

The ratchet principle in a principal agent game with unknown costs: an experimental analysis

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Abstract

This paper tests for ratcheting in a dynamic principal–agent game where the principal does not have complete information. In such situations the principal often uses any information revealed by the agent’s actions to extract the latter’s informational rent in future periods – the “ratchet principle”. This in turn induces the agent to underproduce in order to avoid more demanding schedules in the future. We find little evidence of ratcheting. Agents play the game in a naive fashion and reveal their types even when such revelation is not optimal and the principal often does not exploit such type revelation. © 1998 Elsevier Science B.V. All rights reserved.

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1. Introduction

This paper tests for ratcheting in a dynamic principal agent game where the principal does not have complete information. Such games occur for example in centralized planning of production and government regulation of industries. The principal in such situations often does not commit to a long term payment scheme and uses any information that is revealed by the agent’s actions in an attempt to extract the agent’s informational rent — the “ratchet principle” — where current performance acts as a benchmark in fixing the point of departure for next period’s target.¹ This in turn often induces the agent to underproduce to avoid more demanding schedules in the future.

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¹ Berliner (1957) introduced the term “ratchet principle” which is a variant of March and Simon (1958) goal adaptive behavior.

In this paper we set up an experiment which incorporates these two behavioral phenomena – (1) the behavior of the agent in the incomplete information game where the principal's ability to extract the agent's surplus is constrained by lack of knowledge about the agent's true type and (2) the behavior of the principal in revising the payment scheme once the true type has been revealed. There is a voluminous literature on paired bargaining games. Roth (1995) provides a comprehensive survey. However, there are some notable differences between this paper and previous work on bargaining. Firstly, this paper models the dynamic phenomenon of ratcheting explicitly. Secondly, the bargaining is not over a fixed pie. Instead, the principal wants to identify the agent's true type so as to extract the informational rent. The agent wants to continue enjoying the rent by not revealing his true characteristics.

Section 2 sets up the model. Section 3 describes the experimental design. Section 4 reports the experimental results. Section 5 concludes with a summary and suggestions for future research.

2. The model

We consider a *two-period* principal–agent game. The agent produces an output which is turned over entirely to the principal. At the beginning of period 1 the principal sets a quota, q , for the agent and the agent produces an output, y . The principal observes the agent's output and at the beginning of period 2 sets a new quota and the agent responds with an output again. In our model both q and y are chosen from finite sets of discrete values.

The agent can have either (1) low cost of production – C_L or (2) high cost of production – C_H with $C_L < C_H$. The principal begins with an uninformed prior belief that the two-cost functions are equally likely. Thus the principal's prior belief should be that with probability 1/2 the agent has low cost of production and therefore the probability of high cost is 1/2 as well.

The agent's output response can be greater than, equal to or less than the quota set by the principal. If the output response is less than the quota then both players get a pay-off of zero.

The equilibrium concept involved is *Perfect Bayesian*. At the beginning of period 2 the principal observes the agent's first period output, y^1 , and obtains a posterior distribution via Bayes Rule to get posterior beliefs, p^2 , that the agent has low cost of production and sets a new quota, q^2 . The agent responds with an output again.²

1. The quota, q^2 , set at the beginning of period 2 must maximize the principal's expected second period pay-off given the posterior beliefs, p^2 .
2. The output response in period 2, y^2 , must maximize the agent's second period pay-off.
3. The quota set at the beginning of period 1, q^1 , must maximize the principal's expected two-period pay-off given the second period quota, q^2 , posterior beliefs, p^2 , and the agent's output response, y^2 .

² Superscripts denote time periods.

4. The output choice in period 1 must maximize the agent's two-period pay-off given the second period quota, q^2 , and the second period output, y^2 .
5. The posterior beliefs, p^2 , must be Bayes Consistent with the principal's prior probabilities and the agent's first period output choice.

Let us turn now to the actual experiment to see how subjects play this game. This is the exact game that the subjects were faced with. The pay-offs to the principal and the agent in this game are shown in the two pay-off tables below.³ Each of the two pay-off tables correspond to one of the two types of the agent. The principal chooses a row which is like setting the quota and the agent chooses a column which is his output response. The first number in each cell shows the pay-off to the principal and the second number shows the pay-off to the agent. The LOW COST pay-off table refers to the agent with LOW cost of production while the HIGH COST pay-off table refers to the agent with HIGH cost.

