Learning from Strikes

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Abstract

This paper reports on an experimental study of the influence of asymmetric information and information spillovers on bargaining outcomes. It develops and tests Kuhn and Gu's model (1999) of learning in sequential wage negotiations, by means of two Ultimatum Bargaining Games with uncertainty on the proposer's side. Evidence shows that Dunlop's assertion of inflationary wage demands does not systematically hold and strike incidence is lowered by information spillovers, since demands are revised according to previous bargaining outcomes. However, in the presence of fairness concerns, the ability to observe outcomes but not the bargaining process does not entail a sufficient reduction in information asymmetry to a point of guaranteeing Pareto-improved bargaining outcomes.

Keywords: Asymmetric information, Experiments, Learning, Strikes, Ultimatum Bargaining Games
JEL-Code: C78, C91, C92, J51, J52

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I. Introduction

The economic theory of strikes has long been dominated by the so-called "Hicks' Paradox", according to which a strike can never be Pareto-optimal *ex ante* (Hicks, 1963; Kennan, 1986). Sequential bargaining models under asymmetric information provide the theoretical foundations for circumventing this paradox (Hayes, 1984; Card, 1990; Cramton and Tracy, 1992; Kuhn and Gu, 1999). When the firm is informed of its profitability, but the union is not, Pareto-optimal *ex ante* strikes may occur between rational agents. When initiating a strike, the union acquires information on the firm's profitability and may revise its demands. Consequently, the dissemination of information should act to reduce strike incidence.

While the bulk of literature restricts the scope of bargaining and learning to a single-firm context, except when analyzing wage spillovers among unionized markets, this paper focuses on the collection of information by unions regarding bargaining outcomes in other firms within the same industry. Two conflicting views can then be assessed. Dunlop (1957) assumes that the observation of previously-negotiated wage settlements entails an inflationary wage drift, inasmuch as such settlements become a target for the subsequent unions. In contrast, the sequential bargaining model developed by Kuhn and Gu (1999) under asymmetric information predicts an adjustment of union beliefs and demands whenever unions are in a position to observe previous negotiations in correlated firms. This adjustment should therefore enable reducing the risk of conflict. The contrast between these approaches stems from Dunlop's focus on the role of emotions (envy or equity) in shaping union demands. However, from the study of a panel of Canadian contract negotiations, Kuhn and Gu conclude that union behavior is mainly motivated by a reduction in informational asymmetry. Nevertheless, they cannot directly refute Dunlop's assertion due to their inability to measure emotional concerns.

This paper is aimed at estimating the role of information spillovers on both strike incidence and wage settlements by means of testing, through laboratory experiment, a game directly inspired by Kuhn and Gu. Econometric studies are constrained by the use of proxies of informational asymmetry. The formation of a union's prior beliefs regarding the firm's profitability remains unobservable to the econometrician. Consequently, model outcomes are more frequently estimated than their mechanisms. As remarked by Pencavel (1991), one is not always sure that the results of estimations really measure the implications of asymmetric information instead of the efficiency of proxies. Laboratory experiments, by allowing for direct control over private and asymmetric information, may help in measuring effects on behavior and interactions.

Like in Kuhn and Gu, we propose herein a model in which two union-firm pairs bargain in sequence over the share of a pie. We have designed each union-firm pair negotiation as a non-cooperative Ultimatum Bargaining Game (UBG) with asymmetric information, since UBG enables distinguishing between rationality and emotions in bargaining situations. A UBG is a two-person bargaining game in which a proposer (here the union) proposes dividing a sum to a responder, who either accepts or rejects this proposal; in the case of acceptance, each receives the amount agreed upon, otherwise both players receive nothing. Each union is informed about the probability distribution regarding the state of the firm and about the degree of correlation between the two firms. In contrast, each firm is perfectly informed of its own state. It should be noted that very little research has been conducted on UBG that places uncertainty on the proposer's side (Kagel, Kim and Moser, 1996; Forsythe, Kennan and Sopher, 1991a).

In order to test the link between information and bargaining outcomes, which cannot be estimated by Kuhn and Gu's econometric tests, we have relaxed their constraint of similarity between information on the probability distribution and union beliefs about the state of the firm. We are therefore able to run this game with two types of treatment. In the "high-information treatment", the first union transfers all of its information set cooperatively, including its beliefs and demands, to the second union. In the "low-information treatment", the second union is only informed of the outcome of the first negotiation. This set-up can thus accommodate both the situation in which the two unions belong to the same organization and that in which they belong to different national unions. It also allows testing for the impact not only of learning on strike incidence and on wage settlements, but also of the extent of information (i.e. union organization) on bargaining outcomes.

Our results show that unions' demands align with Myerson's revelation principle (1984). Wage settlements are lower in the second firm since most unions revise their demands downward after a strike in the first firm. Dunlop's hypothesis of inflationary wage demand does not hold in most cases. However, this does not imply that emotions are not at play. As predicted by Kuhn and Gu, in the presence of information spillovers, strike incidence is lower in subsequent negotiations because, in learning from strikes, unions decrease their demands. However, when information is restricted to the outcome of the preceding negotiation, strike incidence is not reduced significantly. Thus, Kuhn and Gu's predictions have been partially refuted. Employers' bargaining behavior, as manifested through their preference for equitable shares, remains a decisive component of both strike incidence and bargaining outcomes.

The remainder of this paper is organized as follows. Section 2 summarizes Kuhn and Gu's model and presents our strike model and its predictions. Section 3 introduces the experimental design, and Section 4 analyzes the experimental data. Section 5 provides some concluding remarks.

II. The Model

Let's first consider the main hypotheses and predictions of the Kuhn and Gu model before presenting our strike game and its theoretical predictions.

