhere to the terms of the contract in pre-final periods (i.e., if firms use a policy of contingent contract renewal), *all* workers have an incentive to fulfill their contractually specified obligations in pre-final periods. Fair workers are willing to provide high levels of effort as long as the wage payment is considered fair. Selfish workers imitate fair workers because, by doing so, they have the chance to be re-employed and earn positive rents also in future periods.

In the appendix we show that similar, cooperative outcomes can be achieved in our IC treatment. However, they can involve above-minimal and involuntary unemployment. More specifically, if fair-minded workers have "strictly egalitarian" fairness preferences,[4] the fraction of fair-minded workers necessary to sustain cooperation in two-worker firms is higher than for firms which employ only one worker.

[4] I.e., Workers employed in a one-worker firm expect the gains from trade to be shared equally between their firm and themselves, and workers employed in a two-worker firm expect that they receive one third of the (net) surplus.

Moreover, even if there are enough fair-minded workers, firms in our setup strictly prefer to employ only one worker when fairness requires that net surplus has to be shared equally between all members of a firm. The reason for the latter effect is the implemented production technology. Because of decreasing returns to scale, the second worker's marginal contribution to total surplus is relatively low. If workers' fairness concerns require the firm to share total surplus equally between the firm and all hired workers, it could be that employing two workers with fair contracts yields lower total profits to the firm as compared to the situation where the firm employs only one worker with the corresponding rent-sharing contract. For the parameters specified in section 2, this is the case (the calculation can be found in the appendix). Employing only one worker and sharing rents equally with this worker is thus a dominant strategy for firms when the fraction of fair workers is high enough to sustain cooperation in one-worker firms. In this situation, firms in the IC treatment will ration jobs but pay high wages and succeed in eliciting above-minimal levels of effort. This, however, gives rise to involuntary unemployment.

Obviously, the relative profitability of employing one or two workers strongly depends on the wage payment necessary to induce work effort by fair-minded workers. Therefore, it is crucial for market outcomes what these workers consider to be a fair wage. So far we have assumed that fair-minded workers fulfill a contract if an only if it offers strictly egalitarian rent-sharing between all members of a firm. This assumption is crucial for making job rationing profitable for firms. While the egalitarian fairness benchmark has received a lot of support in the literature (e.g., Fehr and Schmidt 1999, Fehr, Klein, and Schmidt 2007) and is also intuitively appealing for our setup, it is by no means obvious that it is the only plausible formulation of what constitutes fairness (see Konow 2003 for an overview of different fairness principles).

For instance, it is also possible that a fair-minded worker in a two-worker firm requires only that the surplus generated by *himself* is shared equally between the firm and him. This form of "relation-specific egalitarianism", where workers neglect the surplus produced by other workers, is consistent with evidence from multi-worker gift-exchange games. In experiments studying such games, it has been observed that some workers seem to care relatively little about the payoffs of co-workers and about the firm's payoff resulting from its interaction with these co-workers (see, e.g., Maximiano, Sloof, and Sonnemans 2007, Charness and Kuhn 2007). Under this weaker fairness benchmark, employing two workers is c.p. more profitable for firms since they can reap 50% of total surplus (instead of 33% under the strictly egalitarian fairness benchmark). Indeed, assuming the weaker fairness benchmark for the parameters specified in section 2 changes the predictions for the IC treatment: if the fraction of fair-minded workers is high enough, employing two workers under "relation-specific" surplus sharing is *more* profitable for firms than rationing jobs and sharing surplus only with one worker (see appendix).

Which fairness benchmark describes workers' actual fairness preferences best is ultimately an empirical question. It is also possible that what constitutes a fair wage from a worker's perspective is itself influenced by market conditions. For instance, the prevailing unemployment level could influence workers' perception of what constitutes a fair wage. Akerlof (1982)'s efficiency wage model assumes such a negative relationship between the fair wage and the level of unemployment. Burks, Carpenter, and Verhoogen (2007) have recently provided survey evidence supporting the view that local labor market conditions might affect workers' fairness perceptions. If this is the case, we should expect that workers' willingness to provide effort for a given wage (and, therefore, also firms' profits) will depend on the rate of unemployment.

In the following section, we test the behavioral predictions with our experimental data. We first analyze whether the absence of third party contract enforcement in the IC treatment indeed gives rise to unemployment (Section 4.1). We then study market outcomes and behavior in the IC treatment in more detail. We investigate determinants of firms' hiring decisions and compare different contracting policies used by firms. Finally, we analyze how workers' behavior is influenced by market conditions.

4 Results

4.1 Unemployment

Our main interest concerns the level of unemployment, dependent on the degree to which firms can explicitly enforce workers' performance. Figure 1 depicts the level of "endogenous unemployment"[5] in the two treatments. Initially, unemployment rates do not differ significantly between the different market environments (Mann-Whitney U-Test for period 1 observations only, $p = 0.217$)[6]. After the first few periods, however, we observe a strong increase in unemployment in the IC treatment, while the level of unemployment stays close to zero when contracts are third party enforceable. As a consequence, the overall level of unemployment differs substantially between the different market environments. When effort is not verifiable,

[5]Remember that, in both treatments, 3 workers were unemployed "by design" in every session and every period due to excess supply of labor. To measure "endogenous unemployment" we therefore calculate the total number of unemployed workers *minus* 3 and divide by the number of possible jobs (given that each of 7 firms could offer 2 vacancies in every period the number of possible jobs in each market is 14).

[6]All non-parametric tests use session averages as independent observations. Reported p-values are always two-sided.

the average unemployment rate is higher than 30% while it is only about 5% in the C treatment. The difference between treatments is highly significant (Mann-Whitney U-Test, $p < 0.01$). The strong difference in unemployment can also be seen when analyzing single experimental sessions: the highest average unemployment rate in a market where contracts are explicitly enforced is 8.7%. This number is still lower than the lowest average unemployment rate in one of the IC sessions (21.4%).

Result 1: *We observe strong differences in unemployment between the two treatments. Under explicit contract enforcement (C treatment), unemployment levels are close to the minimal possible level. When effort is not verifiable (IC treatment), unemployment rises strongly before stabilizing on a high level.*

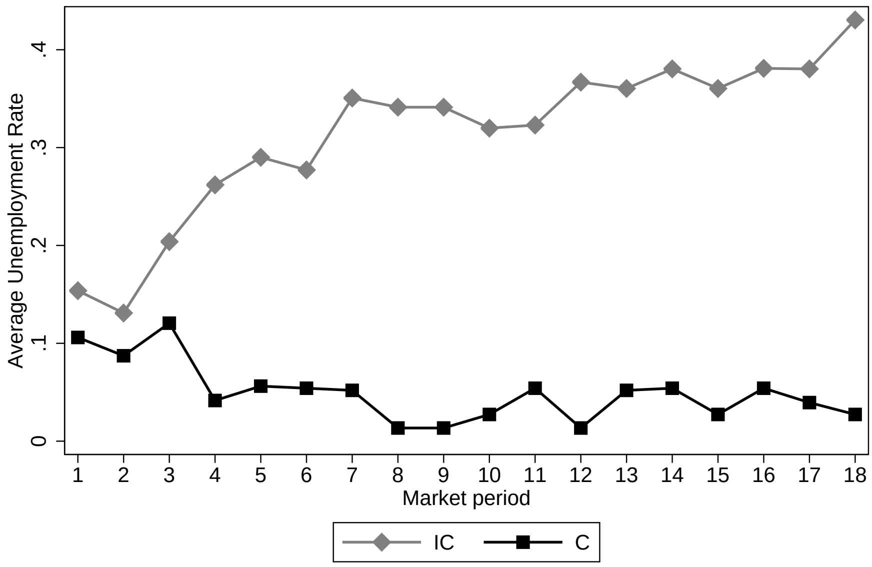

Figure 1: *Evolution of average unemployment over time*

	Potential Vacancies	Actual Offers	Private Offers	Concluded Contracts
C treatment	1260	1242	207	1193
IC treatment	1260	856	616	849

Table 2: *Number of potential and actual (private) contract offers made by firms. Number of contracts accepted by workers.*