HIGH COST PAY-OFF TABLE

	C1	C2	C3
R1	50, 45	80, 35	120, 20
R2	0, 0	70, 20	130, -5
R3	0, 0	0, 0	150, -20

LOW COST PAY-OFF TABLE

	C1	C2	C3
R1	50, 45	80,60	120, 80
R2	0, 0	70,45	130, 50
R3	0, 0	0, 0	150, 30

The principal does not know which pay-off table was being used by the agent but knew that the two tables were equally likely. The agent however is informed about his own type and therefore which pay-off table to look at in making his decisions. Note that the number to the left in each cell is the same in both tables i.e. the principal's pay-off depends only on the choice of the quota and the output response and does not depend on the agent's type. A higher quota, if it is met, yields the principal a higher pay-off. Moreover note that any time the principal chooses R_j and the agent responds with C_k such that k is less than j ,

³ In a pilot of this experiment we generated the numbers in the pay-off matrices in the following way: we used a fixed price of output equal to 7, a reward function of the form $R=50+2^*(y-q)$ where ' q ' is the quota chosen by the principal and ' y ' is the output response of the agent; the high cost function was $C_H=y^2/20$ and the low cost function was $C_L=y^2/50$. Then the pay-off to the principal was $7 \times y - R$ and the pay-off to the agent was $R - C_j$ where $j=H,L$. We constrained the principal to choose a quota from the set {10,20,30,40,50} and similarly the agent's output response was constrained to the same set, though it did not have to be the same number necessarily. However having 5 choices generated excessively noisy results. There were also problems with the equity of the pay-offs to the principal and the agent. Based on the insights gained from the pilot we decided to change the numbers in the pay-off matrices towards meeting the following two goals; firstly, generate sharp predictions and secondly, make the pay-offs more equitable. So we changed the numbers from their original form so that the numbers in the present paper do not correspond to exact functional specifications. The important point here is that both the principal and the agent are constrained to choosing an element from a three element set and these choices are not evenly spaced.

both players get zero pay-off. For instance if the principal chooses Row 3 and the agent responds with Column 2, both of them end up with zero.

In the *static* version of this game each player moves only once with the principal choosing a row first to maximize expected pay-off and the agent responding with an optimal column choice. In the *repeated* version both players move twice. The principal starts out by choosing a row and the agent responds with a column. The principal observes the agent's column choice, updates prior beliefs, if possible, and chooses a row again; the agent responds with a column.

We can then write the following propositions:

Proposition 1. *In the static game, the principal should choose R2 to maximize pay-off. This yields the principal an expected pay-off of 100 francs while the high cost agent gets 20 and the low cost agent gets 50 francs.*

Proposition 2. *There exists an equilibrium of the repeated game described above which induces the following equilibrium path – R1-C1-R2-R2 with probability 1/2 and R1-C3-R3-C3 with probability 1/2; i.e. the equilibrium outcome of the game leads to different output responses from the two types of the agent and hence results in complete revelation of types at the end of the first period, following which the principal revises the quota upwards – R2 for the high cost type and R3 for the low cost type. This yields the principal an expected pay-off of 195 francs, while the high cost agent gets 65 francs and the low cost agent gets 110 francs.*

Proposition 3. *If the principal chooses R2 in period 1 instead of the equilibrium prediction of R1, then the optimal response for both types of the agent in period 1 is C2. A choice of R2 in period 1 should lead to pooling by both types of the agent and reveals no new information about the agent's type in which case the principal is expected to persist with R2 in period 2 in order to maximize expected pay-off. The expected sequences in this case are R2-C2-R2-C2 for the high cost agent and R2-C2-R2-C3 for the low cost agent.*

The proofs of all three propositions are by enumeration and are left up to the reader.

3. Experimental design⁴

The subjects were mostly undergraduate students, with a few non-economics graduate students, at the University of Arizona in Tucson. There were four different experimental sessions in all. The first session consisted of 12 subjects while sessions 2, 3 and 4 had 10 subjects each. The pay-offs were denoted in a fictitious currency "francs". All the players in a session were first assembled in the same room where they had the instructions read out to them.⁵ All subjects were told that they would get a US\$ 5 show-up fee which would be paid to them along with their earnings from the experiment at the end.

⁴ The papers by (1) Cooper et al. (1994), (2) Jung et al. (1994), and (3) Hackett (1993) were instructive in designing the experimental set-up for this paper.

⁵ A copy of the instructions is available from the author upon request.