A. The Kuhn and Gu Model (1999)

Two union-firm pairs bargain sequentially over wages with asymmetric information[1]. Nature determines whether the profit gross of labor costs is Π_G (the firm is in a good state) or Π_B (the firm is in a bad state), with $\Pi_G > \Pi_B > 0$. Only the firm is perfectly informed of its state. The union is only aware of the prior probability, *p*, that the firm is in a good state. The union then makes a demand $d \in [0, \infty)$. If the firm rejects this demand, i.e. a strike occurs, payoffs are null for both parties since their outside option is normalized to zero. If the firm accepts, the union obtains what it had been claiming. The states of the two firms are correlated. $\alpha \in [0,1]$ denotes the common knowledge coefficient of correlation between them. The conditional probabilities that the second firm is in a good state depending on the state of the first firm are[2]:

$$prob(G_2 / G_1) = \alpha + (1-\alpha)p \text{ if firm 1 is in a good state, and}$$
$$prob(G_2 / B_1) = (1-\alpha)p \text{ if firm 1 is in a bad state.}$$

Both unions exhibit the same *ex ante* value of p ($p_1 = p_2 = p$). The second union is informed of the bargaining outcome in the first firm, before posting its demand. Table 1 illustrates the strategies and payoffs involved.

Let's consider the standpoint of union 1 ("the leader"). If $p>b$ (with $b = \Pi_B / \Pi_G$), it should demand Π_G for itself. This demand will be accepted by a firm in a good state since the firm would incur the cost of a strike if the demand were to be rejected. Conversely, the demand will be rejected by a firm in a bad state. The probability of a strike is *(1-p)*. If $p<b$, the union should make a low demand, Π_B, which is always accepted. In this instance, the probability of a strike is zero.

[1] Kuhn and Gu consider a one-shot, take-it-or-leave-it bargaining game and then an infinite-horizon bargaining model with offers and counteroffers. For the sake of simplicity, we only consider the first model.

[2] The joint probabilities of good and bad states in firms 1 and 2 are given in the following table:

	Firm 2's state		
Firms 1's state	Good	Bad	
Good	$\alpha p + (1-\alpha)p^2$	$(1-\alpha)p(1-p)$	p
Bad	$(1-\alpha)p(1-p)$	$\alpha(1-p) + (1-\alpha)(1-p)^2$	(1-p)
	p	(1-p)	1

Let's now turn our attention to union 2 ("the follower"). Its strategy may be influenced by the outcome of the preceding negotiation, which does enable the union to alter its position. If the first union made a low demand *($p<b$)*, the second union is unable to learn anything from the preceding negotiation since this demand is accepted by firms in either state. Its *ex ante* belief with respect to firm 2 is unaffected and union 2 adopts the same behavior as the leader. No strike can occur. The follower may acquire information on the state of firm 1 only if union 1 has made a separating (high) demand. In this case, the firm is forced to reveal its state: rejection means a bad state, whereas acceptance indicates a good state.

In the event union 1 had made a separating demand that was rejected by the firm, the occurrence of a strike in firm 1 leads union 2 to revise its *ex ante* belief. Union 2's updated prior belief that firm 2 is in a good state becomes: $p_r = (1-\alpha)p$. It makes a separating demand by claiming Π_G only if $p_r > b$, hence if $p > \frac{b}{(1-\alpha)}$. Its demand is accepted provided that firm 2 is in a good state. The threshold above which union 2 differentiates is thus higher than that of union 1. Claiming a high wage even though a strike occurred in the first firm means that union 2 is very optimistic. In the event union 1 had made a separating demand that led to a wage settlement, union 2 learns that firm 1 was in a good state. It therefore updates its belief that firm 2 is in a good state: $p^r = \alpha + (1-\alpha)p$. It separates by claiming Π_G only if $p_r > b$, hence if $p > \frac{(b-\alpha)}{(1-\alpha)}$. Its demand is accepted provided that firm 2 is in a good state.

Table 1
Bargaining Strategies in Kuhn and Gu's One-Shot Bargaining Game

Prior	$p < b$	$b < p < b/(1-a)$	$b/(1-a) < p$
A. DEMANDS AND ACCEPTANCE DECISIONS			
A1. Union-Firm pair 1			
Union's demand	Π_B	Π_G	Π_G
Firm in a good state	Acceptance	Acceptance	Acceptance
Firm in a bad state	Acceptance	Rejection	Rejection
A2. Union-Firm pair 2			
Union 2 learning on Firm 1 state	Impossible	Possible	Possible
Union's demand	Π_B	Π_B if strike in Firm 1 Π_G if wage settlement in Firm 1	Π_G
Firm in a good state	Acceptance	Acceptance	Acceptance
Firm in a bad state	Acceptance	Acceptance of Π_B Rejection of Π_G	Rejection
B. BARGAINING OUTCOMES			
B1. Union-Firm pair 1			
Strike probability	0	$(1-p)$	$(1-p)$
Expected wage (conditional upon reaching a settlement)	Π_B	Π_G	Π_G
Expected profit	$p(\Pi_G - \Pi_B)$	0	0
Expected utility of the union	Π_B	$p\Pi_G$	$p\Pi_G$
B2. Union-Firm pair 2			
Strike probability	0	$(1-a)p(1-p)$	$(1-p)$
Expected wage (conditional upon reaching a settlement)	Π_B	$\frac{[ap+(1-a)p^2]\Pi_G+[1-p]\Pi_B}{[ap+(1-a)p^2]+[1-p]}$	Π_G
Expected profit	$p(\Pi_G - \Pi_B)$	$(1-p)(1-a)p(\Pi_G - \Pi_B)$	0
Expected utility of the union	Π_B	$p[a+(1-a)p]\Pi_G + (1-p)\Pi_B$	$p\Pi_G$

When $b < p < b/(1-a)$, union 2 utilizes the information obtained from the preceding negotiation. It asks for Π_G when the leader separated and no strike ensued and asks for Π_B when the leader separated and a strike did occur.

When union 2 learns from the preceding negotiation (column 2), learning reduces strike incidence ($(1-a)p(1-p) < (1-p)$) and increases both union 2's utility compared to union 1 which holds no information ($p[a+(1-a)p]\Pi_G + (1-p)\Pi_B > p\Pi_G$), and firm 2's expected profit ($(1-p)(1-a)p(\Pi_G - \Pi_B) > 0$).