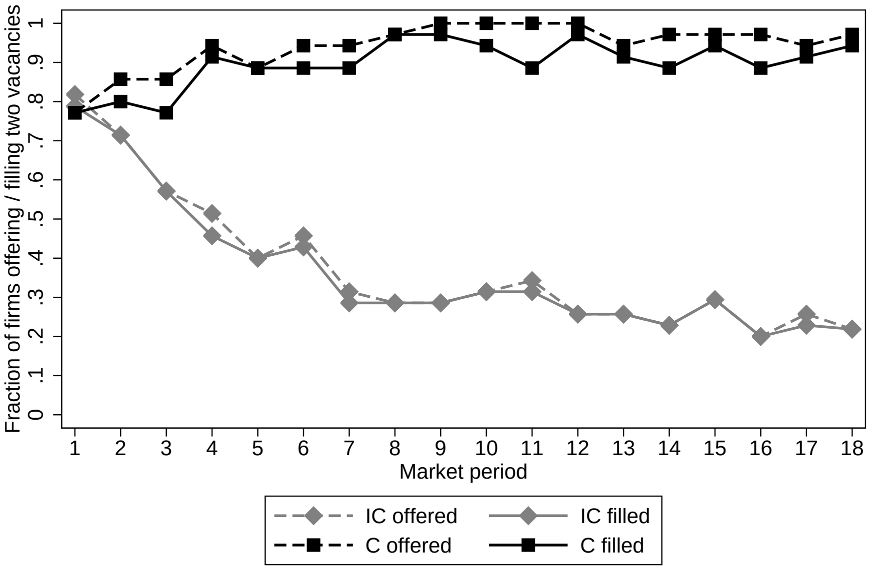

Figure 2: *Fraction of firms offering / filling two vacancies*

The absence of third party contract enforcement has a strong and positive impact on the level of unemployment. We have hypothesized in section 3 that unemployment in the IC treatment could be caused by firms who decide to ration jobs and pay fair, above market-clearing wages to those workers who are employed. In other words, the absence of explicit contract enforcement could lead to *involuntary* unemployment. Table 2 and Figure 2 provide evidence that this indeed the case. Table 2 summarizes the number of potential vacancies (Column 1), the number of firms' actual contract offers (Column 2), and the number of contract offers that are accepted by workers (Column 4) in the two treatments. In total, firms in each treatment could offer up to 1260 contracts. Given our assumptions on the production function, offering the maximum number of vacancies was efficient from a technological point of view in both treatments. However, the number of actual contract offers differs strongly between treatments. While nearly 99% of potential vacancies (1242 out of 1260) are offered in the C treatment, firms in the IC treatment make only 68% (856 / 1260) of the possible contract offers. This indicates that the differences in unemployment between treatments are mainly caused by firms' decisions to ration jobs in IC rather than by differences in workers' contract acceptance between the two treatments. The number of accepted contract offers (Column 4) supports this impression: in both treatments, nearly all contract offers are accepted by some worker. This indicates that differences in workers' contract acceptance (which could, e.g., be caused by differences in workers' reservation wages) can not explain the differences in unemployment between treatments.

Figure 2 sheds more light on firms' hiring policy. The dashed lines depict the fractions of firms who offer a second vacancy in a given period. The solid lines compare the fractions of second contract offers which are accepted by workers. Paralleling the observation on the unemployment level, the fraction of firms who aim at hiring two workers is initially similar in both treatments. After a few periods, however, this fraction increases to more than 90% in the C treatment, but fewer and fewer firms decide to employ two workers in the IC treatment. In later periods of the experiment, a relatively stable fraction of merely 20–30% of firms offers two contracts in this treatmet. The solid lines confirm that unfilled vacancies, which would be an indication for voluntary unemployment, are rarely observed in both treatments. If anything, the fraction of rejected contract offers is slightly higher in the C treatment.[7]

The prevalence of job rationing in the IC treatment also becomes apparent when we analyze the hiring decisions of individual firms during the experiment. Table 3 reports the frequencies with which individual firms hire two workers. Paralleling the observations from Figure 2, a vast majority of firms employ two workers in nearly all periods when work effort is verifiable. By contrast, in the IC treatment 74% of firms hire a second worker in less than half of the market periods. More than 50% of firms ration jobs even in more than 12 market periods.

Result 2: *Differences in unemployment are driven by firms' hiring decisions: when contracts are not explicitly enforceable, firms offer less contracts, and many firms employ only one worker in most periods of the experiment.*

Frequency of hiring two workers	0-2	3-5	6-8	9-11	12-14	15-18
Fraction of firms (C treatment)	–	–	–	–	0.171	0.829
Fraction of firms (IC treatment)	0.229	0.314	0.200	0.086	0.057	0.114

Table 3: *Percentage of firms who hire two workers in a given number of market periods (frequency with which individual firms employ two workers).*

[7] The contract acceptance rate is 96% in the C treatment, compared to 99% in the IC treatment; see Table 2. Most of the rejected offers are contracts which offer zero or negative rents to the workers.

4.2 Contracts in the Different Market Environments

The degree of third party enforceability apparently strongly affects overall market performance. In particular, the absence of explicit contract enforcement mechanisms leads to involuntary unemployment caused by firms' decision to ration jobs. In the remainder of this section, we analyze whether the channels through which unemployment is emerging in the IC treatment are also in line with our hypotheses. We first investigate whether the contracts which are most effective in eliciting work effort in this treatment differ from the profit-maximizing contracts in the C treatment. We then take a closer look at the IC treatment and analyze how the emergence of unemployment shapes the interaction between firms and workers.

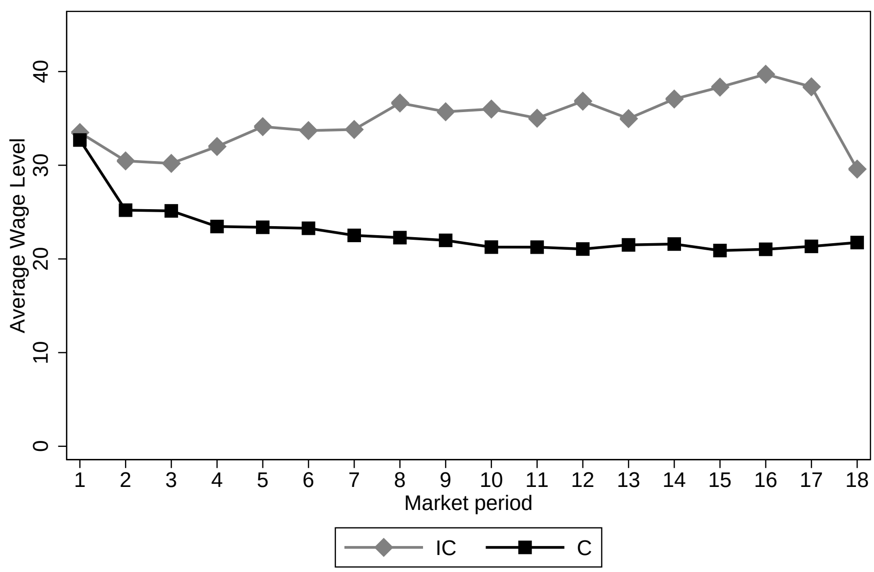

Figure 3: *Evolution of average wage over time*

We have argued in section 3 that firms could try to elicit high work efforts by paying high wages and engaging in long-term employment relationships when third party contract enforcement is not feasible (IC treatment). On the other hand, the profit maximizing contract for firms in the C treatment should be the one which minimizes wage costs for a given—explicitly enforced—effort level. Furthermore, there is no reason to (re-)employ specific workers via private contract offers when effort is verifiable.

Figure 3 and Table 4 show that these predictions are indeed borne out by our data. In Figure 3, we depict the average wage level in the two treatment conditions. When contracts are explicitly enforced, wages quickly converge to a level close to the market-clearing wage predicted in section 3. Remember that in this treatment, profit-maximizing firms require the maximum possible effort of 10. Since unemploy-

	Dependent variable: Firm profits					
	C treatment			IC treatment		
	(1)	(2)	(3)	(4)	(5)	(6)
Wage	-0.814***		-0.808***	0.485***		0.310**
	(0.137)		(0.143)	(0.085)		(0.101)
Private		-2.529	-0.818		18.250***	12.422***
		(3.619)	(2.787)		(2.828)	(2.565)
Constant	64.817***	46.671***	64.823***	8.288***	11.975***	5.420
	(3.609)	(0.802)	(3.541)	(2.808)	(1.293)	(3.006)
N	1193	1193	1193	849	849	849
R^2	0.241	0.007	0.242	0.150	0.160	0.204

Table 4: *Profitability of different contracts in the C treatment (Columns (1)–(3)) and the IC treatment (Columns (4)–(6)). The dependent variable is a firm's profit from a given contract. "Private" is a dummy equal to "1" ("0") if a firm-worker relation was initiated by a private (public) contract offer.* *** *indicates significance on the 1-percent level,* ** *significance on the 5-percent level,* * *significance on the 10-percent level. Reported standard errors (in parentheses) are adjusted for clustering on session level.*

ment benefits are set to zero, profit-maximizing firms should thus pay a wage equal to $c(10) = 18$. The wages observed in the C treatment are very close to this level: on average, firms pay 22.9 points to their workers (in the second half of the experiment, this value even decreases to 21.3 points). This contrasts sharply with the results for the IC treatment where effort is not verifiable. Firms in this treatment pay an average wage of 34.8 points to their workers. Moreover, wage differences across treatments increase over time. Overall, the differences in wages are highly significant (Mann-Whitney U-Test, $p < 0.01$). Table 4 analyzes the profitability of these wage payments from a firm's perspective. In particular, we compare the profitability of paying higher wages and making private contract offers in the two treatments. As expected, paying higher wages when explicit contract enforcement is possible unambiguously decreases firms' profits (see Columns (1) and (3) of Table 4). Whether an employment relation is initiated by a private or public contract offer has no impact on profits in the C treatment (see Columns (2) and (3)). Therefore, it is not surprising that only few firms in this treatment make private contract offers (see Column 3 of Table 2).

