Competition and Relational Contracts

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Abstract: This paper examines how long-term relations between principals and agents overcome moral hazard under different competitive conditions. We implement an experimental market in which the effort of agents is not contractible and where there is an excess demand for agents. We show that implicit agreements can enforce substantial effort of agents even when these are not inherently "disciplined" by market conditions. Comparing our results to those in Brown et. al. (2004) we find, indeed, that higher competition for agents does not reduce the potential of relational contracts to enforce high effort at all. Aggregate market performance is identical in a market with an excess demand for agents or an excess supply of agents. Moreover, we find that the emergence of relational contracts across market conditions leads to strong rigidities in the distribution of surplus.

Our results provide important insights to the functioning of credit- and labor markets. With respect to the credit market our results indicate that reputational concerns can enforce good behavior of borrowers even when these have access to several lenders. This suggests that financial liberalization must not jeopardize lending in credit markets where contract enforcement is costly. With respect to the labor market our results suggest that unemployment is a sufficient but not a necessary disciplining device when labor contracts are costly to enforce. Our findings also suggest that implicit contract enforcement may be a major source of wage rigidities across business cycles.

EFM classification code: 110

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1 Introduction

When explicit contracts are costly to design and enforce principals and agents may choose to rely on implicit, or relational contracts (Williamson 1975; MacLeod, 2000). Relational contracts specify mutual obligations not in an explicit form but in implicit, non-verifiable agreements between trading partners (Baker et. al., 2002). Such implicit agreements are self-enforcing if the future value of the relationship is high for both parties (Bull, 1987).

Recent experimental evidence shows that markets will be pervaded by implicit agreements when explicit contracts are not enforceable. Brown et. al. (2004) find that firms seek long-term relations with individual workers when labor contracts are not enforceable. They show that firms practice a performance contingent employment and wage policy which elicits high effort from workers. Fehr and Zehnder (2004) show that in credit markets where the project choice of debtors is not contractible, relationships between particular borrowers and lenders emerge. Reputational incentives in these relationships motivate borrowers to choose efficient projects and to repay loans. This experimental evidence supports findings from field data that principals and agents do pursue long-term relations in credit markets (Petersen and Rajan, 1994; Elsas and Krahnen, 1998), service markets (Banerjee and Duflo, 2000) and the labor market (Hall, 1982; Auer and Cazes, 2000).

The potential for self-enforcing relational contracts may, however, depend on market conditions. Market conditions affect the outside options of agents and whether a relation with a particular principal can motivate them to perform well (Kranton, 1996, Hörner, 2002). Consider for example a credit market in which there is only one bank which borrowers can turn to. In this market a borrower will fear defaulting on a loan as this could jeopardize his future access to credit. If, however, there are many alternative suppliers of credit a borrower is not as dependent on a relationship with a particular bank and therefore may be more tempted to default on his current lender. Similarly, in a labor market the temptation of a worker to shirk may be higher when high labor demand permits him to switch jobs with ease.

In this paper we compare the emergence and effectiveness of relational contracts across market conditions. We examine an experimental market in which contracts are not third party enforceable and there is an excess demand for agents. We then compare the outcome of this market to the outcome of our recent experiment (Brown et. al., 2004) in which we implemented an excess supply of agents. The comparison of market outcome across market conditions allow us to systematically test the impact of increased competition on the enforcement power of relational contracts.

Models of the labor market suggests that relational contracts can sustain high effort of agents independent of market conditions. MacLeod and Mal-

colmson (1998) show that implicit agreements between firms and employees can be sustained in a market with unemployment or full employment. They show that merely the nature of implicit agreements changes with market conditions: As proposed by Shapiro and Stiglitz (1984) simple rents, i.e. "efficiency wages" can motivate workers who are threatened by unemployment. In contrast, under full employment firms must offer relation-specific quasi-rents to workers in order to motivate high performance. MacLeod and Malcolmson (1998) show that post-effort bonus payments can generate such quasi-rents within a relation. Indeed, any remuneration package which offers deferred payments, such as "seniority wages" (Lazear, 1982) or explicit "bonding" (Carmichael, 1984) can sustain an implicit agreement under full employment.

Credit market models also suggest that relational contracts between lenders and borrowers can be sustained under low or high competition between lenders. Boot and Thakor (1994) show that banking-relationships in which a bank offers below market financing to well performing borrowers can motivate high effort from borrowers even if alternative spot-market financing is available. Indeed in a more recent paper the same authors show that "relationship banking" may be even more prevalent when credit market competition is strong as it enables banks to isolate themselves from competition (Boot and Thakor, 2000)[1].

Existing empirical evidence raises doubts whether implicit agreements between principals and agents can be sustained when demand for agents is high. Auer and Cazes (2000) find that average job tenure is longer in occupations where employee performance is more difficult to enforce. However, they also find that tenure behaves counter-cyclically: long-term relations are less common when economic growth leads to high demand for labor. Examining worker-flow data from the US, Bleakley et. al. (1999) show that long-term employment relationships are less likely to survive high labor demand. They find that there are significantly more voluntary quits by workers during expansionary periods of the business cycle than during recessions. Labor market evidence thus suggests that implicit agreements between firms and employees may be more difficult to sustain when labor demand is high.

Evidence from the credit market suggests that relationship-banking may also be threatened by higher competition for credit clients. Petersen and Rajan (1995) find that an increase in the competitiveness of the financial market leads to less bank credit for young and small enterprises in the US. This is confirmed in cross-country data by Cetorelli and Gambera (2001) who find that high bank concentration increases the access to credit in industries

[1] However, Boot and Thakor (2000) do show that credit market competition may reduce the incentives for banks to produce information on clients and thus reduce the value of relationships.

where young firms have strong external funding needs. Examining trade credit in Vietnam McMillan and Woodruff (1999) find that the provision of informal credit between firms is significantly lower when the potential debtor has alternative supply channels and is thus less reliant on a particular supplier.

Thus, although theory predicts that relational contracts can enforce effort independent of market conditions, initial empirical evidence suggests that increased competition for agents endangers such implicit agreements. In the following re-examine this result with an experimental comparison of relationships and performance across market conditions. Our experimental design allows us to establish whether principals and agents try to establish relations and how successful they are in doing so under different market conditions. Our results suggest that relational contracts are equally effective in motivating agents across market conditions. We find that implicit agreements do emerge in a market with an excess demand for agents. Indeed, we find that aggregate market performance under an excess demand for agents is identical to that in a market with an excess supply of agents.

The paper is organized as follows. In part 2 we present our experimental design for a market with non-enforceable contracts and strong competition for agents. In chapter 3 we present our results on the emergence of relational contracts under these market conditions. In part 4 we examine the impact of relational contracts across market conditions by comparing the results of part 3 to findings of Brown et. al. (2004). In part 5 we conclude by discussing the implications of our results with respect to the credit and labor market.

2 An Experimental Market with Moral Hazard and Strong Competition for Agents

In Brown et. al. (2004) we introduced an experimental design which allowed us to examine the emergence of implicit agreements in a competitive market setting. In that paper we analyzed a market with a strong competition between agents for contracts[2]. We now use the identical experimental design to examine the emergence and impact of relational contracts when principals must compete strongly for the services of agents. The experiment lasted 15 trading periods and each trading period had two stages:

- At stage 1 principals made contract offers to workers stipulating a desired effort $\tilde{e}$ and a non-contingent payment p.
- At the second stage the actual performance of the agent e was determined.

[2]In that paper all results were interpreted with respect to the labor market so that agents were called "workers" and principals were called "firms".

The posting and acceptance of contracts was conducted in a continuous auction involving all principals and agents. There were 10 principals and 7 agents in the market. As an agent could only trade with one principal in each period the experiment implemented an excess demand for agents.

2.1 Main Treatment Procedures & Parameters[3]

Our main treatment is called the **Incomplete Contracts (IC) treatment**. In this treatment contracts were not exogenously enforced. Therefore, the agent could choose any feasible effort e irrespective of the contractually proposed level $\tilde{e}$.

Principals were the contract makers, i.e. they could make contract offers to the agents. A principal could make private or public offers. In case of a private offer, the principal indicated the identification (ID) number of the agent with whom he wanted to trade and then only this agent was informed about the offer. In case of a public offer all agents and all other principals were informed about the offer. As a consequence, all agents could accept a public offer. In a given trading period a principal could make as many private and public offers as he wanted. As soon as an agent accepted one of the offers, the principal was matched with this agent and informed about the ID number of the agent. Once an offer was accepted all other outstanding offers of the principal were immediately removed from the market so that they were no longer available. At any time during a trading period principals were informed about which agents were still in the market. This was done to prevent private offers to agents who had already concluded a contract with somebody else.

In the IC treatment principals and agents had the possibility of trading repeatedly with each other. Technically, repeated transactions with the same trading partner were possible because subjects had fixed ID numbers throughout the experiment. Therefore, a principal could make offers to the same agent (ID number) in consecutive periods and, if the agent accepted the offers, a long-term relation was established.