However, an ensuing strike in the first firm has an uncertain impact on strike activity in the second firm. On the one hand, a strike tends, on average, to moderate wage demands and push wage settlements downward. This moderation decreases the probability of a strike. On the other hand, a strike in the first firm enhances the likelihood of a bad state in the second firm, thereby favoring the occurrence of a strike. In any event, information on the previous negotiation does not motivate unions to inflate their wage demands in comparison with the union that negotiated first; instead, the reduction in information asymmetry allows unions to adjust their strategies accordingly. Thus, Kuhn and Gu assert that information spillovers are Pareto-improving rather than generative of pathological processes, as forwarded by Dunlop.

B. The Strike Game

Our strike game has been largely inspired by the one-shot bargaining model of Kuhn and Gu. However, it differs in that even though each union receives the same information on the probability distribution, we allow for a distinction between unions' beliefs and the probability distribution. This feature relaxes a restriction in the benchmark model and thereby allows us to study the extent of information spillovers and its impact.

Our game has been designed as a double Ultimatum Bargaining Game with uncertainty on the proposer's side; it involves two union-firm pairs which bargain in sequence. The choice of a UBG structure has been motivated by the fact that it allows for a realistic representation of union-firm negotiations. In our game, a union's strength is derived from it being the first mover, yet this strength is tempered by it being the uninformed party. In addition, many experiments on UBG have produced robust results, providing us with an empirical benchmark to compare with our results. These efforts have in particular identified the extent to which emotions play a role in bargaining and, consequently, may help disentangle learning from emotions in our bargaining setting.

Most of the research on bargaining with one-sided private information has placed uncertainty on the side of the responder: the proposer is aware of the actual size of the pie, but the responder is not informed about the initial chance move[3]. To our knowledge, only a few exceptions can be found that place uncertainty on the proposer's side and offer a better representation of union-firm bargaining processes. Kagel, Kim and Moser (1996) show that the rejection rate in UBG is higher when the responder is given the lower payoff and vice versa, in comparison with a situation of full information on both sides. Forsythe, Kennan and Sopher (1991a)[4] consider a two-person pie-splitting game in a cooperative setting; it tests Myerson's revelation principle (1984) stating that a strike is a means for the union to devise incentive mechanisms so as to make the firm reveal its type. From an experiment in which subjects exchange messages, this game reveals that theory does not withstand facts since some strikes occur even though the good state prevails and the strike condition does not hold. However, strikes are indeed more frequent when the bad state prevails and the strike condition holds.

Our ultimatum demand game also accounts for this revelation mechanism but in a non-cooperative setting, by controlling for the unions' beliefs. Two treatments of this game, which differ in the extent of information spillover between the negotiating pairs, have been performed. Whereas

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[3] Two categories of experiments are available (Croson, 1996). On the one hand, some experiments control responders' beliefs over the size of the pie (Mitzkewitz and Nagel, 1993; Güth, Huck and Ockenfels, 1996) or observe the consequences of changes in the prior distribution in demand games (Rapoport, Sundali and Seale, 1996) or in offer games (Rapoport and Sundali, 1996). On the other hand, other experiments do not control for responder's priors (Straub and Murnighan, 1996; Croson, 1996; Güth and van Damme, 1998).

[4] Forsythe, Kennan and Sopher (1991b) propose an experimental study of strikes in which the size of the pie decreases over time as long as subjects argue over its division, yet in the presence of complete information. Coursey (1982) offers a study of strikes whereby bargaining time is severely limited and information incomplete for both parties; his emphasis is on the role of information limitation.

Kuhn and Gu assume that knowledge of the first bargaining outcome held by each union is sufficient for complete dissemination of information, our model introduces additional conditions, i.e. the transfer of information on the first union's belief and demand.

The first treatment ("high-information" treatment, see instructions in Appendix A) involves two union-firm pairs bargaining in sequence, with both unions belonging to the same overall union organization and both firms operating in the same industry. Each union-firm pair bargains over the share of a pie. Each pie amounts to either 30 or 100, depending on the business cycle. It is common knowledge that: *i)* the probability distribution with respect to the state of nature is the same for both firms; and *ii)* the two firms are correlated such that the second firm is in the same state as the first with a probability of 0.8.

The game comprises six steps. Let's consider the first bargaining pair, in which the union is the proposer and the firm the responder. Nature moves by determining whether the firm is in a good state (the pie amounts to 100) with a probability of 0.7 or in a bad state (the pie is 30) with probability 0.3. Then, negotiation commences. In step 1, by being informed only of the probability distribution, the union determines its belief on the pie size (30 or 100) and its wage demand, defined over the interval [0, 100]. In step 2, the firm is informed of the size of the pie. In the event the demand is higher than the actual size of the pie, it is automatically rejected; both parties wind up receiving nil. Otherwise, the firm decides either to reject the demand (in which case both parties get a zero payoff) or to accept it. If an agreement is reached, the union gets what it claimed and the firm winds up with the difference between the actual pie and the union's demand. In step 3, each party is informed of its own payoff.

Consider the second negotiation, which has also been designed as a UBG where the union is the proposer and the firm the responder. In step 4, since both belong to the same organization, the second union is privately informed of: the first union's belief that the first firm is in a good state, its demand and its payoff. During the second union's turn, it declares its belief (either 30 or 100) and makes a demand to the second firm. In step 5, the second firm is informed of the size of the second pie and decides on whether to accept or reject the demand. If the demand is greater than the actual size of the pie, it is automatically rejected and both parties receive nothing. Otherwise, the firm can either reject the demand (in which case both get zero) or accept it. Once an agreement has been reached, the union obtains what it demanded and the firm winds up with the difference between the actual pie and the union's payoff. In step 6, each party is informed of its own payoff.

A second treatment ("low-information" treatment, see instructions in Appendix B) has been designed with the same sequence and rules of bargaining as the "high-information" treatment, except for one difference: the extent of information transferred to the second union has been reduced. The information set consists solely of the probability distribution and the leader's payoff. Thus, the follower is only able to discern a belief on the leader's prior.