After that the players playing as principal and those playing as agent (based on numbers drawn from an envelope) were separated into two rooms. In each session the players were divided equally into two groups – one group designated as “A Players” and the other designated as “B Players”. One “A Player” and one “B Player” were paired up. In sessions 1 through 3, the A Players played as the principal and the B Players as agents for the first half of the experiment, with roles being reversed halfway through. In session 4, A Players played as the principal and B Players as agents for the entire time. The pairings were known only to the experimenter. Since all decisions are made in a sequential manner, a round consisted of a decision by the A Player in period 1, a decision by the B Player in period 1, a decision by the A Player in period 2 and a decision by the B Player in period 2. The pairing was changed at the end of every round. In the B Players’ room, at the beginning of each round, the type of the agent – high cost or low cost – was decided by the agent picking a ball from a bingo cage containing 100 balls. If the agent picked a ball numbered between 1 and 50 (51 and 100) then he would use the high (low) cost pay-off table for that round. The A players were aware of how the agent’s type would be chosen and therefore knew that each table should be equally likely.

In the room containing the A Players, each player was handed a decision form. Each A Player circled a row choice for that period on the form. The forms were then collected and brought over to the room containing the B Players and handed out in accordance with the pairing for that round. The B players looked at the row chosen by the corresponding A player and responded with a column choice. The players then noted down their pay-off for that period. This concluded period 1. The forms were then returned to the respective A players who looked at the B player’s response and circled a row again on the decision form. The forms were then given to the B players who chose a column. Once more the players noted their pay-off for that period and calculated their pay-off for the entire round. That was the end of period 2 and ended the round as well. A new round started after that.

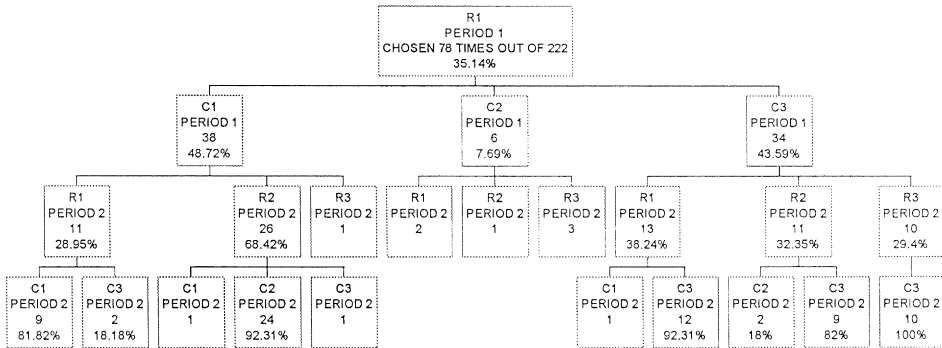
Session 1 consisted of 6 pairs playing 12 rounds resulting in 72 plays of the game with the players changed designation halfway through. In sessions 2 and 3 there were 5 pairs, each playing 10 rounds, with players changing designation halfway through as well. Finally in session 4 there were 5 pairs who played 10 rounds without changing roles. So we had 222 plays of the game in all. At the end of the experiment the players were paid their earnings in US dollars at a pre-determined conversion rate. The average pay-off for a session which lasted between an hour and fifteen minutes to an hour and a half was around US\$ 22 which included the show-up fee.

4. Experimental results and discussions

4.1. Results

The overwhelming sequence of plays deviated from the equilibrium prediction. The principal showed a preference for R2 (55%) over R1 (35%) in period 1. A choice of R2 by the principal should have led to pooling behavior with both types of the agent responding with C2 but instead still led to a separation of types with the agent responding with his one period best response – C2 on the high cost pay-off table and C3 on the low

Table 1
Sequence of play when the principal chooses R1 in period 1



cost pay-off table. In a large majority of cases where the agent revealed his true type, the principal did not exploit this fact by ratcheting up the quota in the next period.

Let us look at the detailed results now. Table 1 shows what happened when the principal started out by choosing R1 in period 1. Tables 2 and 3 break up the choices according to the agent’s type. Table 2 considers only those games where the high cost pay-off table was used while Table 3 looks at the ones with the low cost pay-off table. Table 4 looks at the course of the game when the principal started out by choosing R2 in period 1. Once again Table 5 considers the choices for the high cost agent while Table 6 does the same for the low cost agent. There were very few cases where the principal chose R3 in period 1 and these cases are not interesting because they do not allow the high cost agent to get a positive pay-off.