The material payoff of a principal per period was given by:

$$\pi(p,e) = \begin{cases} 10 \cdot e - p & \text{, if a contract was concluded} \\ 0 & \text{, if no contract was concluded} \end{cases}$$

The material payoff of an agent was given by:

$$v(p,e) = \begin{cases} p - c(e) & \text{, if a contract was concluded} \\ 5 & \text{, if no contract was concluded} \end{cases}$$

[3]The procedures, parameters and information conditions are identical to those implemented in Brown et. al. (2004). This is crucial as in section 4 we compare the outcome of theis experiment to that of our former paper.

where $c(e)$ denotes the cost of supplying effort e.

The set of feasible effort levels was given by $e \in [1, 2, .., 10]$ and payments had to be in the set $p \in [0, 100]$. The cost schedule for agents $c(e)$ is displayed in Table 1. It shows that $c(e)$ is strictly increasing and exhibits increasing (but not strictly increasing) marginal costs. Since the marginal cost of effort is at most 3 while the marginal revenue of effort for the principal is always 10, the efficient effort level is given by $e = 10$. The maximum earnings which principals and agents could share from a single trade was therefore $10 \cdot 10 - 18 = 82$ and therefore the maximum gains from trade are $82 - 5 = 77$.

Table 1: Cost of Effort Schedule

effort	1	2	3	4	5	6	7	8	9	10
cost of effort	0	1	2	4	6	8	10	12	15	18

Obviously, the payoff functions $\pi(p, e), v(p, e)$ do not capture the precise payoff structure in an employment situation nor in a credit transaction[4]. Our payoff structure does however implement the key feature of both markets when contract enforcement is costly: Value maximizing effort of agents is not contractible. It is precisely this situation which we are interested in as relational contracts may then implement pareto improvements in a repeated game. In order to reduce the complexity of our experiment we implement the simplest of payoff structures which retains this feature. For this reason we choose a design in which only non-contingent payments between principals and agents are enforceable.

The payoff functions, the number of principals and agents, the cost of effort schedule and the fact that there were 15 trading periods were common knowledge. At the end of each trading period each participant was informed about the contract $(p, \tilde{e})$ he or she had concluded, the performed effort level, e, their own payoff, the payoff of the trading partner and the ID number of the trading partner. The participants then wrote this information on a separate sheet of paper to ensure that each participant was always fully informed about his or her own trading history.

The experimental instructions were framed in a neutral goods market language in order to isolate behavior from preconceptions of participants on how the labor or credit market "should" work. The experiment was conducted using the software "z-tree" (Fischbacher, 1999). Prior to the 15 trading periods, participants in both conditions absolved two practice periods in order to get accustomed to the computer environment. In both

[4]In labor markets firms may (partly) align the incentives of employees with their own through performance contingent remuneration. Similarly, in the credit market collateral requirements may align the incentives of borrowers with those of lenders.

practice periods subjects only went through the first (bidding) stage of the experiment and no money could be earned during these periods.

2.2 Control Treatments & Data

Our experimental design incorporated two control treatments to the IC treatment.

In the **Complete Contracts (C) treatment** the proposed effort $\tilde{e}$ of the principal was exogenously enforced by the experimentator. Thus if an agent accepted a contract $[p, \tilde{e}]$ at stage 1 of a period then at stage 2 the worker had to perform $e = \tilde{e}$. Otherwise all procedures and parameters were identical to those in the IC treatment. In particular all participants had fixed ID numbers so that a principal could establish a relation with a particular agent (and visa versa). This control treatment allows us to establish whether principals and agents try to establish relations in order to overcome contract enforcement problems. Field data can typically not distinguish whether banking or employment relationships are established in order to overcome contracting problems or for pure transactional reasons such as turnover costs (Hutchens, 1989). This also applies to our IC treatment where participants may choose to trade repeatedly with the same partner out of pure convenience. However, if convenience drives relations then we should see a similar exchange pattern in the C treatment. On the other hand, if contracting problems are responsible for the emergence of relations we would observe significantly more relations in the IC than in the C treatment.

Our second control treatment is called the **Incomplete Contracts, Random ID (ICR) treatment**. In this treatment effort was not enforceable as in the IC treatment. In addition, information conditions prevented principals and agents from establishing relations. This was done by randomly assigning ID numbers to participants in each period. Participants could therefore not identify who they had traded with in the past and thus they could not maintain relationships. A comparison between the ICR and IC treatment allows us to establish the efficiency implications of relational contracts. Due to information conditions each period of the ICR treatment can be characterized as a one-shot situation. Comparing actual effort in the IC treatment to that in the ICR thus allows us to establish whether the potential for repeated transaction significantly increases market performance above the one-shot level.

We conducted five sessions of each treatment and thus a total of 15 sessions. Subjects were students from the University of Zurich and the Swiss Federal Institute of Technology in Zurich. No subject participated in more than one session so that in total 255 subjects (17 in each session) participated in the experiment. On average a session lasted 120 minutes and each subject earned roughly €40.

2.3 Predictions

All three treatments constitute repeated games of finite length. With common knowledge of rationality and selfishness our IC and ICR treatments would therefore lead to very inefficient outcomes. If agents are selfish, principals will anticipate that all agents will perform the minimal effort level $e = 1$ in period 15 no matter what the history of the experiment. Competing for agents, principals will bid each other up to the highest payment which gives them a non-negative profit anticipating that $e = 1$. Principals will therefore offer a contract $[p, \tilde{e}] = [10, 1]$ in period 15. By backward induction principals will offer the same contract in period 1 through 14 and agents will always perform the minimal effort.

These predictions are in strong contrast to the C treatment where contracts are enforceable and thus (value maximizing) full performance can be implemented. With common knowledge of rationality and selfishness principals in the C treatment will offer the contract which is most preferred by selfish agents. As the maximum effort $e = 10$ leads to the highest surplus, principals would offer contracts which demand the maximum effort and a payment so that agents reap the entire gains from trade. Thus with common knowledge of selfishness and rationality the equilibrium contract in each period of the C treatment is $[p, \tilde{e}] = [100, 10]$.

The assumption of common knowledge of selfishness and rationality is questionable in our experiment, as it is in the labor or credit market. Experimental studies find that fairness concerns motivate the behavior of some subjects in a wide range of economic settings (see e.g. Camerer, 2003). This is confirmed by interview studies with human resource managers which suggest that the performance of workers is strongly affected by the fairness of their remuneration (Bewley, 1995; Blinder and Choi, 1990). Recent work by Guiso et. al. (2004) suggests that repayment behavior (and with it household lending) are also strongly affected by social capital and trust.

If principals in our experiment believe that some agents are "fair" or are simply always honor a contract then non-minimal effort can even be sustained in the one-shot transactions of the ICR treatment. In the appendix we show that if there is a sufficient share of "fair" agents principals will offer contracts with substantial payments although they know that selfish agents will shirk. The presence of fair agents who reciprocate high payments with high effort compensates for the potential loss from a selfish agent so that principals yield non-negative expected profits.

If some agents are fair our IC treatment becomes a repeated game of incomplete information. In this setting reputational concerns may motivate even selfish agents to perform high effort in non-final periods (Kreps et. al., 1982). However, the market conditions in our IC treatment make it difficult for reputational incentives to emerge. Remember that in all treatments information on prior performance of an agent was private. If an agent shirks

in the IC treatment only his incumbent principal is informed about it, while all other principals are not. Moreover, due to the excess demand for agents, these do not rely on their incumbent principal for future contracts. The excess demand for agents means that these are assured of a contract even if their current principal expels them. Under these market conditions reputational incentives only arise if the agent estimates the value of the current relationship to be higher than that if he or she switches to an alternative principal in the public market. Thus self-enforcing relational contracts require that incumbent principals offer their agents higher payments than these can get in the public market.

Models of the credit market (Boot and Thakor, 1994) and the labor market (MacLeod and Malcolmson, 1989; Lazear, 1982; Carmichael, 1984) show that principals can generate relation-specific quasi-rents to enforce performance of agents who are in high demand. In the appendix we provide a formal analysis of how relation-specific payments can motivate selfish agents to perform high effort in the IC treatment. There we offer a perfect bayesian equilibria in which selfish agents are motivated to perform maximum effort in (almost) all non-final periods. Selfish agents shirk partly in the initial period, generating private information for incumbent principals on the agents type. As in models of relationship banking this relation-specific information makes it credible for the incumbent principal to offer better contract terms to the agent than an "outside" principal could. These extra payments in turn create sufficient reputational incentives for selfish agents to perform [5].

Our predictions suggest that in the IC treatment high effort of selfish (and fair) agents can be sustained by relation-specific payments of incumbent principals. Expecting such relational contracts to emerge we test the following qualitative hypotheses:

H1: In the IC treatment principals offer higher payments in repeated transactions than those available to agents in the public market. These relations-specific payments are strongly contingent on the agents prior performance.

H2: Average performance in the IC treatment is higher than in the ICR treatment as selfish agents in the IC treatment perform non-minimal effort out of reputational concerns.

H3: Average duration of relationship is higher in the IC than in the C treatment as relational contracts are successfully established by principals and agents.

[5] With the random assignment of subjects to experimental roles heterogeneity of principals may, also contribute to the emergence of self enforcing relational contracts in our IC treatment. Suppose for example that some principals are optimistic about the presence of fair agents while others are pessimistic. In this case optimistic principals may offer high payments while pessimistic ones offer low payments. In this case the competition for agents turns into competition for optimistic principals.