The comparison between these two types of treatment is aimed at varying the institutional framework, since the low-information treatment can be used to understand multi-unionism, whereas the high-information treatment may correspond to a unique national organization. The major goal of the comparison is to determine the impact of higher information spillovers on both the probability of a conflict and the average wage, provided a settlement is reached in the second round of negotiations.

C. Theoretical Predictions

The game's parameters have been ascribed the following values. The firm's profit gross of labor costs takes the value $\Pi_G = 100$ in a good state and $\Pi_B = 30$ in a bad state. The probability associated with a good state is $p=0.7$. The degree of correlation between the firms is $a = 0.8$. The optimal strategies depend on the relationship between the profit ratio, b, and the union's belief, p. $b = \frac{\Pi_B}{\Pi_G} = \frac{30}{100} = 0.3$. The inequality [$b < p < b/(1-a)$] leads to considering the intermediate case identified in Kuhn and Gu (see Table 1). The optimal strategies are given in Table 2.

The Nash equilibrium of this game is separating since the firm is forced to reveal its type. Since $p>b$, the leader should always make a separating demand and ask for 100 (or $100-e$) for itself. Firm 1 should accept this demand if in a good state, since it is not worse than the firm's alternative utility level, normalized to zero. If it turns out that the nature move has determined a bad state, this demand is automatically rejected and both subjects receive 0. The probability for a strike to arise is 0.3. The union's expected payoff is 70 and the expected profit is 0. It should be noted that the first union should not concern itself with what is going to happen in the subsequent negotiation since neither its payoff nor its employer's payoff are being affected. As a matter of fact, this game is not a signaling game. In observing the wage settlement in the first firm, the follower can learn from the preceding negotiation. Thus, the second union should condition its demand on the basis of the observed outcome. In the absence of a strike and when the wage settlement is high in the first firm, union 2 should infer the good state of firm 2 and claim a high wage of 100. In contrast, observing a strike in the first firm should cause the follower to revise its *ex ante* belief downward and moderate its demand. Learning from strikes pushes unions' demands downward and reduces strike likelihood in the second firm. It also allows for a Pareto improvement of both the union's and firm's utility.

Table 2
Optimal Bargaining Strategies in the Strike Game

	Union-Firm pair 1	Union-Firm pair 2
A. *Demands and acceptance decisions*		
Union's demand	100	30, if strike in Firm 1 100 otherwise
Firm in a good state	Acceptance	Acceptance
Firm in a bad state	Rejection	Acceptance of 30 Rejection of 100
B. *Bargaining outcomes*		
Strike probability	0.3	0.042
Expected wage (conditional upon reaching a settlement)	100	78.079
Expected profit	0	2.94
Expected utility of the union	70	74.8

These theoretical predictions are similar for both types of treatment. The common knowledge probability of encountering a good state, the correlation coefficient between the two firms and the information conveyed through the bargaining outcome all constitute sufficient conditions for the subjects to behave in accordance with these predictions. In equilibrium, there should be no difference in bargaining behavior or strike incidence from one treatment to the next.

These predictions state the optimal strategies for selfish agents. Experiments conducted on Ultimatum Bargaining Games have however revealed the systematic occurrence of more equal shares than the theory predicts. A majority of proposers offer a fair share, and unfair offers are frequently rejected by responders. In the present case, introducing fairness motivations would lead the first union, in expecting the firm to be in a good state, to claim 50 to 70 instead of 100, and the second union to claim 15 to 20 instead of 30 whenever a strike has occurred in the first firm. In any event, the leader's demand remains separating since it cannot be accepted by a firm which happens to be in a bad state.

Considering agents to be non-selfish however changes learning opportunities. When the leader transfers its full set of information, the follower becomes able to discriminate from among three elements leading to a strike: the leader's behavior, the employer's decision and the state of the firm. As such, it is able to establish a distinction between intentional and unintentional rejection of a demand by the first employer. This discrimination capacity is lost in the low-information treatment. When the leader's payoff is 0, the follower is unable to distinguish between an incorrect belief regarding the state of the firm and the exercise of the firm's veto power, incited by either union greediness or employer toughness. We can thus forward the hypothesis that with agents motivated by fairness concerns, conflicts are more likely to occur when less information gets spread. If the risk of conflict is denoted r_i, with $i\in\{1,2\}$, the inequality $r_{2High}<r_{2Low}<r_1$ should be observed, with the greater risk of conflict in the first firm and the lower risk in the second firm when the union is highly-informed.

III. Experimental Design

The experiment consisted of 6 sessions, with each session comprising 20 periods. These sessions were all conducted in the GATE laboratory, University Lumière Lyon 2, France. 68 subjects were recruited from undergraduate courses in the area's Textile Engineering School. All of them were inexperienced in bargaining experiments. No subject participated in more than one session. The computer program separated the subjects into groups of four. A total of 17 groups were formed. 9 groups played the high-information treatment and 8 played the low-information treatment. A partner-matching protocol was placed into effect, according to which group assignment remained constant throughout the session. This protocol enables obtaining more independent observations than a stranger protocol. Moreover, panel data analysis allows for controlling possible time effects in the behavior of fixed groups. All interactions were anonymous and the subjects were never informed of the identity of the participants they were matched with in any of the sessions. The experiment was computerized using the ZTree software developed at Zurich University. On average, each session lasted one hour, excluding payment of subjects. All amounts were given in ECUs (Experimental Currency Units), with conversion into French Francs at a rate of 10 ECU = 1 FF upon completion of the session.

Participants were randomly assigned to a specific computer terminal, depending on the number drawn randomly from a box upon entering the room. Before the experiment began, written instructions were distributed to participants and read aloud by the experimenter. All participants were thus completely informed about the rules and parameters of the game. Questions were answered privately by the experimenter. Once the experiment had begun, no communication was allowed. Each subject then discovered on his computer screen the role he was assigned to play. Role assignment remained constant throughout the entire session.