Table 2
Sequence of play when the principal chooses R1 in period 1 and the agent is using the high cost pay-off table

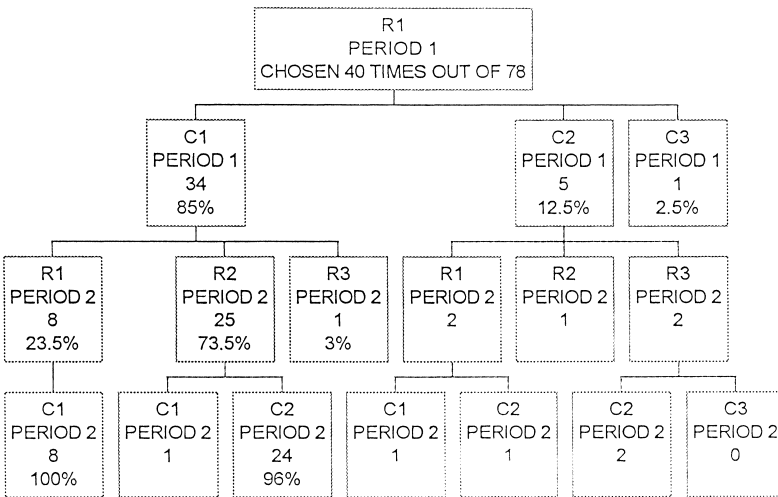


Table 3
Sequence of play when the principal chooses R1 in period 1 and the agent is using the low cost pay-off table

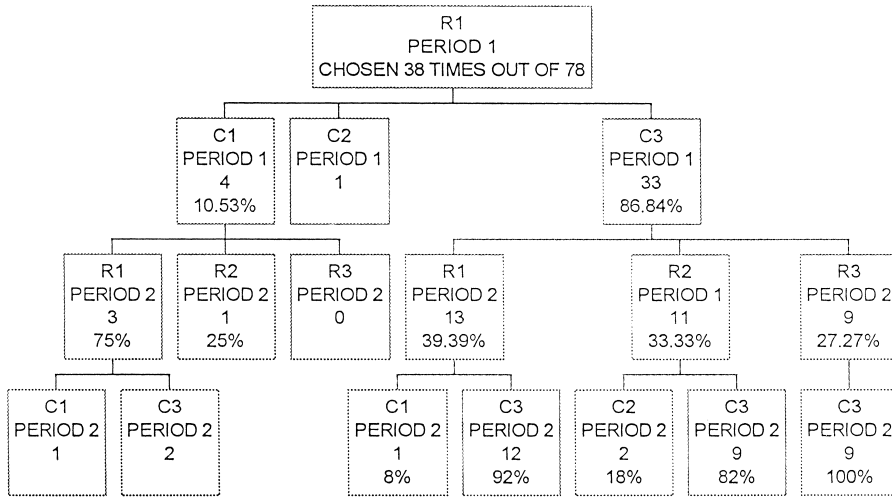
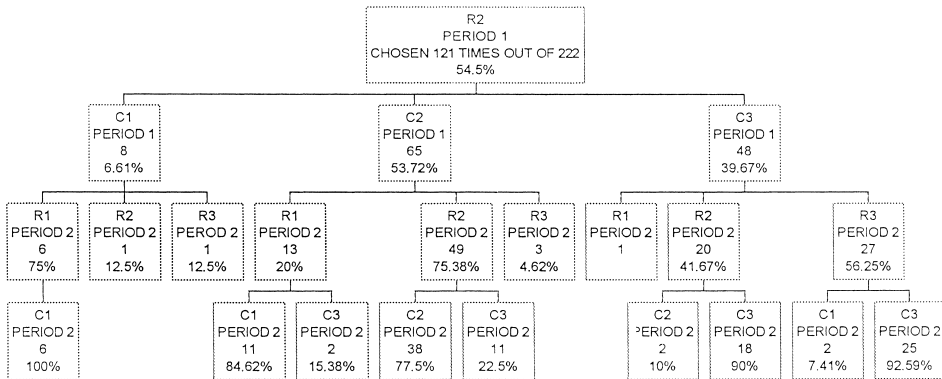


Table 4
Sequence of play when the principal chooses R2 in period 1



Query 1: How did the equilibrium prediction perform?

The equilibrium prediction performed poorly with the equilibrium sequence R1-C3-R3-C3 corresponding to the low cost agent being played nine times while for the high cost agent the equilibrium sequence R1-C1-R2-C2 was chosen 24 times (Table 1).

The principal started by choosing R1 only 35% of the time. The agents using the high cost table responded appropriately with C1 in a majority of cases and the principal is expected to increase the quota to R2 in period 2 but did so only in 68.5% cases. When the principal did raise the quota to R2 it was accepted almost always (92%) as the equilibrium predicts.