3 Relational Contracts under Strong Competition for Agents

In this section we establish whether relational contracts emerge in a market where competition for agents is high. We first consider whether the payment and contract renewal policy of principles provide reputational incentives for agents. We then examine whether these incentives actually motivate agents to perform high effort.

3.1 Contracts and Renewal Policies

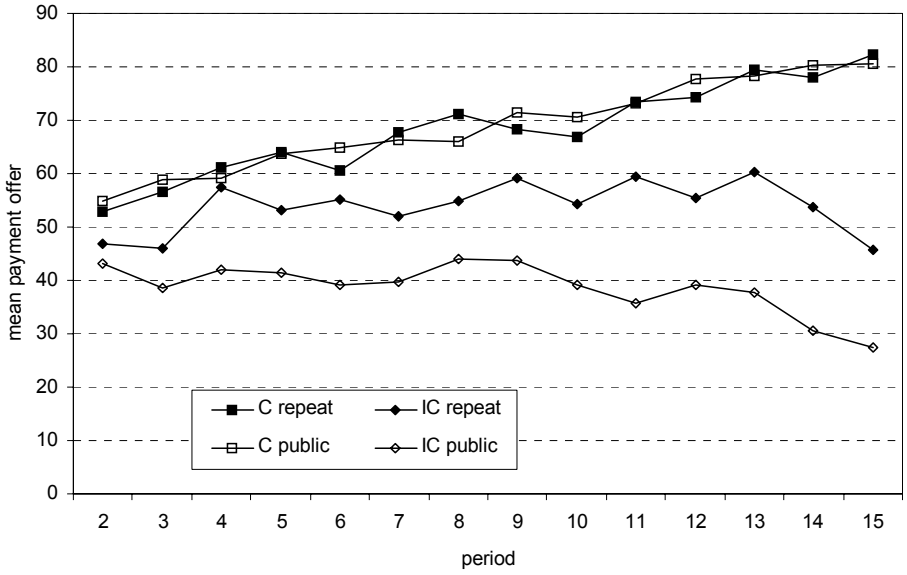
Our predictions suggest that in the IC treatment principals can only create reputational incnetives if they reward well performing agents with higher payments than these can get in the public market. Our data shows that after 63% of all trades in the IC treatment the principal did offer a repeat contract to its agent. Figure 1 shows that payments in these repeat contract offers were substantially higher than those offered on the public market.

As principals typically made several offers in each period[6] we consider the highest public payment offered by each principal as well as the highest "repeat" payment offered by each principal to his prior agent. The figure reports the mean of these highest "public" payments and highest "repeat" payments by period. Figure 1 shows that throughout the IC treatment incumbent principals offered substantially higher repeat payments to agents than these could get in the public market. Public market payments hovered around 40 in the IC treatment while repeat payments rose from under 50 in period 2 to roughly 60 in period 13. The difference between repeat and public payments therefore rises steadily from 3.8 in period 2 to more than 20 from period 11 onwards. Aggregated over all periods the difference between repeat and public payments is 14.6. Our predictions suggest that relation-specific payments must exceed the public market level by the cost of desired effort $c(\tilde{e})$ in order to motivate selfish agents to perform $\tilde{e}$. The large difference between repeat payments and public payments shown in Figure 1 suggests that on average selfish agents would have had the incentives to provide very high effort levels. Remember that the cost of effort $c(e)$ for effort levels $e = 8, 9, 10$ was 12, 15 and 18 respectively.

Our conjecture is that repeat payments are higher in the IC treatment because incumbent principals have superior information on agents and use this information to offer incentive compatible contracts. However, an alternative explanation is that this is simply a selection effect: as agents always accept the highest available payments, those principals who get to trade (and thus by definition get to offer a repeat contract) are those who make

[6] In the IC treatment principals made on average 4.6 offers each per period.

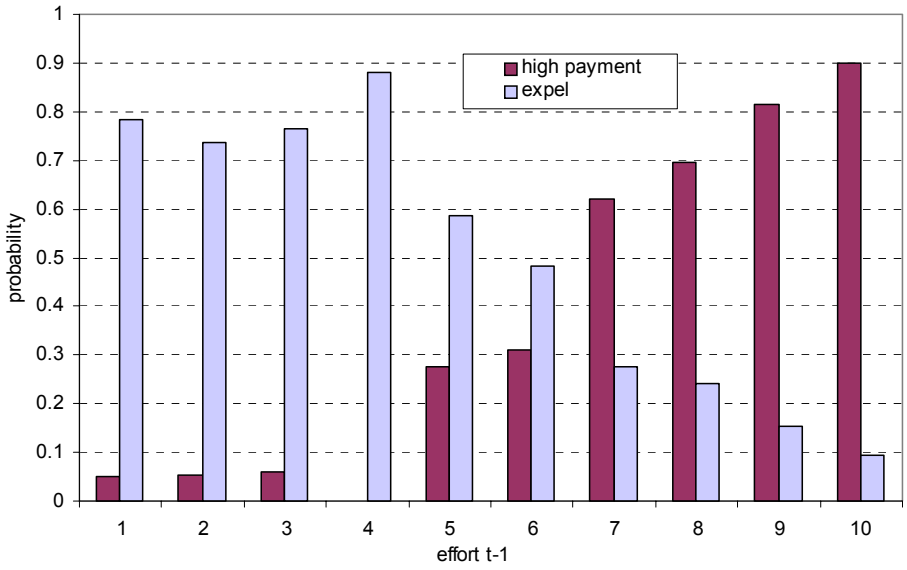
Figure 1: Offered Payments in the IC Treatment



the highest payments. If this selection effect explained higher "repeat" payments we should see an identical pattern in the C treatment where contracts are enforceable. However Figure 1 shows that in the C treatment there was no difference between public and repeat payments at all. Indeed the difference between public and repeat payments in the C treatment is merely 0.1 when averaged over all periods. The figure thus suggests that it is the non-enforceability of contracts which gives rise to relation-specific payments.

Relation-specific payments can only motivate selfish agents in the IC treatment if these payments are contingent on performance. If principals offer high payments only to performers while they expel shirkers then selfish agents will be motivated to provide the desired effort. If, on the other hand, the probability of receiving a high-payment repeat contract does not depend on an agents prior performance, then selfish agents have no incentive to provide a high effort. Figure 2 displays the probability of an agent receiving a repeat contract with a high payment in period t depending on his previous effort e_{t-1}. In accordance with Figure 1 a high payment contract is defined as a contract in which the payment exceeds the mean of the best public payment per principal in that period. The table shows that the probability of receiving such an offer is very much dependent on an agents prior performance. If an agent provided an effort level of $e < 6$ in period $t-1$, then his probability of getting a lucrative repeat contract was below 30%. If, however, the worker performed an effort of $e \geq 7$ this probability rose to above 60%. A worker who performed the maximum effort was virtually

Figure 2: Contract Renewal in the IC



assured of a high-payment repeat contract.

Figure 2 also confirms that principals were very much prepared to expel agents who performed low effort levels. Our experiment did not enable principals to explicitly expel agents. Hence, if a principal no longer wanted to trade with a specific agent then he would simply not offer any private contract to that agent in the following period. Table 2 shows that agents who performed a low effort where much more likely to be expelled than agents who performed a high effort level. We see that after performing an effort level of $e < 6$ less than 50% of agents received any repeat offer. This suggests that principals were willing to terminate a relationship although they were not sure of being able to replace the agent.

Figures 1 and 2 suggest that principals practised a performance contingent policy of offering high payments to agents who performed well, but expelling agents who performed badly. This interpretation is confirmed by the regression analysis reported in Table 2. We conducted a probit analysis in which the probability of a contract renewal is regressed on the agents previous performance. Regression (1) analyses the probability of an agent receiving a high-payment repeat contract, and thus the dependant variable is a dummy variable which takes the value 1 if a principal offered a repeat contract in period t with a payment which exceeded the average public market level. We regress this dummy variable on the effort of the agent in the previous period e_{t-1}, the previous length of the relationship and the period

of the experiment, controlling for session effects with the clustering method. We include the previous length of a relationship as an explanatory variable as principals may be more likely to offer a renewed contract to an agent who they have known for longer, even if he did not perform well in the prior period. We include the period of the experiment as an explanatory variable as principals may be more reluctant to expel an agent later on in the experiment. If principals expect that all "fair" agents are gradually engaged in relationships over the course of the experiment, then they may be more willing to renew the contract with an existing agent, providing he or she does not shirk altogether.

Table 2: Probability of Contract Renewal in the IC[a]

	(1) high-payment	(2) any contract
effort in *t-1*	.134*** (.013)	.080*** (.011)
previous length	.034* (.019)	.052*** (.021)
period	.006 (.007)	.004 (.004)
	N = 484	N = 484
	Wald (3) = 122.95	Wald (3) = 241.85
	Prob = .000	Prob = .000
	Pseudo R^2 = .41	Pseudo R^2 = .29

[a] Maximum likelihood probit regression with robust standard errors adjusted for clustering on sessions (in parentheses). *** indicates significance on the 1-percent level, ** on the 5-percent level and * on the 10-percent level, respectively.