These findings differ strongly to those obtained when explicit contract enforcement is not feasible where more than 70% of employment relations are initiated by a private contract offer (see Column 3 of Table 2). Firms indeed seem to care much more which worker they employ in the IC treatment. Is this selectivity in firms' hiring decision also reflected in a higher profitability of private contracts? Columns (5) and (6) of Table 4 confirm that this is the case. Trades initiated by a private contract offer are more profitable for firms. Moreover, treatments also differ strongly with respect to the relationship between firm profits and wages paid. As can be seen in Columns (4) and (6) of Table 4, paying higher wages increases firms' profits in the IC treatment. This indicates that the direct cost of paying higher wages is more than compensated by workers' increase in effort when generous wages are paid. Thus, the strong differences in wages observed in Figure 3 are well-founded from firms' perspective and reflect differences in the profitability of certain contracts in the two different market environments.

The differences in contracting between the two treatments is also reflected in the average duration of employment relationships. Since effort is verifiable, there is no need to build up long-term work relations in the C treatment; the average duration of a relationship in which a firm hires a specific worker (by directing a private contract offer towards him) is 1.35 periods. On the other hand, repeated interaction between firms and workers, i.e., the emergence of long-term work relationships is frequently observed in the IC treatment: conditional on hiring a worker through a private contract offer, firms employ the same worker on average for 2.90 periods. 51% of firms in this treatment rehire at least one specific worker for more than half of the market periods without interruption. The corresponding fraction of firms who does so in the C treatment is merely 3%.

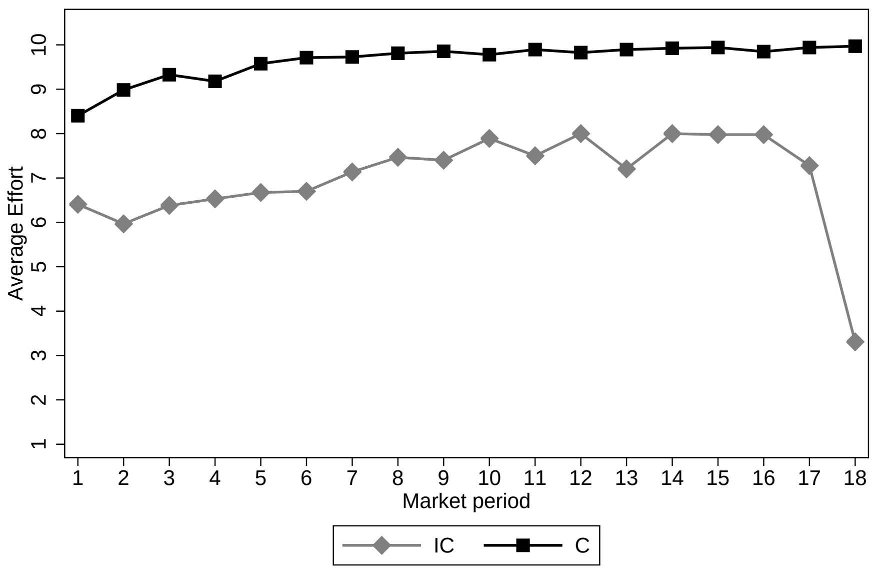

Figure 4: *Evolution of average effort over time*

Firms' strategy to ration job offers, pay high wages and repeatedly employ the same workers in the IC treatment gives powerful incentives for workers to provide effort, although effort is not explicitly enforced. Figure 4 depicts the average level of effort in the two treatments. In line with the theoretical hypotheses and previous evidence (Brown, Falk, and Fehr 2004, Brown, Falk, and Fehr 2008), the figure indicates that cooperation can indeed be sustained when third party contract enforcement is absent. While efforts in the IC treatment are lower than in the C treatment where they are explicitly enforced (Mann-Whitney U-Test, $p < 0.01$), the figure demonstrates that the implicit incentives provided through firms' contracting strategy are strong enough to elicit high work effort. Although effort is not verifiable, workers choose an effort level of 8–10 in more than 50% of cases, and minimum effort is observed in only 12% of cases. Compared to the strong difference in unemployment between treatments, the difference in the second measure of market efficiency—workers' effort—is relatively small.

> **Result 3:** *Successful firms use different contracting policies in the two treatments. When effort is verifiable (C treatment), firms increase profits by employing workers at the lowest incentive compatible wage. When third party contract enforcement is absent, firms operate profitably if they pay generous wages and hire specific workers through private contract offers.*

4.3 Determinants and Consequences of Job Rationing

We now turn to the determinants of firms' decision to ration jobs in the IC treatment. We first concentrate on differences in profits between the different "types" of firms, i.e., firms who employ two workers and firms who ration jobs and employ only one worker.[8] Is the high unemployment in the IC treatment caused by overall higher profits of firms who employ only one worker, as suggested by the analysis of workers with "strictly egalitarian" fairness preferences in section 3? On average, one-worker firms in this treatment indeed earn somewhat higher profits. Average profits of firms who employ one worker in a given period are 36.9 points compared to 29.4 points in two-worker firms (see Column (1) in Table 5). However, this difference in profits

[8] Strictly speaking, there are no stable "types" of firms in our experiment since firms could decide in each market period how many workers they want to hire. Although the correlation between individual firms' job rationing decisions in consecutive periods is highly positive ($\rho = 0.47$, $p < 0.01$), some firms also switch between hiring one or two workers. Firms keep their "type" in 75.6% of cases, two-worker firms become one-worker firms in 13.8% of cases, and one-worker firms employ two workers in the following period in 10.6% of cases. For ease of exposition, in what follows we will thus refer to a firm as "one-worker firm" ("two–worker firm") if it employs one (two) workers *in a certain market period*.

is not statistically significant.

	Dependent variable: Firm profits					
	all market periods	periods 1–6	periods 7–12	periods 13–18	1-worker firms	2-worker firms
	(1)	(2)	(3)	(4)	(5)	(6)
2-worker	-7.499	-12.630***	-3.494	-0.987		
	(5.110)	(2.218)	(6.880)	(7.290)		
Period					0.370	1.087**
					(0.200)	(0.390)
Period18					-42.869***	-33.714**
					(7.141)	(11.625)
Constant	36.879***	36.587***	40.757***	33.395***	35.652***	22.283***
	(2.784)	(1.940)	(2.520)	(3.836)	(0.594)	(1.850)
N	623	208	209	206	397	226
R^2	0.030	0.102	0.008	<0.001	0.238	0.094

Table 5: *Profit differences between one-worker firms and two-worker firms in the IC treatment. The dependent variable is a firm's* total *period profit. "2-worker" is a dummy equal to "1" ("0") if a firm employs two (one) workers in a given period. "Period18" is a dummy equal to "1" for the final market period.* *** *indicates significance on the 1-percent level,* ** *significance on the 5-percent level,* * *significance on the 10-percent level. Reported standard errors (in parentheses) are adjusted for clustering on session level.*

The comparison of average profits over all market periods hides an interesting time pattern in profits for the different types of firms. Figure 5 depicts firms' profits in the IC treatment over time. The figure suggests that, initially, two-worker firms earn considerably less than one-worker firms, but that this difference in profits disappears over the course of the experiment. Comparing firms' profits in the first 6 periods yields a profit difference 12.6 points which is significant at the 1% level (see Column (2) of Table 5). Paralleling the pattern observed in Figure 5, this difference in profitability between the different types of firms vanishes completely in later market periods (cf. Columns (3) and (4) of Table 5). Regressions analyzing the dynamics of profits for the two different types of firms separately indicate that the convergence in profits is caused by an increase in two-worker firms' profitability. Controlling for the drop in profits in the final period, two-worker firms significantly increase their profitability over the course of the experiment (see Column (6) of Table 5). A the same time, profits of one-worker firms increase weakly, but not