The size of the pies was randomly selected before the experimental sessions and we used the same series of values for all sessions in order to make comparisons across groups feasible. At the beginning of each period, the first union (subject A1 in this context-free experiment) had to declare both its belief about the size of the pie and its demand. The first firm (subject B1) was then informed of the actual size of the pie and of the union's demand. He could then decide whether to accept or reject this demand. Each subject was then informed of his respective payoff. Next, the second union-firm pair started to bargain. The second union (subject A2) was informed of A1's payoff and of A1's belief and demand within the context of the high-information treatment. A2 could then decide on his own belief and demand. The second firm (subject B2) was informed of the size of the pie, but not of the outcome of the preceding negotiation since we were not interested in studying the effects of information spillovers on employer behavior. B2 then decided whether to accept or reject the demand. After feedback was provided on each party's payoffs, the round was over and the computer continued into the next period. At the end of each period, once participants had completed their decisions, each one could see a historical table displaying a summary of his decisions, the other player's actions and his payoff in all of the preceding periods.

At the end of the session, participants were requested to fill in a post-experiment questionnaire. Their payoffs were then converted from ECUs into French Francs and they were asked to step one-by-one into a separate room to be paid in private with an envelope containing cash. Payment consisted of the sum of payoffs during each period plus a 20 FF show-up bonus.

IV. Experimental Results

This section presents a discussion of the overall statistics before focusing on a panel data analysis of the role of information on, successively, unions' bargaining behavior and bargaining outcomes in the second round of negotiations.

A. General Results

Many differences arise in a comparison between the first and second negotiations, as indicated in Table 3 below.

Table 3
Summary Statistics

	High Information		Low Information	
	Firm 1	Firm 2	Firm 1	Firm 2

A. Belief and demands				
Rate of belief that pie = 100	0.97	0.77	0.89	0.80
Rate of belief that pie = 30	0.03	0.51 if strike in Firm 1 0.05 otherwise	0.11	0.35 if strike in Firm 1 0.09 otherwise
Average demand	54.58	51.36 [36.84 if strike in Firm 1 60.18 otherwise]	54.63	48.73 [44.42 if strike in Firm 1 52.01otherwise]
B. Bargaining outcomes				
Rate of agreement in firms in a good state	0.85 (108/126)	0.88 (111/126)	0.78 (87/112)	0.80 (90/112)
Rate of agreement in firms in a bad state	0.07 (4/54)	0.30 (16/54)	0.08 (4/48)	0.19 (9/48)
Global strike rate	0.38 (68/180) in which 0.28 (19/68) non-automatic	0.29 (53/180) in which 0.45 (24/53) non-automatic	0.43 (69/160) in which 0.42 (29/69) non-automatic	0.38 (61/160) in which 0.39 (24/61) non-automatic
Average wage (conditional upon reaching a settlement)	51.30	48.82	50.52	43.66
Average profit (conditional upon reaching a settlement)	46.19	42.35	46.39	49.96
Average wage (unconditional)	31.92	34.45	28.73	27.01
Average profit (unconditional)	28.74	29.88	26.38	30.91

Let's examine the high-information treatment. As predicted, whereas a large majority of unions bargaining first believe that the firm is in a good state, the second unions adjust their beliefs by taking into account the outcome of the first negotiation. A c^2 test shows that the composition of beliefs significantly differs from one negotiation to the next at a 0% level. However, almost half of the second unions still believe that their firm is in a good state even though the first bargaining ended in a conflict, by attributing responsibility for the strike to employer toughness.

Accordingly, followers' average wage demands are scaled down after a strike occurred in the first negotiation and, likewise, adjusted upward after an agreement was reached (this is the only case that corresponds with Dunlop's assertion). The differences in demands are significant at a 12%

level, according to the Wilcoxon Mann Whitney test. It should be noted that in both firms, most unions make separating demands yet also exhibit a concern for fairness since they could be making higher demands more consistent with their beliefs. This finding reflects typically-encountered behavior in experiments on the ultimatum bargaining game.

As predicted, most demands are accepted when the firms are in a good state and rejected otherwise. The overall strike rate declines from 0.38 in the first bargaining set (close to the theoretical prediction of 0.3) to 0.28 in the second one. The adjustment in the second unions' demands allows reaching a higher rate of agreement in both types of firms, but this is especially so in bad state firms where the rate of agreement climbs to 0.3 vs. 0.07 in the first bargaining.

Albeit decreasing, the strike rate in the second negotiation remains greater than that predicted theoretically (0.04). This finding can be explained by opposing "automatic" and "non-automatic" rejections. Automatic rejections occur whenever the union's demand is higher than the actual size of the pie, which represents the only case accounted for by the theoretical model with selfish agents. Non-automatic rejections are due to an intentional decision on the part of the employer to reject acceptable demands. In our experiment, the level of demand moderation observed after a conflict is not sufficient to avoid automatic rejections in the second firm: despite their decrease in comparison with the first negotiation, these automatic rejections still generate 55% of the strikes. On the other hand, in the remaining 45% of the strikes, equity considerations induce the firm to intentionally reject demands considered as being unfair. This pattern is also typical of behavior in UBG experiments.

As predicted, experimental evidence indicates both a decrease in average wages in the event of a settlement and an overall increase in union and employer payoffs in the second negotiation. This finding results from both demand moderation and a sharp drop in the incidence of conflicts.

Let's now consider the low-information treatment. The same trends can be observed as for the high-information treatment. In the second firms, unions lower their beliefs and demands after being informed of a strike occurring in the preceding negotiation. A χ^2 test shows that the distribution of beliefs is different between the first and second negotiations, yet similar to the high-information treatment in the second firm, at a 4% level. A Wilcoxon Mann Whitney test accepts the null hypothesis of similar demand distributions in the first negotiation in both treatments at a 6% level. The same test rejects the null hypothesis of a similarity between the average demands submitted during the first and second negotiations at a 5% level. A Wilcoxon Mann Whitney test also rejects the hypothesis of different demand distributions in the second firms from one treatment to the next, at a 41% level. But this is no longer true if the evolution of behavior over time gets considered. However, a change point test, significant at the 2% level, reveals that from the middle of the game onward, highly-informed unions increase their average demand (which amounts on average to 70% of the supposed pie size) after an agreement has been reached in the first firm. In contrast, with the low-information treatment, such an evolution does not occur and unions continue to demand on average 60% of the expected pie size.