The coefficients reported in Table 2 are maximum likelihood estimators of the marginal effect of each explanatory variable. The significant and positive coefficient of "effort in $t-1$" in regression (1) confirms that principals are more likely to offer a high-payment contract to agents who performed well in the prior period. An increase in effort by one point raises the agents probability of receiving a high-payment repeat contract by 13%. The coefficient on "previous length" is of weak significance in regression (1) while the coefficient on "period" is not significant at all. This suggests that when considering whether to offer a lucrative repeat contract principals only consider the immediate performance of the agent. This is not the case in regression (2) which looks at the probability of an agent receiving any contract renewal at all. There we see that not only the previous effort, but also the previous length of a relationship has a significant impact on whether the agent is expelled or not. The positive coefficient of "previous length" in regression (2) suggests that principals are more reluctant to expel agents the longer they

have traded with them already. However, as we see from regression 1 this does not mean that the agent will automatically be offered a high payment.

3.2 Performance and Relations

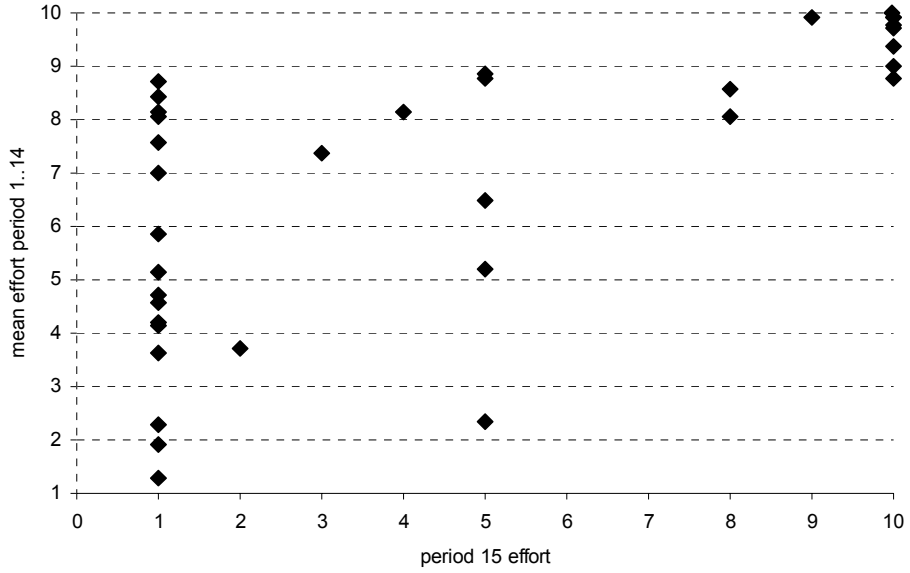
Our results so far show that principals in the IC treatment pursue a performance contingent payment and renewal policy. Our predictions suggest that such a policy could motivate high effort levels even from selfish agents. Figure 3 examines whether this the case by comparing the behavior of individual agents in period 15 to their behavior in prior periods. As the IC treatment constitutes a finitely repeated game we predict that in period 15 agents will behave as they would in a one-shot transaction. In this final period a selfish agent will perform the minimal effort $e = 1$ no matter what the history of the experiment. In previous periods, selfish agents may however provide non-minimal or even maximum effort if the payment and renewal policies of principals provide sufficient reputational incentives. By comparing the behavior of agents in the final period to that in previous periods we can therefore establish whether principals' payment and renewal policies did motivate selfish agents.

Figure 3 plots the effort of each agent in period 15 (horizontal axis) against his average effort in period 1 through 14 (vertical axis). The figure shows that in the final period 16 of the 35 agents (46%) provided the minimal effort $e = 1$, a further 8 agents performed an effort between two and five, and 11 agents (31%) performed an effort of at least $e \geq 8$. Those agents who performed $e = 1$ in period 15 can be characterized as selfish, as all of these agents received contracts with non-minimal payments ($p > 10$) in this period. Interestingly, Figure 3 shows that only two of the 16 agents who shirked in period 15 provide minimal effort levels (average effort less than 2) earlier on in the experiment. In contrast to this 6 of these shirkers (38%) provide an average effort of more than seven and a further 6 of them provide an average effort between four and six in period 1 through 14. Indeed, we find that final period shirkers performed an effort level $e > 1$ in 73% of their prior trades.

Figure 3 suggests that the payment and renewal policies of principals in the IC treatment provided strong reputational incentives for agents to perform. Agents who are not "fair" at all based on their final period behavior seem to perform substantial effort levels in prior periods. However, note that Figure 3 does not take into account potential differences in payments between period 15 and earlier periods. If payments are lower in period 15[7] than in earlier periods then the higher effort of agents in non-final periods could simply be the reaction of fair agents to higher payments.

[7] Figure 1 shows that payments do actually fall in the final periods of the IC treatment

Figure 3: Performance of Agents in the IC



In order to disentangle pure fairness effects from reputation effects of implicit agreements we compare performance levels in the IC treatment to those in the ICR treatment. If the high effort of agents in non-final periods of the IC treatment is pure driven by fair agents behavior, then we should see similar effort patterns in the ICR treatment were reputational effects were not possible. Table 3 compares the frequency of all possible effort levels in the IC and ICR treatment.

The table shows that the maximum effort level is the most frequent effort level in the IC treatment, with agents performing $e = 10$ in over 30% of all trades. Moreover, roughly 60% of all trades in the IC are characterized by an effort level of $e \geq 7$. Remarkably, agents perform the minimal effort level $e = 1$ in only 15% of all trades, although the high demand for their services assures them a future contract even if they shirk. As a result the mean effort level in the IC treatment is 6.7 with session averages of 5.4, 5.7, 6.0, 7.4 and 8.0.

Table 3: Frequency of Effort Levels in the IC and ICR

	Frequency of Effort									
	1	2	3	4	5	6	7	8	9	10
IC	0.15	0.04	0.03	0.04	0.08	0.06	0.07	0.07	0.14	0.31
ICR	0.16	0.06	0.07	0.11	0.21	0.10	0.14	0.03	0.04	0.07

In contrast to this, the maximum effort level $e = 10$ is performed in only 7% of trades in the ICR treatment. Indeed, the most common performance level in the ICR is $e = 1$. The mean effort level in the ICR treatment is 4.9 with session averages of 3.6, 4.6, 4.7, 4.7, and 7.2. A one-sided Mann-Whitney test[8] comparing session averages confirms that performance in the IC treatment is significantly higher than in the ICR ($p = .028$). We can therefore conclude that the high effort levels observed in the IC treatment are partly due to reputational incentives which motivate selfish agents to perform in non-final periods.

Our above results suggest that principals and agents are successful in establishing relational contracts in the IC treatment. We should therefore observe that the pattern of trade in this treatment is dominated by repeated transactions between particular principals and agents. Table 4 displays the share of relations which are renewed in the IC treatment by period. The table shows that the incidence of contract renewal rises from 26% in period 2 to over 45% in period 11. Aggregated over all periods existing relations are continued in 39% of all possible instances in the IC treatment.

More importantly, the table shows that contract renewals are much more frequent in the IC than in the C treatment. In the C treatment the share of contract renewals hovers around 10% over the whole course of the experiment. We argued above that contract renewals in the IC treatment may arise out of pure convenience of principals and agents. However, in this case we should see similar rates of renewals in the IC and C treatments. The fact that there are more contracts renewals in the IC than the C suggests that relational contracts are the cause for most long term relations in the IC treatment. A one-sided Mann-Whitney test on session averages confirms that contract renewals are significantly more frequent in the IC than in the C treatment ($p = .004$).

Table 4: Contract Renewals

	Period													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IC	0.26	0.24	0.29	0.39	0.43	0.37	0.43	0.35	0.43	0.46	0.43	0.43	0.40	0.37
C	0.12	0.11	0.12	0.12	0.09	0.03	0.14	0.06	0.03	0.21	0.06	0.09	0.09	0.14

Result 1 *Relational contracts do emerge in a market where principals must compete strongly for agents. Principals reward well performing agents with payments that exceed the public market rate and this motivates even selfish agents to provide high effort out of reputational concerns. The emergence of relational contracts raises market efficiency and leads to a bilateralisation of trade.*

[8] As we have a directed hypothesis we apply the one-sided test with $m = n = 5$.

4 Market Conditions and the Impact of Relational Contracts

In the previous section we showed that relational contracts can emerge even when market conditions do not assist principals in disciplining agents. However, this does not imply that endogenous contract enforcement is unaffected by market conditions. It may well be the case that relational contracts lead to even high market performance when there is an excess supply of agents.

In this section we compare the emergence and impact of relational contracts to those in a market where agents had to compete strongly for contracts. We address three questions: Are relations more likely to emerge when agents must compete for contracts rather than when there is an excess demand for agents? Are relational contracts more effective in sustaining high effort when market conditions assist in "disciplining" agents? Finally, we also examine the distributional effects of relational contracts. Do relational contracts isolate the distribution of surplus from competitive pressures as suggested by MacLeod and Malcolmson (1998)? We address these questions by comparing market outcome in the IC treatment to that in Brown et. al. (2004) where we implemented an identical experiment with opposite market conditions.