In those cases where the principal received a response of C3 indicating a low cost agent the principal chose R3 (in keeping with our prediction) in period 2 only 30% of the time.

Table 5

Sequence of play when the principal chooses R2 in period 1 and the agent is using the high cost pay-off table

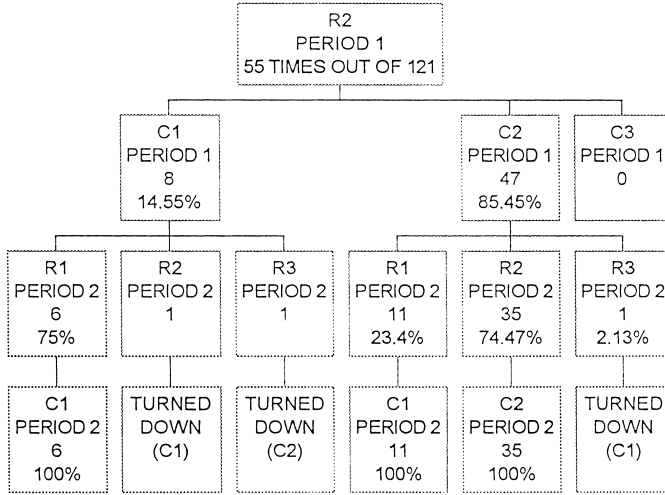
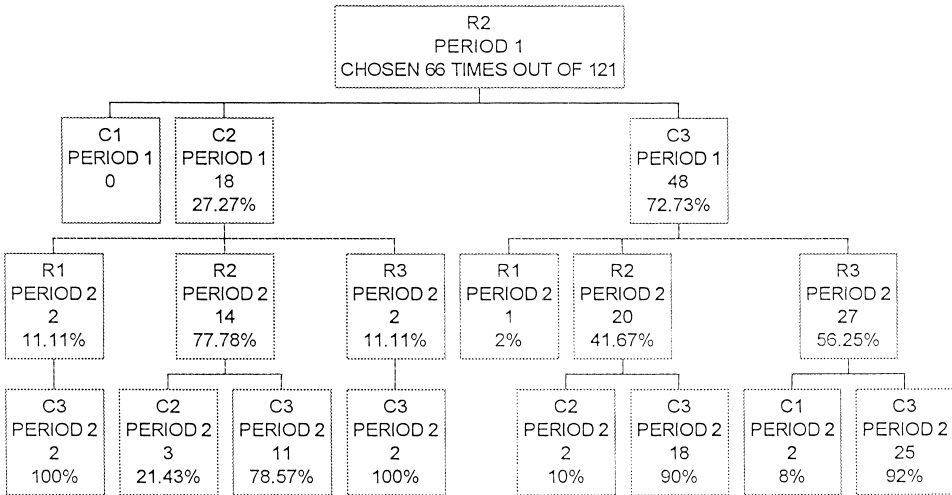


Table 6

Sequence of play when the principal chooses R2 in period 1 and the agent is using the high cost pay-off table



70% of the time the principal did not exploit the agent’s type revelation by ratcheting the second period quota up and chose either R1 (38%) or R2 (32%). When the principal did choose R3 however, the agent responded with C3 every time and there were no rejections.⁶

⁶ One of the C3 responses in period 1 came from a subject using the high cost pay-off table, who, when the principal chose R3 in period 2, quite paradoxically responded with C3 again.

Query 2: Did a choice of R1 by the principal lead to type separation as the theory predicted?

A choice of R1 by the principal in period 1 led to a clear separation of types as predicted. A Kruskal–Wallis test for the equality of the distribution of the agent's first period response to R1, gives us a chi-squared value of 41.962 with a p -value of 0.0001. We therefore can reject the null hypothesis that the distribution of the agent's first period response is identical across the two tables. Tables 2 and 3 let us break up the agent responses by the type of pay-off table being used. When the agent was using the high cost pay-off table (see Table 2) 85% of the time the agent behaved in accordance with the equilibrium prediction and responded with C1.

Turning to Table 3, for the agent using the low cost pay-off table, we find that 87% of the time the response to R1 is C3, as the equilibrium predicts.

Query 3: What happened when the principal made the off-equilibrium choice of R2 in period 1? Did this choice lead to pooling behavior from the agents as expected?

Table 4 looks at the sequence of play when the principal starts out by choosing R2 in period 1. Once again Tables 5 and 6 break up the choices according to table type, the former for the high cost pay-off table and the latter for the low cost pay-off table. As we have mentioned before we would expect both types of the agent to respond to R2 with C2.