With respect to the fist negotiation, a c^2 test allows concluding that no difference exists either in the strike rates or in the average payoffs between the two treatments, at a 1% level. As a consequence of revising beliefs and demands, just like when high information spillovers are allowed, the rate of agreement in the second negotiation increases regardless of the firm's situation. However, the strike rate remains significantly higher, at an 11% level, than when unions receive more information, as demonstrated by a c^2 test. As predicted when considering fairness concerns, $r_{2High}<r_{2Low}<r_1$. As with the high-information treatment, a large proportion of strikes (39%) are due to intentional rejections of acceptable demands. However, whereas more information enables a decline in the share of automatic rejections in overall strikes in the second negotiation, the share of unintentional rejections is stable when unions are less informed. Lastly, once an agreement has been reached, the average wage settlement is lower in the second firm, just like when unions are better informed. However, in contrast with the high-information treatment, there is no significant difference in the average wage that is not conditional upon a settlement involving the first and second firms, as concluded by a Wilcoxon Mann Whitney test, which rejects similarity at a 22% level. This result is due to the incidence of strikes, which remains higher when unions receive less information.

In sum, experimental evidence from both treatments rejects the hypothesis of an inflationary wage demand, as emphasized by Dunlop, since unions revise their demands downward after having observed a strike in the preceding negotiation. Average wage demand only increases once an agreement has been reached when unions are given more opportunity to learn. As in Kuhn and Gu (1999), learning from strikes can serve to reduce the frequency of conflict and make each party better off in most cases. Does this mean that behavior is entirely determined by learning? Information spillovers seem insufficient for achieving the predicted demand revision; emotions are also at play since employers wind up rejecting acceptable demands. While the extent of information favors settling agreements by means of helping unions revise their demands, it also induces tougher behavior on the part of employers, who intentionally reject more demands, thereby explaining that average wages are considerably lower than predicted.

For a better understanding of the role of information and learning in bargaining behavior, a strict test of the structural model was performed, through a panel data analysis. No control variables were added since the aim herein is to identify the pure effect of information variables. We performed OLS estimations on union demands and payoffs and probit regressions on union beliefs and strike incidence in the second negotiation. For each estimation, both individual and time dimensions were taken into account, to control for possible heterogeneity. The results obtained with pooled data were tested against models with effects (the LM test). Whenever the models with effects fit the data more closely, the OLS fixed effect model was tested against the random effect model (the Hausman test). Similarly, the simple binomial probit models were tested against the random group and time effect models. Only the results of the best-fitting models have been presented below. The results on union behavior (beliefs and demands) will be examined before those on bargaining outcomes.

B. Information, Union Beliefs and Demands

Union behavior in the second negotiating round yields information weighted differently according to its extent (see Table 4 below).

When less informed (right part of Table 4), unions pay attention to the average union payoff in the first negotiation by revising both their belief upward, as predicted by Kuhn and Gu, and their demand downward. This means that they learn from the preceding negotiation: the greater the first union's payoff, the more likely the second firm enjoys a good state, yet the risk of intentional rejection by the employer also rises if the demand is considered as feasible but unfair. The occurrence of a strike also significantly lowers demands. Information incites cautious behavior under the low-information condition.

Table 4
Determinants of Union Beliefs (Binomial Probit Model) and Demands (Least Squares with Individual Dummy Variables and Time Effects)

	High Information				Low Information			
	Beliefs (pie = 100)		Demands		Beliefs (pie = 100)		Demands	
Variable	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Constant	-1.3547 (0.8187)	0.0980	0.2407 (2.0027)	0.9045	0.1816 (0.5759)	0.7525	2.5634 (1.5196)	0.0936

Union's belief in the first negotiation	0.1464 (0.9688)	0.8799	8.5153 (2.6566)	0.0016	…	…	…	…
Union's demand in the first negotiation	0.0187 (0.0146)	0.2010	-0.0752 (0.05166)	0.1470	…	…	…	…
Union's payoff in the first negotiation	0.0445 (0.0331)	0.1788	-0.0982 (0.0688)	0.1552	0.0252 (0.0123)	0.0397	-0.0839 (0.0293)	0.0048
Strike in the first negotiation	0.0506 (1.6791)	0.9760	-7.0133 (4.0588)	0.0858	0.2096 (0.5965)	0.7253	-6.8904 (1.6555)	0.0001
Pseudo R^2	0.3660		…		0.1324		…	
χ^2	69.72486		…		21.1987		…	
Adjusted R-squared	…		0.9997		…		0.9997	

Note: Standard errors are reported in parentheses. In the high-information treatment (the low-information treatment, respectively), the number of observations is 180 (160). In the Probit estimation, the value of the log-likelihood is -61.7215 (-69.46502) and the value of the restricted log-likelihood is -96.5839 (-80.0644). The significance level of the χ^2 is 0.0000 (0.0002) and the percentage of good predictions is 0.83 (0.8). In the OLS estimations, the value of the log-likelihood is -475.2172 (-424.5319) and the value of the restricted log-likelihood is -1233.4833 (-1096.1833).

When unions are better informed (left part of Table 4), their demands are positively influenced by information on leaders' beliefs and negatively by information on the occurrence of a strike. Their behavior is not highly significantly influenced by the other unions' demands and wage, which challenges Dunlop's conjecture. Surprisingly, their beliefs are not determined by information spillovers. This finding contrasts with union behavior in a situation where unions are given limited information, which means that the determinants of union behavior cannot be restricted to information and learning.

C. Information, Strike Incidence and Payoffs

When information spillovers are considerable, a subset of information on the first negotiation influences both strike incidence (see Table 5) and union payoffs (Table 6) in the second negotiation. This influence vanishes when information spillover is limited.