Table 5: Treatments for Comparison across Market Conditions[9]

		Market Conditions	
		10 Principals 7 Agents	10 Agents 7 Principals
Contracts enforceable	no	IC	IC*
	yes	C	C*

The experimental design in this paper and that in our former paper differed only in respect to the number of principals and agents in the market. In the IC treatment described above there were 10 principals and 7 agents in each period. Brown et. al. (2004) implemented the opposite market conditions of 7 principals and 10 agents in each period. Otherwise, all experimental procedures and parameters were completely identical. In

[9] A detailed analysis of the IC* and C* treatments is provided in Brown et. al. (2004), where the are labelled "ICF" and "C" treatments respectively

the following we can therefore compare market outcome under strong competition for agents (IC) to market outcome when agents must compete for contracts. As shown in Table 5 we will henceforth call the respective treatment from Brown et. al. (2004) the IC* treatment. We validate our results through identical comparisons for our control treatment with enforceable contracts (C and C* conditions).

MacLeod and Malcolmson (1998) suggest that relational contracts can be equally effective in sustaining high performance under high or low competition for agents. They also suggest that relational contracts may isolate the distribution of surplus from competitive pressures. Our predictions in section 2 and those yielded in Brown et. al. (2004) provide qualitatively similar predictions for our IC and IC* treatments[10]. In the following we therefore test the following hypotheses:

H4: There is no significant difference in the duration of relations between the IC and IC* treatment.

H5: There is no significant difference in effort levels between the IC and IC* treatment.

H6: Relational contracts lead to strong rigidities in distribution across market conditions. Mean payments vary much less between the IC and IC* treatments than they do between the C and C* treatments.

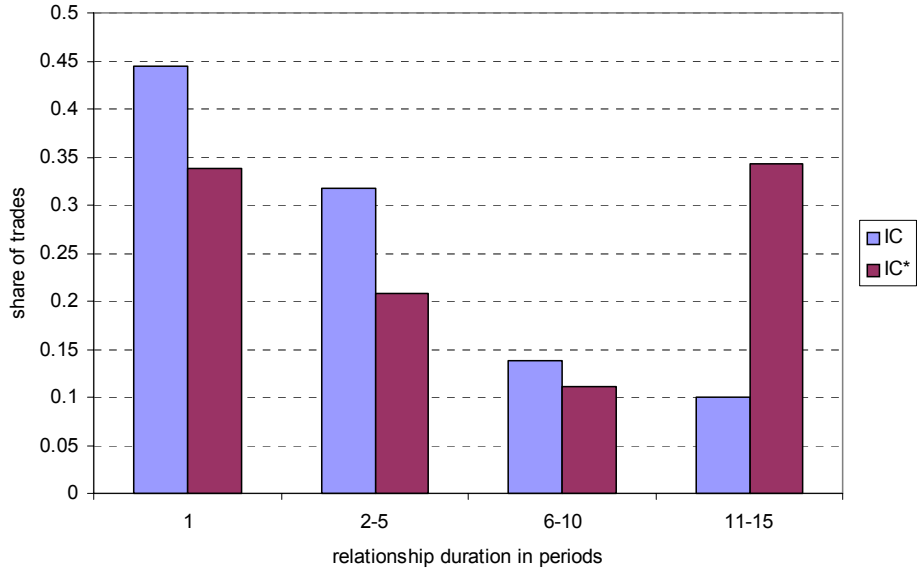
4.1 Market Conditions and Relations

Figure 4 illustrates the frequency of long term relations in the IC and IC* treatments. The figure classifies relations according to their total length. We distinguish between one-shot transactions (relation was broken off after only 1 period), short relations of 2-5 periods, medium-term relations of 6-10 periods and long-term relations with a total duration of 11-15 periods. For each trade we identified the final length of the relationship in which it took place. The figure shows the share of all trades which took place in one-shot, short, medium-term and long-term relations.

Figure 4 shows that long-term relations are much less frequent in the IC than in the IC* treatment. In the IC* treatment over a third of all trades take place in relations of 11 and more periods while 45% of all trades take

[10] To be precise, our predictions for the IC (see appendix to this paper) and IC* treatment (see Brown et.al., 2004) suggest that market performance and average tenure may be slightly higher in the IC*. This is because a pooling equilibrium in which all agents perform maximum effort in all non-final periods cannot be sustained in the IC treatment but can be sustained in the IC*. However, in the appendix we show that an equilibrium can be sustained in the IC treatment in which all agents perform in all but the first and the last periods. As a consequence, we side with the predictions of Macleod & Malcolmson (1998) that market conditions should have no significant effect on the potential for relational contracts.

Figure 4: Market Conditions and Relations



place in relations of 6 and more periods. In contrast, in the IC treatment only 10 % of all trades take place long-term relations while only 25% take place in relations of less more than 5 periods.

A non-parametric test confirms that average tenure is significantly lower in the IC than in the IC* treatment. For each trade we computed the previous length of the relationship between the trading parties. Then we took the mean "previous length of the relationship" across trades for each session. This measure of duration is 1.7, 1.9, 2.59, 2.59, and 3 in the five IC sessions while it is 2.2, 2.62, 3, 5.2 and 6.2 in the five IC* sessions. A (2-sided) Mann-Whitney Test comparing these session averages rejects the hypothesis that relationship duration is identical in the IC and IC* treatments. However, due to the strong variance in session outcome of the IC* this result is only of borderline significance ($p = .075$).

Figure 4 suggests that high competition for agents makes it more difficult to sustain relational contracts, as agents are no longer reliant on their incumbent principle. An alternative explanation could however be that due to their contract making role principals are less inclined to switch trading partners than agents, so that market conditions which permit agents to switch lead to less relations than market conditions which permit principals to switch. If a general "complacency" of principals were the cause for the result observed in Figure 4 we should also see a similar result when comparing our complete contracts treatments. However, a comparison of trade

patterns in the C and C* treatments shows that the relationship duration is unaffected by market conditions when contracts are enforceable. In both the C and C* treatments more than 95% of all trades take place in relations of less than 6 periods. A Mann-Whitney test of average duration per session confirms that there is no significant difference in trade patterns between the C and C* treatments ($p = .841$). It seems therefore that high competition for agents only has an adverse effect on long-term relations when contracts are not enforceable. This confirms our conjecture that higher competition for agents makes it more difficult to establish and maintain implicit agreements.

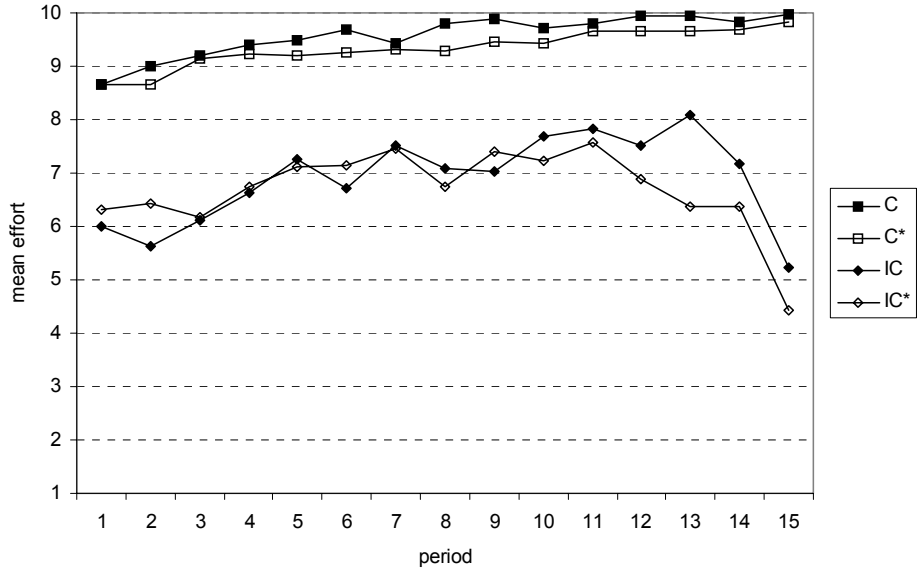
This conjecture is also confirmed by examining the break up of relations in the IC and IC* treatments. A contract renewal required two decisions in our experiment. First, the principal had to offer a private contract offer to his prior agent. Then the agent had to accept this offer from among the available private and public contracts. If improved market conditions for agents are responsible for less relations in the IC treatment, we should see that repeat trades fail at the second stage: The break up of relations in the IC would be due to agents not accepting repeat contracts of principals. A regression analysis confirms that this is the case.

Using the maximum-likelihood probit method we regressed the probability of a principal offering a repeat contract on his agents prior effort and a dummy variable "IC" which is 1 for all trades in the IC treatment and 0 for all trades in the IC* treatment. Controlling for session effects and applying robust standard errors we find that the IC dummy is insignificant (coeff $= .075, prob = .325$). Thus principals are equally likely to offer a repeat contract under both market conditions, ceteris paribus. We then regressed the probability of an agent accepting a repeat contract on the payment offered by the principal and the IC dummy. Controlling again for session effects and applying robust standard errors we find a significant negative coefficient for the IC dummy (coeff $= -.440, prob = .001$). A renewal contract with an identical payment offer had a 44% lower chance of being accepted by the agent in the IC treatment than in the IC* treatment.

4.2 Market Conditions and Market Performance

Figure 4 suggests that high competition for agents may lead to less relational contracts than when agents must compete for contracts. However, less long-term relations does not necessarily imply that relational contracts are less effective in the IC than in the IC* treatment. Our predictions suggest that agents in the IC treatment are motivated by the promise of quasi-rents in their incumbent relation. They perform high effort because they expect their incumbent principal to offer them higher future payments than they might get in the public market. Figure 2 showed that agents in the IC treatment do indeed have a higher probability of receiving lucrative future contract terms

Figure 5: Market Conditions and Market Performance



if they perform well. Thus agents can "insure" themselves against lower payments in the public market by performing well. This, however, does not mean that an agent will not break off a relationship if he gets the chance of a higher payment elsewhere. Thus, we may observe more break-offs of relations in the IC than in the IC* treatment (where such opportunities for switching are lower) although implicit agreements are actually at work.