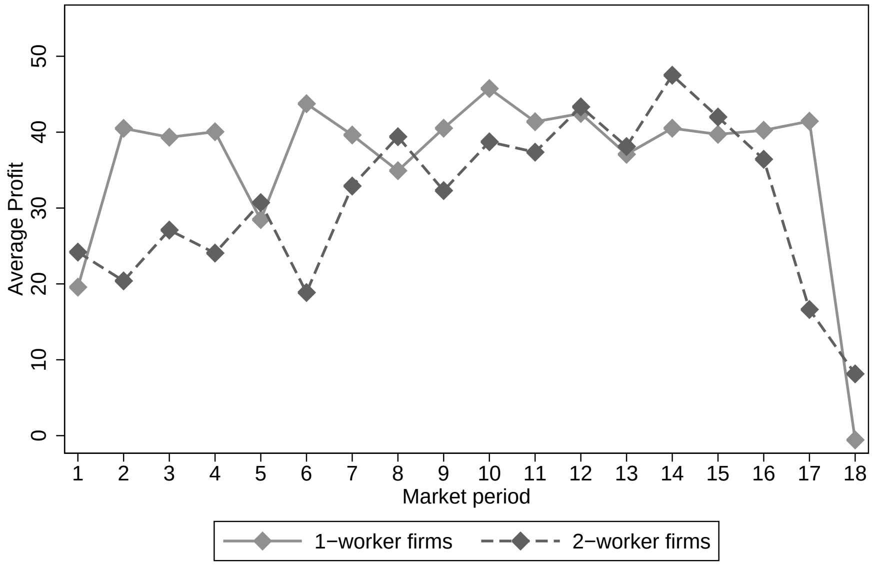

Figure 5: *Firm profits in 1-worker firms and 2-worker firms (IC treatment)*

significantly (see Column (5) of Table 5). This shows that a (stronger) increase of profits of two-worker firms rather than a decrease of profits in one-worker firms accounts for the convergence of profits between the different firm types.

> **Result 4:** *When third party contract enforcement is absent, one-worker firms are initially more profitable than two-worker firms. In later periods, profits in two-worker firms converge to the profit levels of one-worker firms.*

In section 3, we have argued that the relative profitability of employing one or two workers in the IC treatment should depend on what constitutes a fair contract offer. If fair-minded workers have strictly egalitarian fairness preferences, one-worker firms will always be more profitable. The analysis of firm profits in the IC treatment has demonstrated that, in the beginning of the experiment, this seems to be case. In this sense, profit differences could account for the strong increase in unemployment in these periods. However, the analyses so far also have shown that a relatively stable fraction of firms employ two workers in later periods of the experiment (see Figure 2) and that these firms manage to earn similar profits as one-worker firms. The only way how two-worker firms can catch up in terms of profits are differences in the effort-wage relation between different types of firms. Because of the decreasing-returns-to-scale production technology, two-worker firms can operate as profitably as one-worker firms only if workers accept receiving a lower share of the surplus, and put in “extra” effort for a given wage level compared to workers in one-worker firms. Thus, if the effort-wage relation gets steeper over time in two-worker firms, this could explain the increase in these firms' profits observed in Figure 5.

	Dependent variable: Effort					
	1-worker firms			2-worker firms		
	(1)	(2)	(3)	(4)	(5)	(6)
Wage	0.141***	0.141***	0.129***	0.164***	0.166***	0.134***
	(0.008)	(0.009)	(0.022)	(0.010)	(0.008)	(0.014)
Period		0.011	-0.037		0.082**	-0.051*
		(0.029)	(0.148)		(0.024)	(0.023)
Wage*Period			0.001			0.004**
			(0.003)			(0.001)
Constant	2.243**	2.157***	2.620**	1.518**	0.881***	1.857***
	(0.522)	(0.325)	(0.093)	(0.327)	(0.138)	(0.301)
N	372	372	372	438	438	438
R^2	0.643	0.644	0.644	0.595	0.610	0.620

Table 6: *Determinants of worker effort in the IC treatment. Estimations for 1-worker firms (Columns (1)–(3)) and 2-worker firms (Columns (4)–(6)). Observations from the final market period are excluded. *** indicates significance on the 1-percent level, ** significance on the 5-percent level, * significance on the 10-percent level. Reported standard errors (in parentheses) are adjusted for clustering on session level.*

Table 6 reports estimation results on the relationship between wages and workers' effort choices in the IC treatment. To avoid biases due to the strong drop in efforts in the final period of the market (cf. Figure 4), final-period observations are excluded from the analysis. The estimation shows that the effort-wage relations are positively sloped both for one-worker firms and two-worker firms (see Columns (1) and (4) of Table 6). However, the dynamics of the workers' effort choices indeed differ between the different types of firms. Controlling for wages paid, average effort in two-worker firms increases over time (see Column (5)). Column (6) confirms that this is the result of a steeper wage-effort relationship, i.e., for any given level of the wage workers in two-worker firms are willing to provide higher efforts over time. Columns (2) and (3) show that for workers employed in one-worker firms this effect is absent. For a given wage, these workers provide similar levels of effort throughout the experiment.

Result 5: *The convergence in profitability of one-worker firms and two-worker firms can be attributed to an increasing steepness in the effort-wage relation of two-worker firms: for a given wage level, workers in two-worker firms are increasingly willing to provide high levels of effort.*

It seems as if the firms who employ two workers are able to use the increased level of unemployment in later periods to become more profitable. One potential explanation for this is that unemployment may serve as a worker disciplining device. Monetary payoffs for unemployed workers are zero in our experimental setup; therefore workers who are unemployed incur an immediate cost from not having a job. A consequence of the *increase* in unemployment is that being unemployed becomes relatively more costly. There are two reasons for this effect: first, due to firms' job rationing decisions, fewer and fewer job offers are available. Secondly, more unemployed workers compete for a job offer when unemployment is high. It should thus be less likely to get a job offer when unemployment is high. Table 7 summarizes the job acquisition rate of previously unemployed workers in the IC treatment. The figures depict the fraction of workers who were unemployed in period $t-1$ and acquire a job in period t (either through a private or a public contract offer). The acquisition rate decreases from more than 50% in early periods to about 20-35% in later periods. The correlation between the (lagged) unemployment rate and the job acquisition rate is strongly negative ($\rho = -0.53$, $p < 0.01$).

Period (t)	2	3	4	5	6	7	8	9	10
Acquisition rate (t)	0.78	0.51	0.52	0.41	0.52	0.39	0.26	0.33	0.35
Unemployment ($t-1$)	0.16	0.14	0.21	0.27	0.30	0.29	0.37	0.36	0.36
Period (t)	11	12	13	14	15	16	17	18	
Acquisition rate (t)	0.35	0.28	0.32	0.25	0.22	0.17	0.20	0.32	
Unemployment ($t-1$)	0.34	0.34	0.37	0.37	0.39	0.37	0.40	0.39	

Table 7: *IC treatment: workers' probability of being hired in period t if unemployed in period $t-1$.*

Does the higher cost of being unemployed indeed discipline workers? Table 8 depicts results of probit estimations on the determinants of workers' shirking behavior (reporting marginal effects). The dependent variable is a dummy equal to "1" if a worker shirks, i.e., if he provides less than the contractually desired effort level. Explanatory variables include the wage stipulated in the contract, the type of contract offer, the current job acquisition rate, and a dummy equal to "1" if the worker has been unemployed in the previous period. In line with the previous results, the estimations indicate that workers who are hired via a private offer and who receive higher wages tend to shirk less. More importantly, however, the coefficients for the job acquisition rate and the unemployment dummy indicate a decrease in shirking rates through unemployment: controlling for the wage received, workers tend to shirk less when job offers are scarce (i.e., when the job acquisition rate is low) and when they have been unemployed before. Interestingly, we observe that workers who have experienced unemployment *themselves* shirk less once they find a job again. This suggests that, in our setup, unemployment disciplines especially the previously unemployed workers, and not necessarily all employed workers as in Shapiro and Stiglitz (1984).

> **Result 6:** *The increase in unemployment in the IC treatment leads to a strong decrease in the job acquisition rate for unemployed workers. This makes being or becoming unemployed more costly. The higher pressure on workers is reflected in workers' contract fulfillment: workers shirk less when (i) jobs are scarce and (ii) when they have been unemployed previously.*

We have seen that, for a given wage level, previously unemployed workers are more likely to fulfill a contract by providing the contractually agreed upon effort level. As a consequence, firms should be able to negotiate more advantageous contract terms, and appropriate a higher share of the surplus when unemployment is high. However, it is unclear so far why this helps especially the firms who employ two workers to become more profitable.

The answer lies in the differences in contract offers between one-worker firms and two-worker firms. Firms who employ two workers in a given period are more likely to hire workers who have been unemployed before. Although only roughly 20% of firms employ two workers in later periods, these firms account for almost two thirds (65.1%) of job offers to previously unemployed workers. One reason for this effect is that firms who employ two workers rely more on public job offers than one-worker firms. 70.7% of public contract offers come from firms who employ two workers.[9] Another reason lies in the policies of contract renewal employed by firms who employ one vs. two workers. Table 9 reports estimations on determinants of contract renewal in the IC treatment. Comparing the re-employment strategies of different firm types shows that, for a given effort level provided, workers in two-worker firm face a higher probability of being dismissed (see Column (1) of Table 9). The same holds even

[9]This figure excludes contract offers from the first period where most firms (i) employ two workers and (ii) do so via public contract offers because they have not gained experience with specific workers.