Table 5
Determinants of Strike Incidence (Binomial Probit Model)

	High Information		Low Information	
Variable	Coefficient	P-value	Coefficient	P-value
Constant	1.0480 (0.6623)	0.1136	0.0177 (0.4579)	0.9692
Union's belief in the first negotiation	-0.2996 (0.7658)	0.6957	…	…
Union's demand in the first negotiation	0.0067 (0.0144)	0.6416	…	…
Union’s payoff in the first negotiation	-0.0347 (0.0228)	0.1271	-0.0073 (0.0087)	0.3992
Strike in the first negotiation	-1.5293 (1.2799)	0.2321	-0.2561 (0.4826)	0.5957
Pseudo R^2	0.4224		0.0048	
χ^2	9.2656		1.0256	

Note: Standard errors are reported in parentheses. In the high-information treatment, the number of observations is 180. The value of the log-likelihood is -104.4622 and the value of the restricted log-likelihood is -109.0950. The significance level of the χ^2 is 0.0548 and the percentage of good predictions is 0.72. In the low-information treatment, the number of observations is 160. The value of the log-likelihood is -105.8348 and the value of the restricted log-likelihood is -106.3476. The significance level of the χ^2 is 0.5988 and the percentage of good predictions is 0.62.

Summary results indicated that extended information among unions was associated with a decrease in the strike incidence due to automatic rejections. From the Probit estimation, only the first union’s payoff could be taken into account. With lower payoffs, strike incidence in the second negotiation drops since a low payoff induces a downward revision of demands. But when unions are less informed, knowledge of the outcome of the preceding negotiation does not significantly affect strikes, in contrast with Kuhn and Gu’s principle. While information variables are not directly relevant, employer reluctance to accept unequal shares is probably a more influential determinant of strike incidence.

Table 6
Determinants of Union Payoffs
(Least Squares with Group Dummy Variables and Time Effects)

	High Information		Low Information	
Variable	Coefficient	P-value	Coefficient	P-value
Constant	12.9805 (9.5612)	0.1763	20.3137 (7.8879)	0.0109
Union's belief in the first negotiation	-2.4132 (12.6834)	0.8493	…	…
Union's demand in the first negotiation	-0.1888 (0.2467)	0.4449	…	…
Union’s payoff in the first negotiation	0.7252 (0.3286)	0.0286	0.1458 (0.1523)	0.3399
Strike in the first negotiation	29.0160 (19.3771)	0.1361	5.8308 (8.5938)	0.4985
Adjusted R^2	0.5872		0.5052	

Note: Standard errors are reported in parentheses. In the high-information treatment, the number of observations is 180. The value of the log-likelihood is -756.5952. The value of the restricted log-likelihood is -854.5558. In the low-information treatment, the number of observations is 160. The value of the log-likelihood is -688.0387, and the value of the restricted log-likelihood is -744.9514.

Similarly, in a situation of extended information, the second union’s payoffs are positively affected by the first one’s and, to a certain extent, by the occurrence of a strike in the first negotiation since a signal is being conveyed on the necessity of revising demands. In contrast, the very same variables, when constituting the entire information set, exert no significant influence.

Thus, in contrast with the theoretical predictions of our strike model with selfish agents, bargaining outcomes differ with the extent of the information set. Kuhn and Gu’s predictions on the Pareto-improving effect of information spillovers do not stand when unions only receive information on the preceding negotiation outcome. This information is influential only when embedded in a larger set of information, even though the other pieces of information do not directly influence outcomes, but merely help the second unions better understand the first bargaining outcome and thus revise their own demands. Once again, employer behavior is possibly a better direct candidate in explaining bargaining outcomes.

V. Conclusion

It is now widely acknowledged that asymmetric information in bargaining pairs provides an important source of conflict in wage negotiation. Consequently, whenever the uninformed party in a negotiation can improve its knowledge, it should be better off since the risk of conflict should diminish. Information on the business climate, and thus on the capacity of the firm to pay, can be obtained by observing the preceding negotiations in other companies. Kuhn and Gu (1999) offer such a model, in which two union-firm pairs bargain in sequence over the share of a pie, with each firm being correlated to the other. We have proposed herein a model that replicates this structure, but differs from the Kuhn and Gu model as regards: 1) a dissociation between union beliefs and the probability distribution on the state of the firm, and 2) the extent of the information set transferred from the first to the second union. While the "low-information" treatment replicates the Kuhn and Gu model, our "high-information" treatment endows the second union with additional information on the first union's behavior.

Experimental evidence has confirmed the predictions of both the Kuhn and Gu model and our model that information spillovers and learning constitute a driving force behind the revision of demands in bargaining, i.e. unions decrease their demand when learning of a conflict arising in the preceding negotiation. This finding casts some doubt then on Dunlop's conjecture that observing preceding negotiation outcomes leads unions to pathologically raise their demands, thereby entailing an inflationary wage process. An upward revision of demands is observed only when unions are able to learn from the first union's behavior and not just from the bargaining outcome.

However, learning is insufficient to achieve the predicted demand revision and, hence, the predicted wage. Informational conditions must be distinguished as well. Whenever unions can learn solely from the first bargaining outcome, information spillovers do not significantly influence strike incidence and bargaining outcomes, thus refuting Kuhn and Gu's predictions. In contrast, whenever they are given more complete information that enables them to learn from the lead union's bargaining behavior, information spillovers lower strike incidence and Pareto-improve the bargaining outcomes.

Three conclusions may be drawn from this experimental asymmetric information game. First, in the presence of fairness concerns, the opportunity to observe the bargaining outcome, but not the bargaining process itself, cannot enable reducing informational asymmetry sufficiently to guarantee Pareto-improving the bargaining outcomes. Second, if the informational structure were extrapolated to the institutional organization, union heterogeneity would challenge the potential benefits related to information spillovers, whereas union unity incites more profitable behavior for both parties. Third, though the pathological behavior predicted by Dunlop is not encountered in the experimental data, this does not mean that emotions are absent. On the contrary, employers do reject acceptable offers. This finding clearly underscores the necessity to more actively consider not only asymmetric uncertainty but also both parties' bargaining behavior.