The effectiveness of implicit agreements in our experiment is determined by the number of actual trades and the effort level provided by agents in these trades. As the maximum number of trades were sealed in each treatment[11] a comparison of market performance between the treatments can rely on a comparison of mean effort. Figure 5 illustrates the mean effort level for the IC, IC*, C and C* treatments by period.

Figure 5 shows that market performance is not adversely affected by higher competition for agents. Mean effort evolves nearly identically in the IC and IC* treatments, rising from an initial level of around 6 to roughly 8 and then suffering from an end-game effect which reduces effort to roughly 5. The end-game effect seems to set in earlier on in the IC treatment where competition for agents is higher. This is a slight indicator that when agents are

[11] In each treatment a maximum number of 525 trades could be sealed (7 in each of the 15 periods in each of 5 sessions). In the C, IC, C* and IC* conditions 518, 520, 519 and 523 trades were made respectively.

less disciplined by market conditions contract enforcement may be more difficult. However, on aggregate market performance in the IC treatment with an average effort of 6.7 is all but equal to that in the IC* treatment (6.9). A (2-sided) Mann-Whitney Test on session averages suggests that market conditions do not affect market performance at all when contracts are not enforceable ($p = .421$). Figure 5 thus confirms the hypothesis of MacLeod and Malcolmson (1998) that relational contracts can sustain equally high performance levels under any labor market condition.

Not surprisingly, market conditions do not affect market efficiency at all when contracts are enforceable. The figure shows that effort levels are almost at their maximum in both the C condition and the C* condition. In the C condition average effort is 9.6 overall periods, while in the C* condition it is 9.3.

Result 2 *The potential of relational contracts to enforce effort is stable across market conditions. High competition for agents leads to a lower frequency of long-term relations. However, market performance is not reduced as agents perform well in order to insure themselves against lower payments in the public market.*

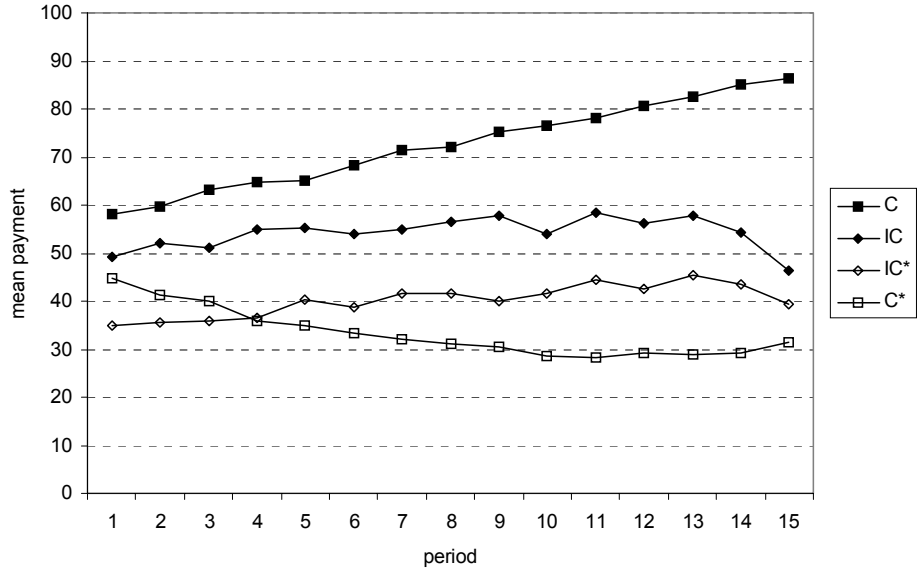
4.3 Market Conditions and Distribution

When relational contracts dominate exchange, the distribution of surplus is unlikely to vary strongly with market conditions. MacLeod and Malcolmson (1998) predict that distribution in implicit agreements will not fully be determined by market forces, but rather by social norms which prevent either principals or agents from using a strong market position to renegotiate terms. As these social norms may remain stable over market conditions, so may the distribution of surplus. This prediction is supported by Brandts and Charness (2004) who find that norms of gift-exchange (Akerlof, 1982) prevent major variations of wages across labor market conditions.

The impact of relational contracts on distribution across market conditions is relevant to both the labor and credit market: In the labor market relational contracts can potentially explain wage rigidity across business cycles. In the credit market implicit agreements contracts could imply that financial liberalization will not strongly reduce financing costs for borrowers.

As market performance is identical in the IC and IC* treatments (as well as in the C and C*) our design allows us to compare distribution of surplus by simply looking at average payments levels. Figure 6 shows the mean payment level by period for all four treatments. The figure shows that when contracts are enforceable the distribution of surplus is strongly affected by market conditions. In the C treatment principals compete strongly for agents, bidding payments up throughout the experiment. Payments rise

Figure 6: Market Conditions and Distribution



from under 60 to well over 80 during the course of the C treatment. In contrast, in the C* treatment agents compete for contracts driving payments down to just over 30 during the course of the experiment. The mean payment level over all periods is only 33.3 in the C* treatment compared to 72.5 in the C treatment. Thus when contracts are enforceable the difference in payments between market conditions is on average 29.8.

When contracts are not enforceable distribution is much more rigid. In the IC treatment the payment level hovers between 50 and 60 throughout the experiment leading to a mean payment of 54.2. In the IC* treatment (where agents compete for contracts) payments are lower at a mean level of 40.1. Market conditions therefore do affect distribution when contracts are not enforceable[12]. However, the impact of market conditions on distribution is substantially lower than when contracts are enforceable. The mean difference in payments between the IC and IC* treatment is 14.1, less than half the corresponding difference when contracts are enforceable! Figure 6 confirms the prediction of MacLeod and Malcolmson (1998) that relational contracts do isolate distribution from competitive pressures[13].

[12] This finding is confirmed by a 2-sided Mann Whitney test on session averages which rejects the hypotheisi that payments are identical in the IC and IC* treatments ($prob. = 0.008$).

[13] One could argue that Figure 6 provides only a conservative estimate of the actual rigidities which might arise in the face of a market shock. Remember that participants in

Result 3 *The emergence of relational contracts leads to strong distributional rigidities across market conditions.*

5 Conclusions

In this paper we have compared the emergence and impact of relational contracts across market conditions. We showed that effective implicit agreements can emerge even when agents are not "disciplined" inherently by market conditions. Indeed, we find that increased demand for agents has no adverse effect on the potential of relational contracts to enforce high effort. With relational contracts dominating exchange across market conditions we also find strong rigidities in the distribution of surplus between principals and agents.

With respect to the labor market our results show that unemployment is by no means a necessary disciplining device (Shapiro and Stiglitz, 1984) when employment contracts are costly to enforce. Our findings confirm the predictions of MacLeod and Malcolmson (1998) and Carmichael (1984) that involuntary unemployment is not a natural phenomenon of labor markets which suffer contracting problems. Our results further provide strong evidence that implicit agreements are an important source of distributional rigidities over the business cycle. This finding supports labor market theories (Akerlof and Yellen, 1990) and empirical studies (Fehr and Falk, 1999) which suggest that contract enforcement is a major source of wage rigidities.

With respect to the credit market our results can be applied to the impact of financial liberalization on credit market performance. On the one hand our findings confirm that lenders can enforce good behavior of borrowers even when these have many alternative sources of credit (Boot and Thakor, 1994). Thus increased competition among lenders due to financial liberalization must not lower the ability of lenders to discipline borrowers and therefore may not reduce the availability of credit. On the other hand our results show that borrowers may not benefit strongly from increased competition in credit markets. We find that relational contracts isolate the distribution of surplus from competitive pressures, so that in credit markets where contract enforcement is costly interest rates may not fall when competition among lenders rises.

our IC condition did not subsequently take part in IC* condition (or visa-versa). Thus if distribution is influenced by social norms, then in our experiment these norms can develop independently according to market conditions, as participants have not experienced the opposite market condition. Now suppose that a principal and an agent establish a relationship in the IC treatment and then suddenly find themselves in the IC* treatment. If the social norm which influenced that relation does not change with market conditions, then we can expect that payment levels will be even more rigid.

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Appendix

In this appendix we provide perfect bayesian equilibrium for games which resemble our ICR and IC treatments. We do not attempt to generate quantitative predictions for these treatments as implemented in the experiment. Rather, the objective is to demonstrate how the presence of fair agents and reputational incentives (in the IC) can sustain non-minimal effort in both treatments.