Table 4 shows that 55% of the time the principal started by choosing R2. In 54% of those cases, the principal got a response of C2, where as in 40% cases the response was C3. To test if a choice of R2 led to separation of types as well, we carried out a Kruskal–Wallis test for the equality of the distribution of the first period responses by the agent. In this case, since we expect both types of the agent to respond with C2, the distribution of the agent's first period responses should be close. But the test returned a chi-square value of 52.504 with a p -value of 0.0001 – thereby providing conclusive evidence in favor of the alternative hypothesis that the distributions were not equal.

Breaking up the responses by table we find that a choice of R2 in period 1 still induced separation of types even though it was not supposed to. Looking at Table 5 we find that when the agent was using the high cost pay-off table, in 85.5% of cases the agent responded to R2 with C2. The principal, recognizing a high cost agent, should persist with R2 in period 2 and in fact did so 75% of the time and was never rejected. If we look at Table 6 for the low cost agent who is expected to respond to R2 with C2 in period 1 as well, we find that in 73% of cases the low cost agent responded with C3 thereby revealing his true type to the principal, while the predicted response C2 was chosen in 27% of cases. But following this revealing C3 response the principal ratcheted the quota up to R3 in only 56% of cases.

If the low cost agent pools with the high cost type and responds to a choice of R2 with C2 then the principal has no way of updating the prior thereby allowing the low cost type to get away with the informational rent. Consider the following null hypothesis: **following a response of C2 against R2 in period 1, the principal persists with R2 in period 2 as well.** A Kruskal–Wallis test for the equality of the distribution of the principal's second period choice in response to C2 returned a value of 1.678 and thus we do not reject the null hypothesis at the 5% level. In 75% of the cases where the principal received the non-revealing C2 response from the agent, (see Table 4) the principal

persisted with R2 in period 2. If the low cost agent responded correctly with C3 in period 2 then he gained 15 francs (95 from R2-C2-R2-C3 which is the predicted sequence against 80 from R2-C3-R3-C3 which is the expected sequence once the agent reveals his type).

Query 4: Did the principal take advantage of the type revelation by the agents by ratcheting up the quota in the second period?

As we noted in Query 1, most of the time the principal did not exploit the agent's type revelation. In those cases where the principal received a C1 response (signaling a high cost agent) following R1 in period 1 the quota was raised to R2 in 68.5% of cases. On the other hand 43% of first period agent responses to R1 are C3 which revealed the agent's type as low cost. In every case the principal should move to R3 in period 2 but did so in roughly 30% of cases. As Table 3 shows, when the principal received a response of C3 following a choice of R1, the principal mostly chose R1 or R2 (73% of the time) and not R3 as expected. In every case where the principal ratcheted the quota up to R3 though, it was fulfilled with the agent choosing C3 in period 2. The response to R1 or R2 is C3 as well which yields the agent a much higher pay-off than the equilibrium sequence (160 from R1-C3-R1-C3, 130 from R1-C3-R2-C3 as opposed to 110 from the equilibrium play of R1-C3-R3-C3). Again as Table 6 shows 73% of the agent responses to R2 are C3 which reveal the agent's type as low cost. But in response the principal raises the quota to R3 in only 56% of cases. And this tendency is pervasive across different experimental sessions. The behavior of the principal in the second period can be tied in with the experimental results from dictator-ultimatum games.⁷ When the principal started with R1 (see Table 1), she received an almost equal number of C1 (48%) and C3 (43.5%) responses. Now these are completely revealing responses. At this point the principal's second period choices can easily be compared to the choices made by the proposers (allocators) in an ultimatum game. When the principal gets a C1 (C3) response the second period choice should be R2 (R3). Choosing R1 in period 2 following C1 would constitute a "fair" offer because it would allow the agent to capture the rent. In those cases where the principal received a C1 response the "fair" offer (R1) was chosen 29% of the time. A C3 response which signified a low cost agent, was met with the appropriate quota R3 in only 30% of the total choices whereas in 70% of the cases the principal chose R1 or R2 which would constitute a "fair" offer. We will postpone a detailed discussion of this till Section 4.2. In all the rounds except the last one the principal and agent changed roles halfway through the session. The generosity of the principal in the first half of the game may be motivated by the fact that in the second half the principal will have to play as agent and is trying to establish a reputation for "fairness" in the hope that the generosity