	Dependent variable: 1 if $e < \hat{e}$		
	(1)	(2)	(3)
Wage	-0.017***	-0.015***	-0.016***
	(0.003)	(0.003)	(0.003)
Unemployed before	-0.106***	-0.127***	-0.103**
	(0.036)	(0.025)	(0.040)
Private		-0.162**	
		(0.079)	
Acquisition rate			0.260*
			(0.148)
N	849	849	849
Pseudo R^2	0.162	0.172	0.174

Table 8: *Determinants of contract fulfillment in IC treatment. Probit estimations, reporting marginal effects. "Unemployed before" is a dummy equal to 1 if the respective worker had no contract in the previous period. "Acquisition rate" is the fraction of previously unemployed workers who find a new firm in a given period (see Table 7). *** indicates significance on the 1-percent level, ** significance on the 5-percent level, * significance on the 10-percent level. Reported standard errors (in parentheses) are adjusted for clustering on session level.*

when we control for firms' total profits (see Column (2) of Table 9). Only if an *individual* worker's effort is so high that it yields firm profits comparable to those in one-worker firms, the likelihood of being re-employed does not differ from workers in one-worker firms (Column (3) of Table 9). Since workers in two-worker firms are less productive due to decreasing returns to scale, this implies a much tighter contract renewal policy of two-worker firms as compared to one-worker firms. In other words, for a given wage level a worker employed in a two-worker firms has to provide (costly) extra effort in order to attain re-employment chances comparable to a worker in a one-worker firm.

> **Result 7:** *Due to firms' strategies of offering and renewing work contracts, previously unemployed workers are more likely to be hired by firms who employ two workers.*

The higher likelihood of hiring workers from the pool of unemployed workers, together with the stricter contract renewal policy explains why two-worker firms more than proportionally profit from high unemployment in the IC treatment. Another

	Dependent variable: 1 if worker is not re-hired		
	(1)	(2)	(3)
2-worker	0.165***	0.200**	-0.093
	(0.039)	(0.089)	(0.108)
Effort worker i	-0.138***		
	(0.012)		
Firm's total profit		-0.010***	
		(0.001)	
Firm's profit from worker i's effort			-0.016***
			(0.002)
Period	-0.022***	-0.019***	-0.023***
	(0.007)	(0.006)	(0.006)
N	807	807	807
Pseudo R^2	0.386	0.200	0.241

Table 9: *Determinants of worker dismissal. Probit estimations, reporting marginal effects. "2-worker" is a dummy equal to 1 if a firm employs 2 workers in a given period.* *** *indicates significance on the 1-percent level,* ** *significance on the 5-percent level,* * *significance on the 10-percent level. Reported standard errors (in parentheses) are adjusted for clustering on session level.*

consequence of the tighter re-employment policy of two-worker firms is a higher turnover rate and, overall, shorter employment relations compared to one-worker firms. Only in 19% of cases, two-worker firms hire the same workers in two consecutive periods. The comparable number for one-worker firms is 83%.

Summarizing our findings, the outcomes in the IC treatment resemble an endogenously "segmented" labor market: one the one hand, the majority of firms employ only one worker when contracts are not third party enforceable. These firms are characterized by stable employment relationships based on private contract offers and contingent contract renewal. Moreover, these firms share the gains from trade generously, paying high wages to their workers which result in high work effort and high monetary payoffs both for workers and firms. On the other hand, a minority of firms operates successfully by employing two workers when unemployment is high. Interactions between these firms and their workers resembles those in "secondary" labor markets (Saint-Paul 1996). In contrast to the one-worker firms, successful two-worker firms are characterized by low wages and thus low rent payments to workers. Moreover, these firms exhibit a higher turnover rate due to a tighter contract renewal policy and a higher fraction of public contract offers. High unemployment disproportionally helps these firms, since they are more likely to hire previously unemployed workers. For a given wage, these workers tend to shirk particularly little. The "secondary sector" firms are therefore able to pay lower wages to elicit a certain level of work effort. When unemployment is high, this strategy yields profits similar to those of firms who ration jobs and rely on long-term employment relations and high wages.

5 Conclusions

In this paper, we have analyzed the relationship between contract enforcement and the emergence of involuntary unemployment. In an experimental labor market where the trading parties can form long-term relationships, we compared a work environment where contracts were not third party enforceable to a situation where contracts were "complete" and effort was verifiable.

Our main findings are as follows: unemployment is much higher in the treatment without explicit contract enforcement. Importantly, unemployment in this treatment is involuntary, being caused by the firms' employment and contracting policy. Firms pay high wages but offer fewer vacancies than possible and technologically efficient. This policy, however, succeeds in eliciting high efforts from the employed workers. When complete contracts can be written, wages are close to the market clearing level, firms do not ration jobs, and unemployment is mostly voluntary.

To the best of our knowledge, our paper is the first which empirically established a direct, causal link between contract enforcement and the emergence of unemployment which has long been discussed in efficiency-wage theories (Shapiro and Stiglitz 1984, MacLeod and Malcomson 1989, Akerlof and Yellen 1990). Our findings also contribute to the literature on the efficiency-wage foundation of dual labor markets (Bulow and Summers 1986, Saint-Paul 1996. Although firms face identical technological constraints in our setup, we observe a segmentation of the labor market when third party contract enforcement is not feasible. Most firms ration the number of jobs, and build up long-term employment relations which are characterized by generous rent-sharing between firms and workers. Behavior of these firms and their workers seems isolated from the market environment (e.g., the level of unemployment). On the other hand, there is also a minority of firms operating successfully without rationing job offers. These firms pay lower rents to workers, and use a tighter re-employment policy. Market conditions are very important for these firms: since they employ more workers through public contract offers and since previously unemployed workers shirk less, these firms become profitable only when unemployment is high.

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6 Appendix

In this appendix, we analyze whether it can be profitable for firms to offer fair, rent-sharing contracts in the IC treatment when we assume that a fraction of workers is fair-minded. Our aim is not to fully characterize the set of feasible (Bayesian) Nash Equilibria. Rather, we want to illustrate how fairness preferences shape the profitability of certain contracting strategies and how this could influence labor market outcomes. In particular, we aim at illustrating how contractual incompleteness can render job rationing optimal for firms and, thus, can give rise to unemployment.

We first analyze the case where fair-minded workers insist on an equal distribution of surplus among all members of a firm. It is shown that under these preferences, it can be beneficial for firms to build up long-term work relationships and offer strictly positive rents throughout the game. However, in this situation it is always more profitable for firms to ration jobs and employ only one worker. We then analyze the case where a fair-minded worker requires an equal share of the surplus generated by himself. It is shown that—under this weaker fairness benchmark—firms always prefer to employ the maximum number of workers.

6.1 Strictly egalitarian fairness preferences

We assume that a fraction $0 \leq p \leq 1$ of workers has "strictly egalitarian" fairness preferences. Workers' types are private information. A worker with such preferences is assumed to fulfill the contract offered to him as long as the offered wage and desired level of effort are such that the worker receives at least an equal share of the total (net) surplus generated if all workers employed by the firm receive the same contract offer and fulfill their contract. If the contract terms yield lower material payoffs to the worker, the worker will accept the contract offer and shirk by providing the minimum possible effort.[10] The utility function of a worker with such preferences can be summarized as follows:

$$u(w,e,\hat{e}) = \begin{cases} w - c(e) & \text{if} \quad w - c(\hat{e}) < \frac{1}{n+1} n[q(n)\hat{e} - c(\hat{e})] \\ w - c(e) - b\max[\hat{e} - e; 0] & \text{if} \quad w - c(\hat{e}) \geq \frac{1}{n+1} n[q(n)\hat{e} - c(\hat{e})] \end{cases}$$

n denotes the number of workers employed by the worker's firm, $q(n)$ is the productivity of effort of a worker employed in a n-worker firm, $\hat{e}$ and e are the contractually

[10] Since rejecting a contract offer yields a material payoff of zero and since the cost of providing the minimum effort is also zero, we can assume without loss of generality that all contract offers where $w > 0$ are accepted.

desired and actually exerted levels of effort, $c(\hat{e})$ and $c(e)$ are the effort cost of the desired and exerted level of effort, and w is the wage stipulated in the contract. The assumption regarding the fairness parameter b are as follows:

$$b > max\{c'(e)\}$$

This implies that a fair-minded worker maximizes utility by fulfilling the contract (i.e., choosing $e = \hat{e}$) as long as he gets (at least) an equal share of the net surplus that is created if all n workers of the firm fulfill their contract. In case the contract offers him less than a fraction $\frac{1}{n+1}$ of net surplus, the worker will always choose the minimum possible level of effort.