We analyze a simplified version of our experiment which maintains the main structural elements of that design: an excess demand for services of agents, non-enforceability of effort, a finite horizon and private information on prior performance. We consider a game of T periods and $n > 2$ players of which there is $n-1$ principals, but only 1 agent. We assume that in each period the $n-1$ principals simultaneously make one contract offer each $[p, \tilde{e}]$. After being informed about all offers the agent chooses his preferred one and then chooses a feasible effort level. As in our experimental design we assume that the monetary payoffs of a principal in each period t are:

$$[1]\ \ \pi_t(p_t, e_t) = \begin{cases} 10 \cdot e_t - p_t & \text{,if a principal trades} \\ 0 & \text{, if a principal does not trade} \end{cases}\text{'}$$

The monetary payoff of the agent per period is correspondingly

$$[2]\ \ v_t(p_t, e_t) = \begin{cases} p_t - c(e_t) & \text{,if the agent trades} \\ 5 & \text{, if the agent does not trade} \end{cases}$$

To simplify our analysis (by circumventing integer effects) we assume that p is a continuous variable $p \in [0, 100]$. We also assume that $\tilde{e}$ and e are continuous variables with $\tilde{e}, e \in [1, 10]$. The cost of effort schedule is identical to that implemented in our experiment, adjusted for the continuity of e:

$$[3]\ \ c(e) = \begin{cases} -1 + e & \text{, if } 1 \leq e \leq 3 \\ 2 + 2e & \text{, if } 3 < e \leq 8 \\ 12 + 3e & \text{, if } 8 < e \leq 10 \end{cases}$$

With common knowledge of rationality and selfishness minimal effort will be the outcome in this game. Our following argument relies therefore on introducing incomplete information over preferences of players in the tradition of Kreps et. al. (1982). We assume that there is a positive probability $\delta \in (0, 1)$ of the agent being fair preferences which incline him to provide non-minimal effort even in a one-shot situation. To simplify our analysis we assume that fair agents have a bad conscience if they do not fulfill a contract

which they agreed to[14]. The utility of a fair agent in any period t is thus given by:

$u_t = p_t - c(e_t) - \max[b(\tilde{e}_t - e_t); 0]$

We assume that the marginal disutility of non-adherence b is higher than the marginal cost of effort at all effort levels, i.e. $b > 3$. As a consequence a fair agent worker will always adhere to any contract which he has accepted.

We first establish qualitative predictions for our ICR treatment by examining a one-period game. Proposition 1 shows that when there is a sufficient share of fair agents non-minimal effort can be sustained even when there ar eno repeated game incentives.

Proposition 1: Consider a game of $T = 1$ period with $n - 1 > 1$ selfish principals and 1 agent who is fair with probability $\delta \in (0, 1)$. If $\delta > .1$ there exists a perfect bayesian equilibrium in which a fair agent performs non-minimal effort while a selfish agent shirks.

Proof: Throughout this proof we drop the time index as we are looking at a one-period game. All principals know that with a probability $1 - \delta$ the agent is selfish. If the agent is selfish he will accept the contract with the highest payment p and perform $e = 1$. Principals however also know that with probability δ the agent is fair. If a fair agent accepts a contract he will perform $e = \tilde{e}$. The expected profit of a firm which has a contract $[p, \tilde{e}]$ accepted is thus:

$\pi^e[p, \tilde{e}] = \delta 10\tilde{e} + 10(1 - \delta) - p$

Competition for the agent will lead firms to offer the contract which maximizes the utility of a fair agent subject to $\pi^e \geq 0$. As the utility of a fair agent is increasing in his payment p the equilibrium contract will imply zero profits for principals:

[4] $p^* = 10\tilde{e}^*\delta + 10(1 - \delta)$.

A fair agent will thus earn $p^* - c(\tilde{e}^*)$ which from [4] is:

[5] $u(p^*, \tilde{e}^*) = 10(\delta\tilde{e}^* + 1 - \delta) - c(\tilde{e}^*)$

Deriving [5] by $\tilde{e}$ we see that the equilibrium contract in a one-period game depends on the share of fair agents δ and the marginal cost of effort $\partial c(e)/\partial e$. As the marginal cost of effort is either 1 (for $e \leq 3$), 2 (for $3 < e \leq 8$) or 3 (for $e > 8$) in our experiment we have:

[14] This assumption is of course a strong simplifcation of non-selfish preferences. In particular a fair agent does not care about the distribution of surplus as discussed in Akerlof (1982) or Fehr and Schmidt (1999). Neither does a fair agent care about the intentions of the principal as suggested by Falk and Fischbacher (1998).

$$\tilde{e}^*(\delta) = \begin{cases} 1 & \text{if } \delta < .1 \\ 3 & \text{if } .1 \leq \delta < .2 \\ 8 & \text{if } .2 \leq \delta < .3 \\ 10 & \text{if } \delta \geq .3 \end{cases}$$

Thus if $\delta \geq .1$ principals will offer a contract $[p^*, \tilde{e}^*] = [10\tilde{e}^*\delta + 10(1-\delta), \tilde{e}^*]$ with $\tilde{e}^* > 1$. This will only induce non-minimal performance of a fair agent while a selfish agent will shirk. This concludes our proof of Proposition 1.

In a one-period game the presence of fair agents can motivate principals to make non-minimal payments. However only a fair agent responds to this with non-minimal effort while a selfish agent would shirk. Thus in our ICR treatment only pure fairness motives can lead to non-minimal effort.

Proposition 2 shows that in a multi-period game there exist perfect bayesian equilibria in which performance is substantially higher than in the one-period game. In these equilibria even a selfish agent performs high effort in non-final periods out of reputational concerns. The incumbent principal generates such reputational incentives by offering wages to a performing agent which exceed the public market level. Endogenous relation-specific information makes it credible for the incumbent principal to make these higher payments.

Proposition 2: Consider a game of $T > 1$ periods with $n - 1 > 1$ selfish principals and 1 agent who is fair with probability $\delta \in (0, 1)$. If $\delta < \frac{1}{4T-3}$ there exists a perfect bayesian equilibrium in which both agent types perform maximum effort in all periods $1 < t < T$.

Proof: Our proof is by construction. We show that the following strategies constitute a perfect bayesian equilibrium in a multi-period game:

- All principals offer the identical contract $[p_1^*, \tilde{e}_1^*] = [p_1^*, 10]$ in period 1.
- The agent selects one of the available contracts in period 1. If the agent is fair he performs $e_1 = 10$. If the agent is selfish he performs $e_1 = 10$ with a probability $\gamma_1 \in (0, 1)$ and $e_1 = 1$with a probability $1 - \gamma_1$.
- In all periods $t > 1$ the incumbent principal offers a contract

$$\left[p_t^{inc}, \tilde{e}_t^{inc}\right] = \begin{cases} [28, 10] & \text{if } e_k = \tilde{e}_k \text{ all } k < t. \\ [10, 1] & \text{if } e_k < \tilde{e}_k \text{ any } k < t. \end{cases}$$

- In all periods $t > 1$ "outside" principals offer a contract $\left[p_t^{out}, \tilde{e}_t^{out}\right] = [10, 1]$.
- In all periods $t > 1$ a fair agent performs $e_t = 10$.

- If the agent is selfish he performs $e_t = 10$ in all periods $1 < t < T$. In the final period a selfish agent performs $e_T = 1$.

We prove Proposition 2 in six steps:

Step 1 (behavior of a fair agent): In period $t = 1$ all principals offer the same contract. A fair agent will accept and adhere to this contract if $p_1^* - c(\tilde{e}_1^*) \geq 5$ and thus $p_1^* \geq 23$.

In any period $t > 1$ a fair agent who accepts a contract of the incumbent principal earns $u_t = 28 - c(10) = 10$. If he accepts the contract $\left[p_t^{out}, \tilde{e}_t^{out}\right] = [10, 1]$ of an outside principle he earns $u_t = 10 - c(1) = 10$. It is thus a (non-unique) best response for the agent to always accept the contract of his incumbent principle and perform $e_t = 10$.

Step 1 (behavior of selfish agent): From Proposition 2 we know that a selfish agent will accept the contract in period T which offers the highest payment $p_T^* \geq 5$ and will then perform $e_T^* = 1$. If the selfish worker performed in all prior periods it is a unique best strategy of the selfish agent to accept the contract of the incumbent principal $\left[p_T^{inc}, \tilde{e}_T^{inc}\right] = [28, 10]$. If the agent shirked in any prior period $t < T$ he is indifferent between the contract of the incumbent or any outside principal.

Consider now the effort choice of a selfish agent in any period $t < T$. If he shirks he will get a future contract of $[p_k, \tilde{e}_k] = [10, 1]$ in all future periods k. If he performs the desired effort of his incumbent principal he incurs the costs for the demanded effort $c(\tilde{e}_t) = 18$, but receives a repeat contract in period $t + 1$ where he expects a payment p_{t+1}^{inc}. A selfish agent will perform the maximum effort $e_t = 10$ in any non final period $t < T$ if the following incentive constraint is met:

$$-18 + \sum_{k=t+1}^{T-1} \left[p_k^{inc} - 18\right] + p_T^{inc} \geq 10, or$$

$$[7] \quad \sum_{k=t+1}^{T} \left[p_k^{inc} - 18\right] \geq 10$$

His participation constraint in any period $t < T$ is given by:

$$[8] \quad \sum_{k=t}^{T-1} \left[p_k^{inc} - 18\right] + p_T^{inc} \geq 0$$

Condition [7] shows that a selfish agent only has an incentive to perform if he expects higher future wages from his incumbent principal than he expects to get from an outside principal[15]. If the incumbent principal rewards a

[15] If outside principals offer identical payments to those of the incumbent principal a selfish agent has nothing to lose by being fired. The incentive constraint of the selfish agent is the reason why a pooling equilibrium in which fair and selfish agents perform maximum effort in all non-final periods cannot be sustained when there is an excess demand for agents.In a pooling equilibrium all principals have identical information and thus the incumbent cannot commit to offering a higher payment than outside principals.

performing agent with $\left[w_t^{inc}, \tilde{e}_t^{inc}\right] = [28, 10]$ in all periods $t > 1$ we see from [7] that the incentive constraint of a selfish agent is met with equality in all periods $t < T$. Moreover the participation constraint [8] is met with inequality. It is therefore a (non-unique) optimal strategy of the selfish agent to perform $e_t = 10$ with any probability $\gamma_t \in [0, 1]$ in any $t < T$.