⁷ These are both bargaining games where the subjects are paired up and one person in the pair is known as the allocator (or proposer) and the other person as responder (or recipient). The allocator is given a sum of money which is to be divided among that person and the responder. In a dictator game, the game ends as soon as the allocator has made the decision as to how much of the money to keep and the responder has no role to play. In the ultimatum game, on the other hand, the responder gets to either accept or reject the offer made by the allocator. If the responder turns down the allocator's offer then they both get zero. Now the game theoretic solution to this simple bargaining problem says that the allocator should offer the responder the smallest possible amount, keeping the rest, and the responder in the ultimatum game should accept whatever amount offered, no matter how small the amount is.

would be reciprocated. We then turned to session 4 where the players never changed roles. In this session the principal does not have to worry about any retaliation. In this last session there were 25 cases where the principal received a response of C3 from the agent in the first period signaling a low cost agent. In 84% of those cases the principal chose not to move to R3 in the second period and this tendency persists throughout the session. Thus the conclusion is that the principal is showing a tendency for behaving in a “generous” fashion.

Query 5: What about rejections by the agent?

Roth (1995) points out that there is a fairly high rate of rejections – ranging from 14% to 19% – of first period offers made by the proposers in ultimatum games. However in this experiment there are few rejections. We have pointed out before that if the principal receives a first period response of C2 from the agent, then a “fair” offer would be R1 in period 2; while following a choice of C3 in period 1, both R1 and R2 would be considered “fair”.

If we look at Table 2 we find that when the agent responds to R1 with C1 revealing himself as high cost the principal ratchets the quota up by choosing R2, which constitutes an “unfair” offer, in 73.5% cases. However in an overwhelming 96% cases the offer is accepted by the agent. In Table 3 we look at the behavior of the low cost agent. After getting a revealing response of C3 in period 1, the principal makes the “unfair” offer R3 which captures the agent’s rent in 27% of cases while making the “fair” offer of R1 and R2 the remainder of the time (73%). Obviously the offers of R1 and R2 are accepted by the agent. But every single one of the R3 offers which extracts the agent’s informational rent are accepted as well. The same pattern can be observed in Tables 5 and 6 which highlight the sequence of plays when the principal started out with R2. In Table 5, 75% of the offers (R2 following C2) are “unfair” but get accepted in every single case. Similarly in Table 6, when the principal increases the quota to R3 following C3, it is accepted in 92% of cases.

4.2. Discussions

There exists a large volume of experimental work on bargaining games which report on the regularity with which play by experimental subjects deviate from game theoretic predictions about equilibrium play. Such deviations have now been documented enough in various different set-ups for them to be dismissed via arguments that the subjects were confused about the instructions.

Observation 1: Why the preponderance of R2 choices by the principal in period 1?

First, a choice of R2 may represent a failure to realize the strategic nature of the choice of R1 which would have led to the agent revealing his true type. If the principal’s attitude is to try for the highest quota possible without any fear of being turned down, then R2 is the obvious choice. With R2 the participation constraint of the high cost type is binding even though the low cost type gets to enjoy the informational rent. R2, in that sense, constitutes a focal point in the principal’s choice. However in light of subsequent events, the choice of R2 does not seem anathema any more. If the agent is going to reveal his type following R2 in period 1 by choosing C1(C3) on the high (low) cost table then

choosing R2 in period 1 makes sense because it yields a much higher pay-off $1/2 * (70+70) + 1/2 * (130+150) = 210$ from starting with R2, as opposed to 195 from starting with R1). It is probable that the principal “experimented” with R2, obtained type revelation and stuck to it from that point onwards.

Observation 2: Why did the agents choose to reveal their type even where revelation was sub-optimal and why did the principal in most cases choose not to take advantage of that information?

We will discuss these two observations together because we believe that the phenomena are related. One possible explanation is that the agents played the game in a myopic fashion, completely ignoring the dynamic aspects of the game and the costs involved in revealing their type. Backward induction is often beyond the grasp of many experimental subjects. This insight has found reinforcement in a variety of sequential move experiments, as for instance the Stahl/Rubinstein game.⁸ Neelin et al. (1988) carry out a series of experiments where they demonstrate that given a bargaining game with a shrinking pie and alternating offers which consists of *more than two rounds*, the Stahl/Rubinstein theory is rejected. The authors comment that subjects do not behave in a manner consistent with the predictions of backward induction. Ochs and Roth (1989) also conclude that the perfect equilibrium fails as a point predictor of observed behavior.