In what follows, we will show that for these fairness preferences there can be no equilibrium where (i) all firms employ two workers and (ii) efforts exceed the minimum possible level. To do so, we first analyze under which conditions two-worker firms would be willing to pay strictly positive rents to workers in the final period of the game. Next we calculate firms' and workers' payoffs in pre-final periods, analyzing the requirements to sustain cooperation in these periods. We then analyze the case of one-worker firms. Finally, we show that for any fraction of p, firms are better off if they employ only one worker.

6.1.1 Two-worker firms

Final period

Firms are assumed to maximize (expected) monetary profits. In the final period, T, a firm has to decide between offering payoff-equalizing contracts to workers (and receiving above-minimal effort only from the fraction of fair workers) and the outside option of offering an uncooperative contract where both types of workers shirk.
Since unemployment benefits for workers are equal to 0, workers will accept any contract that offers them at least a wage of 1. Therefore, the outside option of a firm is to offer a wage of 1 and desire work effort of 1. This outside option ensures the following last period profits Π_T^O for firms:

$$\Pi_T^O(w, \hat{e}) = \Pi_T^O(1, 1) = nq(n) * 1 - n1$$

It is easy to see that—with the parameters specified in section 2.3—firms who offer the uncooperative contract $[1, 1]$ are always better of if they employ $n = 2$ workers. Since $q(2) = 7$, a firm hiring two workers at $[w, \hat{e}] = [1, 1]$ earns $\Pi_T^O = 12$ whereas a one-worker firm earns only $\Pi_T^O = 9$ (since $q(1) = 10$).

Can a firm do better than this in period T by hiring two workers at a fair, i.e., payoff-equalizing wage? Since all fair workers fulfill such a contract in T and all selfish workers shirk, the expected profits of a firm employing two workers at payoff equalizing terms $[w, \hat{e}]$ look as follows:

$$\Pi_T(w,\hat{e}) = p^2 2[q(2)e(w)-w]+(1-p)^2 2(q(2)*1-w)+p(1-p)2[q(2)e(w)+q(2)*1-2w]$$

The first term specifies the firm's profit if the firm happens to employ two fair-minded workers (which occurs with probability p^2), the second term specifies the profits in case both workers are selfish (occurring with probability $(1-p)^2$), and the final term summarizes the cases where one worker is fair-minded and fulfills the contract and one worker is selfish (which occurs with probability $p(1-p)2$).

To make offering a strictly positive rent profitable for firms, it is necessary that $\Pi_T(w,\hat{e}) > \Pi_T^O = 12$. From this, we can derive a threshold value p^* for the fraction of fair workers above which it is profitable for firms to offer payoff equalizing contracts in period T. Under our assumptions regarding the production function, effort cost, and workers' utility, this threshold value is $p^* \approx 0.82$. If $p < p^*$ no firm will offer other contract terms than $[w, \hat{e}] = [1, 1]$ in period T. If $p \geq p^*$, two-worker firms will offer the "fair" contract $[w, \hat{e}] = [53, 10]$. Any intermediate wage-effort combination will never be offered by a two-worker firm in period T, i.e., it is not optimal to desire $1 < \hat{e} < 10$ in period T at a payoff-equalizing wage.

Pre-final periods

Analyzing optimal contracts in pre-final periods is relatively straightforward. A fair worker will cooperate in any period t as long as the contract offered is at least sharing surplus equally. A selfish worker will cooperate and fulfill a contract in pre-final periods if expected *future* rents give him higher payoffs than the immediate gains from shirking. If $p > p^*$, firms will offer the fully cooperative contract $[w, \hat{e}] = [53, 10]$ in period T. If a firm re-employs its workers in period $t+1$ as long as they fulfill the stipulated contract in period t and dismisses all workers who do not do so, a selfish worker in period $T-1$ has to decide between shirking in period $T-1$ and being unemployed in period T vs. adhering to the contract in $T-1$ and being re-employed in period T. The first option yields a payoff of $\pi_{T-1}+\pi_T = w_{T-1}-c(1)+0$, the latter option yields $\pi_{T-1} + \pi_T = w_{T-1} - c(\hat{e}_{T-1}) + 53$ since a re-employed selfish worker receives $w_T = 53$ in period T and shirks (i.e., $e_T = 1$). As $c(\hat{e}_{T-1}) < 53$, selfish workers who are offered $[w, \hat{e}] = [53, 10]$ in period $T-1$ will fulfill their contract.

Therefore it is optimal for two-worker firms to offer $[w, \hat{e}] = [53, 10]$ in all pre-final periods $t < T$ if $p > p^*$. Under this contract, both types of workers fulfill their contracts in $t < T$ and earn $\pi_t = 53 - c(10) = 35$ and firms earn $\Pi_t = 2 * q(2) * 10 - 2 * 53 = 34$. In the final period, fair workers fulfill and earn $\pi_T = 35$, selfish workers shirk and earn $\pi_T = 53$, and firms earn $\Pi_T = p^2 * (34) + (1-p)^2 * (-84) + p(1-p) * 2 * (-27) > \Pi_T^O$.

6.1.2 One-worker Firms

Final period

Can it be profitable for a firm to employ only one worker in period T and offer him a strictly positive rent? To analyze this question, remember that a firm's outside option is hiring two workers at the minimum possible wage of 1. If a firm instead hires one worker at a payoff equalizing wage level, its expected final-period profits are given by

$$\Pi_T(w, \hat{e}) = p[q(1)e(w) - w] + (1 - p)[q(1) * 1 - w]$$

We can again calculate a threshold share of fair workers, p^{**}, above which it is profitable for a firm to offer a fair, cooperative contract to one worker in the final period. Evaluating Π_T and Π_T^O for our parameter constellation yields the threshold $p^{**} \approx 0.68$. Above p^{**}, a firm employing one worker and offering the payoff-sharing contract $[w, \hat{e}] = [59, 10]$ receives higher expected profits than Π_T^O. Again, it is not profitable for firms to offer fair contracts at intermediate desired effort levels $1 < \hat{e} < 10$.

Pre-final periods

Turning to pre-final periods and applying the results for two-worker firms, cooperation by selfish and fair-minded workers can be sustained in every period $t < T$ if $p > p^{**}$. If this is the case, a firm can offer the fully cooperative rent-sharing contract $[w, \hat{e}] = [59, 10]$ to one worker in every period and apply a strategy of contingent contract renewal, i.e., re-employing its worker if he adhered to the contract in the period before and dismissing the worker if $e \neq \hat{e}$ in the previous period. Fair workers adhere to this contract in every period since it offers them a fair share of the surplus. Selfish workers imitate fair workers in all pre-final periods since the prospect of being re-employed and earning future rents gives them an incentive to do so in all but the final period. In the final period, selfish workers provide minimum effort and earn $\pi_T = w = 59$.

6.1.3 Comparing one-worker firms and two-worker firms

Comparing the results for the one-worker and two-worker case, it is immediately obvious that there can be no Bayesian Nash Equilibrium with above-minimal cooperation and full employment (i.e., all firms employ two workers). The threshold share of fair workers necessary for inducing cooperation in the final period (and consequently in all pre-final periods) is higher for the two-worker firm than for a one-worker firm, i.e., $p^* > p^{**}$. If the actual level of fair minded workers is between the two thresholds, cooperation can only be achieved if just one worker is employed by the firm.

Moreover, even if there are sufficiently many fair-minded workers to make cooperation in two-worker firms feasible (i.e., if $p \geq p^*$), firms are better of if they employ only one worker. The fair contract which induces maximum effort in the two-worker firm is $[w, \hat{e}] = [53, 10]$. This contract yields firm profits of $\Pi_t = 34$ in all periods $t < T$ and $\Pi_T(n = 2) \geq \Pi_T^O$ in T. By contrast, the fair and fully efficient contract in a one-worker firm is $[w, \hat{e}] = [59, 10]$. This contract generates strictly higher firm profits in every period: $\Pi_t = 41$ in $t < T$ and $\Pi_T(n = 1) \geq \Pi_T(n = 2)$ for all values of p.

There are several reasons for why cooperation is harder to achieve in two-worker firms. First, two-worker firms face a higher probability of meeting *at least one* selfish worker who definitely shirks in final period: $1 - p^2 > 1 - p$. Moreover, surplus to be distributed is not twice as high as in one-worker firms due to decreasing returns to scale ($q'(n) < 0$). Both effects increase the threshold level of fair-minded workers necessary to induce cooperation in the final period for two-worker firms. The latter effect in addition decreases profits of two-worker firms in every period compared to the profits of a one-worker firm. For our assumptions on the production function, receiving 33% of the higher total (net) surplus generated in a two-worker firm is less profitable than receiving 50% of the (smaller) surplus produced in a one-worker firm.