Step 3 (Contract of incumbent principal in periods t>1): In equilibrium the principal who traded with the agent in period 1 will in any period $t > 1$ have the following rational belief concerning the workers type:

$$\delta_t^{inc} = \begin{cases} \frac{\delta}{\delta+(1-\delta)\cdot\gamma_1} & \text{if } e_k = 10 \text{ all } k < t \\ 0 & \text{if } e_1 < 10 \text{ any } k < t \end{cases}$$ [16]

If the agent shirked in any prior period the incumbent principal believes he is selfish. Moreover, the in equilibrium the agent knows that his identity has been revealed and will therefore shirk in all future periods. For any payment $p_t > 10$ the incumbent principal will thus yield negative payoffs. Given that all outside principals offer $\left[w_t^{out}, \tilde{e}_t^{out}\right] = [10, 1]$ it is a (non-unique) best strategy to also offer this contract to an agent who shirked.

If the agent performed in all prior periods the incumbent principal knows that he is fair with a probability $\delta^{inc} = \frac{\delta}{\delta+(1-\delta)\cdot\gamma_1}$. Given that all outside principals offer $\left[w_t^{out}, \tilde{e}_t^{out}\right] = [10, 1]$ the expected profits of the incumbent firm in any period $t > 1$ are thus

$$\pi_t^{inc}\left(p_t^{inc}, e_t^{inc}\right) = \begin{cases} 0 & \text{if } p_t^{inc} - c(e_t^{inc}) \leq 10 \\ 10\delta^{inc}e_t^{inc} + (1-\delta^{inc})10 - p_t^{inc} & \text{if } p_t^{inc} - c(e_t^{inc}) > 10 \end{cases}$$

Profit-maximization for the incumbent obviously implies that the agent receives a utility which is exactly as high as his outside option, so that $p_t^{inc} - c(e_t^{inc}) = 10$. Thus we have

$\pi_t^{inc}\left(p_t^{inc}, e_t^{inc}\right) = 10\delta^{inc}e_t^{inc} + (1-\delta^{inc})10 - c(e_t^{inc}) - 10$. Deriving this expression by e_t^{inc} we see that it is optimal for the incumbent principal to offer $\left[p_t^{inc}, \tilde{e}_t^{inc}\right] = [28, 10]$ if

$10\delta^{inc} - \partial c(e_t^{inc})/\partial e_t^{inc} > 0$ and thus $\delta^{inc} \geq \frac{3}{10}$. This requires that

[9] $\frac{7}{10}\frac{\delta}{(1-\delta)} > \gamma_1$.

Step 4 (Contracts of "outside" principals in periods t > 1): Given the strategy of the incumbent principal in periods $t > 1$ outside principals know that their contract offer affects the type of agent they can attract. Suppose that in any period $t > 1$ the incumbent offers $\left[p_t^{inc}, \tilde{e}_t^{inc}\right] = \begin{cases} [28, 10] & \text{if } e_k = \tilde{e}_k \text{ all } k < t. \\ [10, 1] & \text{if } e_k < \tilde{e}_k \text{ any } k < t. \end{cases}$ while the other $n-3$ outside principals offer $\left[p_t^{out}, \tilde{e}_t^{out}\right] = [10, 1]$. Now consider the remaining outside principal.

If the principal offers a contract $[p_t, \tilde{e}_t]$ with $p_t - c(\tilde{e}_t) < 10$ he will not attract the agent at all.

[16] This is supported by an off-equilibrium belief that an agent who shirks in any period $t > 1$ is selfish.

If the principal offers a contract $[p_t, \tilde{e}_t]$ with $p_t - c(\tilde{e}_t) < 18$ he will only attract the agent if the agent shirked in the past, as otherwise the agent would prefer the contract of his incumbent principal. For $p_t - c(\tilde{e}_t) < 18$ the principal knows that the agent must be selfish and the only rational belief of the agent is that the principal thus knows he is selfish. The agent can thus no longer conceal his identity and will shirk in period t and all following periods. Thus for all contracts $[p_t, \tilde{e}_t]$ with $18 + c(\tilde{e}_t) > p_t > 10$ the principal would earn negative profits.

If the principal offers a contract $[p_t, \tilde{e}_t]$ where $p_t - c(\tilde{e}_t) > 18$ he can lure the agent away from his incumbent principal no matter what type he is. As it is optimal for the principal to demand $\tilde{e}_t = 10$ and assuming that an agent who switches will only performs $e = \tilde{e}_t$ if he is fair[17] the principal has expected future profits of:

$\pi_t^{out} = -\, p_t^{inc} + (1-\delta)10 + \delta 10\tilde{e}_t + \delta \sum_{k=t+1}^{T} \left(10\tilde{e}_t - p_t^{inc}\right)$

or

$\pi_t^{out} = -\, 18 + \delta\left[90 + (T-t)\,72\right]$

If this is negative for all periods $t > 1$ the outside principal will not challenge the incumbent. This will be the case if $\pi_2^{out} < 0$ and thus $\delta < \frac{18}{[90+(T-2)72]}$ or

$$[10] \quad \delta < \frac{1}{4T-3}.$$

If condition [10] is met an outside principal cannot make strictly positive profits by offering a contract with $p_t > 10$ in any period $t > 1$. Any contract he offers with $p_t \leq 10$ will earn him zero profits so that it is a (non-unique) best strategy for him to offer $\left[p_t^{out}, \tilde{e}_t^{out}\right] = [10, 1]$ all $t > 1$.

Step 5: (contracts of principals in period 1): In period 1 the principals will bid each other up to a payment which generates zero expected future profits. Given the performance strategy of selfish and fair agents and the contract strategy of a principal if he becomes the incumbent the expected profits are given by:

$$\begin{aligned}
\pi_1 = & -p_1 + (1-\delta)(1-\gamma_1)10 + \delta + (1-\delta)\gamma_1 100 && \text{(period 1)} \\
& + \left[\delta + (1-\delta)\gamma_1\right]\left[(T-2)\,72\right] && \text{(period 2... T-1)} \\
& - \left[\delta + (1-\delta)\gamma_1\right]28 + (1-\delta)\gamma_1 10 + \delta 100 && \text{(period T)} \\
= & -p_1 + 10 + \delta 90 + \left[\delta + (1-\delta)\gamma_1\right](T-1)\,72 &&
\end{aligned}$$

We therefore have

$p_1^* = 10 + \delta 90 + \left[\delta + (1-\delta)\gamma_1\right](T-1)\,72$

We have $p_1^* > 28$ (which is required for a fair agent to accept) if

[17] This is an out of equilibrium belief as in equilibrium the agent never switches principals. However, the belief is reasonable because we know from step 2 that a selfish agent is indifferent between performing and shirking in every period if the incumbent offers a contract with $p_t^{inc} - c(\tilde{e}_t^{inc}) = 10$ and we know from step 3 that an incumbent principal cannot commit to a contract which offers more than this!

[11] $5\delta + 4\left[\delta + (1-\delta)\gamma_1\right](T-1) > 1$

Step 6: (compatibility of conditions): Step 3,4 and 5 all put conditions on the share of fair agents δ the performance of a selfish agent in period 1 γ_1 and the duration of the game T. From [9] and [10] we can establish that we require $T < \frac{1}{4\delta} + \frac{3}{4}$and $\frac{7}{10}\frac{\delta}{(1-\delta)} > \gamma_1$. Inserting these conditions into [11] we can establish that all three conditions can be simultaneously met if and only if

$5\delta + \left[\delta + (1-\delta).7\frac{\delta}{(1-\delta)}\right]\left(\frac{1}{4\delta} + \frac{3}{4} - 1\right)4 > 1$. This is the case for all $\delta > 0$. This concludes our proof of Proposition 2.

We have shown that there exists an equilibrium which sustains high effort of selfish agents in all periods 2 through to $T-1$ of a mutli-period game such as our IC treatment. Selfish agents partly shirk in period 1 generating private information for the incumbent principal. This private information makes it credible for the incumbent to commit to higher payments that outside principals and thus generates reputational incentives for the agent to perform his current relationship.

In this equilibrium the agent stays with the same principal throughout the game. All quasi rents generated in this relationship from period 2 onwards are fully reaped by the principal. However, overall the principal does not earn strictly positive profits. In period 1 principals bid each other up to the payment which yields exactly zero expected profits. The principal who gets the contract in that initial period may be lucky or not. If he is lucky and the agent performs in period 1 then as the incumbent the principal earns significant quasi-rents from period 2 through to period T. If however the principal is unlucky and the agent is selfish and shirks in period 1 the principal makes significant losses.