However George Akerlof (1982) model of labor contracts as partial gift exchange might provide an alternative explanation.⁹ The model posits that in their interaction, workers acquire sentiments for each other and also for the firm. As a consequence the workers acquire utility for an exchange of “gifts” with the firm – the amount of utility depending upon the so-called “norms” of gift exchange. On the worker’s side, the “gift” given is work in excess of the minimum work standard; on the firm’s side the “gift” given is wages in excess of “a specified minimum”. In fact Fehr et al. (1996a, b) provide experimental support to this conjecture by showing that reciprocity plays an important role in contract enforcement in a principal agent set-up and leads to gains from trade, even though such reciprocity is not incentive compatible. Their research demonstrates that firms persistently offer contracts with large rents and workers, in turn, behave reciprocally by choosing higher effort levels in cases where they are offered higher rents. The authors argue that reciprocal motivations as formalized by Rabin (1993) have important implications for contract enforcement. In our case reciprocal behavior involves the agent’s “gift” to the principal in revealing his true type even where revelation is not called for and the principal’s “gift” involves not taking away the informational rent of the agent.

⁸ This a paired bargaining game where the players make alternating offers in an attempt to split a shrinking pie. Suppose the initial pie is US\$ 5.00 and every time an offer is rejected the pie gets halved. The game ends after three rounds. So the value of the pie in each round is US\$ 5.00, US\$ 2.50 and US\$ 1.25. If rationality is common knowledge then the first player’s demand is determined as follows: If play continues to the last round then the first party can obtain US\$ 1.25 (less ϵ) and the second party must accept this division. Therefore, in the second round, the second party must offer at least US\$ 1.25 to the first. So if play continues to the second round then the second party will get US\$ 1.25 (US\$ 2.50 – US\$ 1.25). Hence in the first round, the first party must offer US\$ 1.25 to the second, which leaves the first party with US\$ 3.75 (US\$ 5.00 – US\$ 1.25). The first party’s predicted demand yields the so-called Stahl/Rubinstein split. The theory predicts that the first player will always demand the Stahl/Rubinstein split and the second player will always accept it.

⁹ I am indebted to James Andreoni for suggesting this idea to me.

The experiments in dictator/ultimatum games may also provide a clue to the principal's generosity. Guth et al. (1982), Hoffman et al. (1994), Forsythe et al. (1994) among others, report that even though the subgame perfect equilibrium predicts that the allocator in these games should essentially ask for 100% of the pie, in a majority of cases the modal offer made by the allocator is either half of the total sum or less than but close to half of the total sum. This tendency to be "generous" carries over to this experiment where the principal is deliberately not taking advantage of the type revelation by the agent and is thus foregoing a higher pay-off.

Observation 3: Why the low frequency of rejections?

Offers which should have been considered "unfair" by the agents, were seldom turned down. Ruffle (1995) points out that in his experiments recipients' perceptions of their deservingness coincide closely with those of the allocators; offers by allocators to recipients do not differ significantly from the hypothetical offers made by the recipients themselves. Thus the reason behind the low frequency of rejections is that the agents realize after receiving the "unfair" offer that they have actually revealed their types through their first period choice and therefore are willing to accept the principal's offer. The comparison is not necessarily between the principal's pay-off and the agent's pay-off but between what the agent could have obtained if he did not reveal his type against what he gets when he does reveal his type.

5. Concluding remarks

The basic insights that we gain from this experiment are: (1) The equilibrium prediction fared poorly. (2) The principal showed a predilection for an off-the-equilibrium-path choice. (3) The agents, in a large majority of cases, revealed their true types, even when such revelation was sub-optimal in a dynamic sense. (4) The principal, in many cases, chose not to exploit the agent's type revelation thereby foregoing a higher pay-off and allowing the agent to continue enjoying the informational rent. In the previous section we have tried to explain the reasons behind the systematic deviations from the equilibrium prediction. Here we would like to conclude with some broad, general remarks and suggestions for future research. Hoffman et al. (1995) comment "in laboratory experiments we cannot assume that subjects behave as if the world is completely defined by the experimenter... subjects may be concerned about the extent to which their decisions have post-experimental consequences, or that others may judge them by their decisions." Behavior is thus affected by a variety of social norms which are often non-economic in nature. Norms may be legally unenforceable but nevertheless people do feel the necessity to abide by them.

In terms of possible extensions it would be interesting to have subjects play more rounds and see if there is any tendency to play in a more strategic manner, with "learning". However we believe that this paper is an important step in experiments involving contract enforcement in a principal agent set-up in the absence of complete information. Except for the work done by Fehr et al., there is not much experimental work which tries to model how reciprocal behavior might affect contract negotiations in such situations.

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