6.2 Relation-specific egalitarian fairness preferences

How do outcomes change if workers' fairness preferences are not characterized by the strict egalitarianism stipulated above? In what follows, we stick to the assumption that a fraction p of workers is fair-minded. However, we now assume that a fair-minded worker considers a contract offer fair if it splits the surplus *generated by himself* equally between him and the firm. The fair-minded worker's utility function is therefore given by:

$$u(w, e, \hat{e}) = \begin{cases} w - c(e) & \text{if} \quad w - c(\hat{e}) < q(n)\hat{e} - c(\hat{e}) \\ w - c(e) - b\max[\hat{e} - e; 0] & \text{if} \quad w - c(\hat{e}) \geq q(n)\hat{e} - c(\hat{e}) \end{cases}$$

If the firm employs only one worker, this notion of fairness is equivalent to the one assumed above. However, firms employing two workers can now extract up to 50% of the net surplus generated by workers' efforts, compared to only 33% in the strictly egalitarian case. If other words, a fair-minded worker neglects his firm's payoff from relations with other workers, and considers only the distribution of payoffs in his own work relationship.

As a consequence, the threshold fraction of fair-minded workers necessary to give two-worker firms an incentive to offer positive rents in the final period of the game decreases. Following the steps of the calculation above, it now pays off for firms to employ two workers in the final period and offer them fair contract terms as soon as $p > p^{***} \approx 0.68$. At this critical value, a two-worker firm's best strategy in the final period is to offer the fair contract $[w, \hat{e}] = [34, 8]$. In pre-final periods, the optimal strategy for a two-worker firm is to offer the fully cooperative contract $[w, \hat{e}] = [44, 10]$.

Since the "relation-specific" fairness benchmark implies that fair-minded workers in one-worker firms still require 50% of net surplus, the critical value for profitably employing one worker and the optimal contracts for one-worker firms remain unchanged from the previous analysis. Importantly, this implies that under the weaker fairness benchmark it is *always* better for firms to employ *two* workers for our experimental parameters. If $p < p^{***}$, both types of firms can only implement minimal effort in all periods. Since the second worker is productive, a firm prefers employing two workers at the same effort level for the minimal wage $w = 1$. If $p > p^{***}$, a firm employing one worker receives 50% of $q(1) * e - c(e)$, whereas a firm employing two workers receives 50% of $2 * [q(2) * e - c(e)]$. In every pre-final period, the maximum effort $e = 10$ will be provided in both types of firms. This means that a two-worker firm's payoff is equal to 50% of the first-best surplus, whereas a one-worker firms payoff is equal to the same share of the lower surplus that can be achieved with one worker. Similarly, in the final period of the game, payoffs for a two-worker firm are strictly higher than the one for a one-worker firm for every level of $p > p^{***}$.

7 Instructions of the Experiment (IC Treatment)

In what follows, we present a translation of the instructions for buyers (i.e., employers) in the IC treatment. The instructions for workers in this treatment had a similar structure. The instructions of participants in the C treatment differed only in the description of the second stage (i.e., the work phase).

Instructions for Buyers

You are now taking part in an economic experiment. Please read the following instructions carefully. Everything that you need to know to participate in this experiment is explained below. Should you have any difficulties in understanding these instructions please raise your hand. We will answer your questions at your cubicle.

At the beginning of the experiment you will receive an initial endowment of **8 Euros**. Over the course of the experiment you can increase your income by earning **points**. The amount of points that you earn during the experiment depends on your decisions and the decisions of other participants.

All points that you earn over the course of the experiment will be exchanged into Euros at the end of the experiment. The exchange rate will be:

1 Point = 4 Cents

At the end of the experiment, the amount of money that you earned during the experiment as well as your 8 Euros initial endowment will be paid out in cash.

The experiment is divided into several periods. In each period you have to make decisions which you will enter in a computer. In total, there will be 18 periods.

Please note that communication between participants is strictly prohibited during the experiment. In addition we would like to point out that you may only use the computer functions which are required for the experiment. Violation of these rules will lead to exclusion from the experiment. In case you have any questions we shall be glad to assist you.

Prior to the experiment the 24 participants were divided into 2 groups: buyers and sellers. In this experiment there are 7 buyers and 17 sellers.

You will be a buyer for the entire duration of the experiment. All participants have received an identification number which they will keep for the entire experiment. Your identification number is stated on the documentation sheet in front of you.

Short Overview of the Experimental Procedures

In each period of the experiment every buyer can trade a product with no, one or two sellers. The seller earns a profit through the trade when he sells the product at a price which exceeds his production costs. The buyer earns a profit through the trade when the price he pays for the product is less than what the product is worth to him. The production costs of the traded product as well as the buyer's valuation of the product depends on the quality of the product. In addition the value of the product for the buyer depends on the number of products bought. Two products of a certain quality are worth more to the buyer, but not worth twice as much as one product of the same quality.

The experiment lasts 18 periods. In each period the procedures are as follows:

Each period commences with a **trading phase** which lasts 200 seconds. During this phase buyers can submit trade offers which can be accepted by sellers. When submitting an offer a buyer has to specify three things:

- Which price he offers to pay
- which product quality he desires
- and finally, which sellers he wants to submit the offer to. Buyers can submit two types of offers: private offers and public offers. **Private offers are submitted to one specific seller** and can only be accepted by that seller. **Public offers are submitted to all sellers** and can be accepted by any seller.

As a buyer you can submit as many offers as you like in each period. Once submitted, offers can be accepted constantly. **Each seller can only enter one trade agreement in each period. Each buyer can at most enter two trade agreements.** As there are 7 buyers and 17 sellers, some sellers will not trade in each period.

After the trading phase, every sellers who accepted a trade agreement has to determine which quality of product he will provide to his buyer. **Hereby, the seller is not obliged to provide the product quality desired by the buyer.**

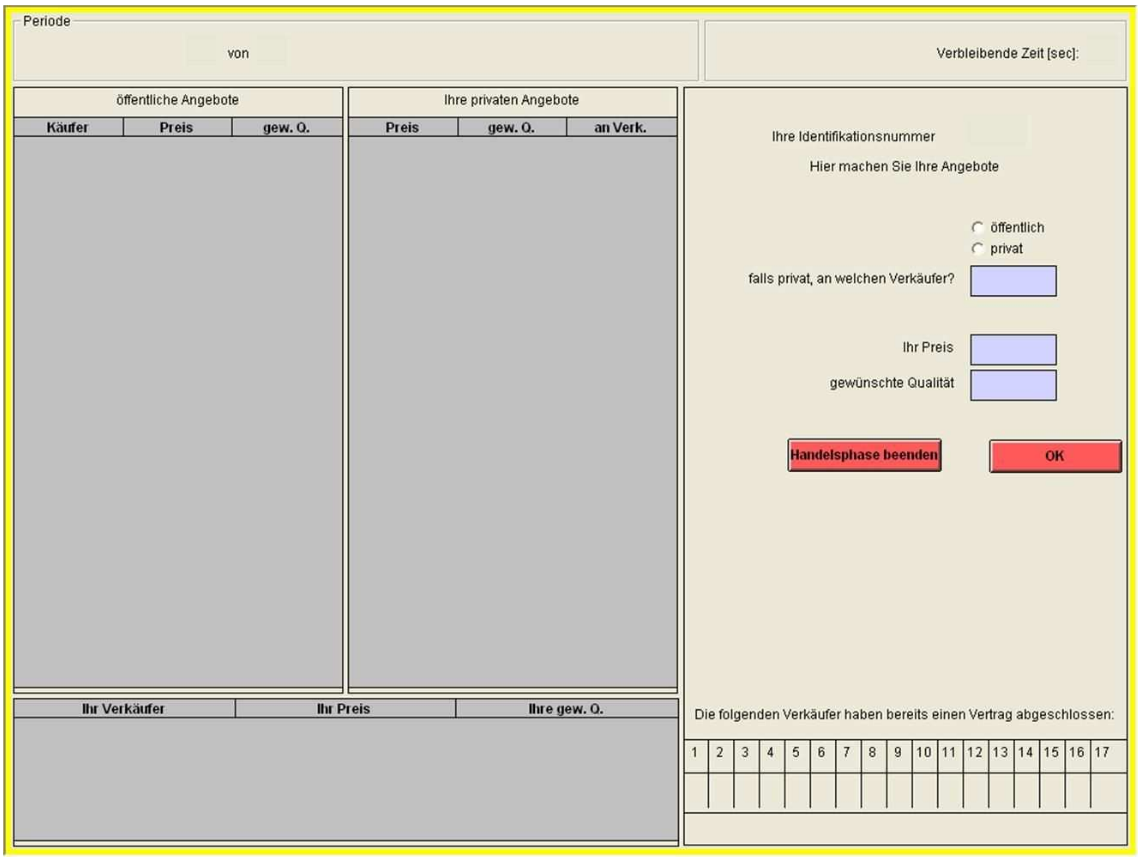
Once every seller has chosen which product quality to provide, earnings of all participants for the given period are determined. Subsequently, the next period commences. The earnings from all 18 periods will be summed up at the end of the experiment, exchanged into Euros and paid out in cash together with your initial endowment.

The Experimental Procedures in Detail

There are 7 buyers and 17 sellers in the experiment. You are a **buyer** for the entire duration of the experiment. During the experiment you will enter your decisions in a computer. In the following we describe in detail how you can make your decisions in each period.

1. The Trading Phase

Each period commences with a trading phase. During the trading phase the buyers can enter into trading agreements with the sellers. In order to do so, **each buyer can submit as many trade offers as he wishes.** In each trading phase you will see the following screen.



In the top left corner of the screen you will see the current period of the experiment. In the top right corner of the screen you will see the time remaining in this trading phase, displayed in seconds. **The trading phase in each period lasts 200 seconds.** When this time is up the trading phase is over. Hereafter, no further offers can be submitted or accepted for this period.

Once you see the above screen displayed the trading phase commences. As a buyer you now have the opportunity to submit trade offers to the sellers. In order to do so you have to enter three things on the right hand side of the screen:

(A) First, you have to specify whether you want to submit a public or private offer:

Public trade offers

Public offers will be communicated to all participants in the market. All sellers see all public offers on their screens. A public offer can therefore be accepted by **any seller**. As a buyer you will also see all public offers submitted by all buyers. If you want to submit a public offer, please mark the field "public" using the mouse.

Private trade offers

Private offers are submitted to **one seller** only. Only this seller will be informed about this offer and only this seller can accept the trade offer. No other seller or buyer will be informed about that offer. If you want to submit a private offer, please mark the field "private" using the mouse. In the field below, you then have to specify **which seller you want to submit the offer to.** Each of the 17 sellers has an identification number (Seller1, Seller2, ..., Seller17). Each seller keeps his identification number for the entire duration of the experiment. To submit an offer to a specific seller you enter the number of that seller (e.g. "4" for Seller4).

(B) Once you have specified who you want to submit an offer to, you must determine **which price you offer.** You enter the offered price into the field "your price". The price you offer must not be below 0 or above 100:

$$0 \leq \textbf{Price offered} \leq 100$$

(C) Finally, you have to specify which product quality you desire. You enter this in the field "desired quality". **Your desired quality** cannot be lower than 1 or higher than 10.

$$1 \leq \textbf{Desired quality} \leq 10$$

After you have completely specified your trade offer, you have to click the "ok" button to submit it. As long as you have not clicked "ok" you can still change your trade offer. After you click "ok" the offer will be displayed to all sellers you have submitted it to.

On the left side of your screen you see the heading "public offers". All public offers in the current trading phase will be displayed here—your public offers as well as the public of all other buyers. You can see which buyer submitted the offer, which price he offered and which quality he desired. All buyers also have an identification number which they keep throughout the experiment (Buyer1, Buyer2, ..., Buyer7).

In the middle of your screen, under the header "your private offers" you will see all private offers which you have submitted in the current trading phase. Here you can see which seller you submitted an offer to, which price you offered and which quality you desired.

As long as none of your offers has been accepted by a seller, you as a buyer can submit as many private and public offers as you wish in each

period. Each offer that you submit can be accepted at any time during the trading phase.

As soon as one of your offers has been accepted you are informed which seller accepted which of your offers. In the bottom left corner of your screen the identification number of the seller who accepted the offer will be displayed as well as your offered price and desired quality. At the same time all your other offers will be automatically canceled.

You can then decide if you want to enter another trade agreement. **Each buyer can enter no, one or two trade agreements in each period.** If you want to enter another trade agreement you can submit further offers to the sellers. As long as none of your offers has been accepted by a seller you can offer as many private and public offers for the second trade as you wish.

If you do not want to enter another trade agreement you can press the button "finish trading phase". This reduces the length of the trading phase if other buyer wants to submit further offers. By pressing the button, the offers you have already submitted will be automatically canceled and you can not submit any further offers. Trade agreements which were already accepted by a seller of course persist. In addition you will continue to see the screen of the trading phase until it is definitely over.

No seller can enter more than one trade agreement in each period. You will be constantly informed which sellers have not yet entered a trade agreement. In the table with the title "The following sellers have already entered a trading agreement" you can see 17 fields. Once a seller has accepted an offer a "+" will appear in the field next to his identification number. You cannot submit private offers to a seller who has already accepted an offer.

The trading phase is over after 200 seconds have elapsed, or once all buyers have entered two trade agreements, or if the remaining buyers have signalized that they do not want to enter trade agreements anymore by pressing the button "finish trading phase".

No buyer is obliged to submit trade offers, and no seller is obliged to accept a trade offer.

2. Determination of actual product quality

Following the trading phase, all sellers who have entered a trade agreement determine which product quality they will supply to their respective buyer. First, the sellers see again the price and the desired quality on a new screen. If you have entered two trade agreements in one period your sellers can also see the price and the desired quality of your other seller. The sellers then decide independently which actual product quality to choose for their product. **The product quality which**

you desired in your trade offer is not binding for your seller(s). Your seller can choose exactly the quality you desired, but he can also choose a higher or lower product quality. The product quality which your seller chooses has to be an integer between 1 and 10:

$$1 \leq \textbf{Actual product quality} \leq 10$$

While the sellers determine the actual product quality, we ask you on a separate screen to specify which quality(ies) you expect him (them) to supply. In addition we ask you to state how sure you are about this expectation.

How are incomes calculated?

Your income:
If you **do not enter a trade agreement** during a trading phase you earn an income of **0 points** in this period.
If you have entered **one** trade agreement, your income depends on which price you offered and which product quality your seller supplied to you. Your income will equal 10 times the actual product quality minus the price you pay. Your income will thus be determined as follows:

Your income = 10*Actual product quality - Price

If you have entered **two** trade agreements, your income depends on which prices you offered to both sellers and which product qualities were supplied to you by the sellers. The value of the products **in total** can be higher for you if you enter two trade agreements but the value of **a single** product is lower.
In other words, two products of a certain quality are worth more to you, but not worth twice as much as one product with the same quality. If you buy **one** product you earn 10 times the chosen product quality. If you buy **two** products you earn 7 times the quality of the first product and 7 times the quality of the other product. Of course, when you buy two products you also have to pay two prices. Your income if you enter two trade agreements thus is determined as follows:

Your income = 7*Actual product quality product 1 + 7*Actual product quality product 2 - Price 1 - Price 2

An example: If you enter **one** trade agreement and the actual product quality is 8, your income is 80 minus the price. If you enter **two** trade agreements and both actual product qualities are 8 your income is 112 (=7*8+7*8) minus both prices.

However, if—for instance—one actual product quality is 8 and the other quality is 1, your income is 63 (= 7*8 + 7*1) minus both prices.

As you can see from the above formula your income is higher, the higher the product quality actually supplied to you by the seller(s). At the same time your income is higher, the lower the price(s) you have to pay for the product(s).

Income of your seller:
If a seller has not entered a trade agreement during a trading phase he earns an income of 0 points in this period.
If a seller has accepted a trade offer his income will equal the price he receives minus the production costs he incurs for the product supplied. The income of your seller is determined as follows:

Income of your seller = Price - production cost

The production costs of a seller are higher, the higher the quality of the product he chooses. The production costs for each product quality are displayed in the table below:

Quality	1	2	3	4	5	6	7	8	9	10
Production costs	0	1	2	4	6	8	10	12	15	18

The income of your seller is higher, the higher the price which he is paid. Further, his income is higher, the lower the product quality he supplies to you.

The incomes of all buyers and sellers are determined in the same way. **Each buyer can therefore calculate the income of his seller(s) and each seller can calculate the income of his buyer.** Further, each buyer and seller is informed of the identification number of his trading partner in a given period.

Please note that buyers and sellers can incur losses in each period. These losses have to be paid from your initial endowment of money or from earnings in other periods.

You will be informed about your income and the income of your seller on a separate **"income screen"**. On the screen the following information will be displayed:

- Which seller(s) you traded with
- Which price(s) you paid
- Your desired quality(ies)
- The actual product quality(ies) supplied by your seller(s)

- The income of your seller(s) in this period
- Your income in this period.

Please enter all the information into the documentation sheet supplied to you. After the income screen has been displayed, the respective period is concluded. Thereafter the trading phase of the following period commences. Once you have finished studying the income screen pleas click on the "OK" button.

The sellers also view an income screen which displays the above information. They see the ID of their buyer, the price, desired and actual product quality as well as their own income, your income and—if you have entered two trade agreements—the income of your other seller.

The experiment will not commence until all participants are completely familiar with all procedures. In order to make sure that this is the case we kindly ask you to solve the exercises below.

In addition we will conduct a **trial of the trading phase**, so that you can get accustomed to the computer. This trial phase will not be added to the result of the experiment and therefore not remunerated. Following the trial phase we will begin the experiment which will last for 18 periods.