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Appendix A

Instructions for the High-Information treatment

[*Upon arrival, each participant draws a card in an envelope indicating the name of a computer terminal in the laboratory. When all participants are seated, the experimenter thanks them for coming, distributes the instruction sheets and reads them aloud.]*

You will be participating in an economics experiment in which you can earn money. The amount of your earnings will depend not only on your decisions, but also on the decisions of the other participants.

During this session, in each period, 4 subjects will interact sequentially in pairs, first A1 with B1, then A2 with B2. Each pair is to share a pie whose amount is given in ECUs (*Experimental Currency Units*). This amount may be either 30 or 100.

This session consists of 20 periods. You will be assigned a role (either subject A1 or A2, or subject B1 or B2) at random. You will keep the same role and interact with the same participants throughout these 20 periods. You will never be informed of the identity of the other participants.

Roles

- Subject A1 is to propose a share of a first pie to subject B1. A1 is not informed of the exact size of the pie. He knows that this size may be either 30 or 100, depending on a chance move. He also knows that this amount is 100 with a probability of 0.7. You may think of this probability, for example, like taking a single ball out of a basket with 7 balls marked 100 and 3 marked 30.

- Subject B1 then has to decide whether to accept or reject A1's demand. As opposed to A1, B1 is informed of the exact size of the pie before making his decision.

- Subject A2 must propose a share of a second pie to subject B2, once the first pie has been shared between A1 and B1. Like A1, A2 is not informed of the exact amount to be shared when making his decision. He only knows that:
  - The pie size is either 30 or 100.
  - The pie amounts to 100 with a probability of 0.7.
  - The second pie has the same size as the first pie shared between A1 and B1 with a probability of 0.8.

  In addition, A2 receives the following information on the share of the first pie:
  - A1's belief about the size of the first pie;
  - A1's demand;
  - A1's payoff.

- Subject B2 then has to decide whether to accept or reject A2's demand. As opposed to A2, B2 is informed of the exact size of the pie before making his decision.

Each period consists of six steps.

- *Step 1:* Subject A1 takes two successive decisions:
  - He decides which size of the pie his demand is to be based upon (either 30 or 100).
  - He then chooses the amount to demand for himself.
- *Step 2:* Subject B1 is informed of the actual size of this first pie and of A1's demand.
  - If A1's demand is greater than the size of the pie, then this demand is rejected automatically. A1's and B1's payoffs are zero for the current period.
  - If A1's demand is equal to or lower than the size of the pie, B1 must make the following decision:
    - Either he rejects A1's demand, in which case A1's and B1's payoffs are zero for the current period;
    - Or he accepts A1's demand, in which case A1 obtains the amount he claimed and B1 receives the difference between the actual amount of the pie and A1's demand.
- *Step 3:* A1 and B1 are informed each of their own payoff.
- *Step 4:* Subject A2 is informed of the amount of the first pie on which A1 based his demand, of A1's demand and of his payoff. Then, he makes the two following decisions:
  - He decides which size of the second pie his demand is to be based upon (either 30 or 100).
  - He chooses the portion of this amount to be kept for himself.
- *Step 5:* Subject B2 is informed of the actual size of the second pie and of A2's demand.
  - If A2's demand is greater than the size of the second pie, then this demand is rejected automatically. A1's and B1's payoffs are zero for the current period.
  - If A2's demand is equal to or lower than the size of the second pie, B2 must make the following decision:
    - Either he rejects A2's demand, in which case A2's and B2's payoffs are zero for the current period;
    - Or he accepts A2's demand, in which case A2 obtains the amount he claimed and B2 receives the difference between the actual amount of the pie and A2's demand.

- *Step 6:* A2 and B2 are informed each of their own payoff.

At the end of the session, you will be paid according to the following rules:

Your earnings are equal to the sum of your payoffs all throughout the 20 periods. ECUs will be converted into French Francs at a rate of 10 ECUs to 1 FF. In addition, you will receive a show-up bonus of 20 FF. You will be paid in a separate room to preserve the confidentiality of your payoff.

* * *

If you have any questions regarding these instructions, please raise your hand; your questions will be answered in private. Once the session begins, talking is not allowed. Any violation of this rule will result in being excluded from the session and not receiving payment. Thank you for your participation.

Appendix B

Instructions for the Low-Information treatment

You will be participating in an economics experiment in which you can earn money. The amount of your earnings will depend not only on your decisions, but also on the decisions of the other participants.

During this session, in each period, 4 subjects will interact sequentially in pairs, first A1 with B1, then A2 with B2. Each pair is to share a pie whose amount is given in ECUs (*Experimental Currency Units*). This amount may be either 30 or 100.

This session consists of 20 periods. You will be assigned a role (either subject A1 or A2, or subject B1 or B2) at random. You will keep the same role and interact with the same participants throughout these 20 periods. You will never be informed of the identity of the other participants.

Roles

- Subject A1 is to propose a share of a first pie to subject B1. A1 is not informed of the exact size of the pie. He knows that this size may be either 30 or 100, depending on chance. He also knows that this amount is 100 with a probability of 0.7. You may think of this probability, for example, like taking a single ball out of a basket with 7 balls marked 100 and 3 marked 30.
- Subject B1 then has to decide whether to accept or reject A1's demand. As opposed to A1, B1 is informed of the exact size of the pie before making his decision.
- Subject A2 must propose a share of a second pie to subject B2, once the first pie has been shared between A1 and B1. Like A1, A2 is not informed of the exact amount to be shared when making his decision. He only knows that:
    - The pie size is either 30 or 100.
    - The pie amounts to 100 with a probability of 0.7.
    - The second pie has the same size as the first pie shared between A1 and B1 with a probability of 0.8.

  In addition, A2 receives information on A1's payoff.

- Subject B2 then has to decide whether to accept or reject A2's demand. As opposed to A2, B2 is informed of the exact size of the pie before making his decision.

Each period consists of six steps.

- *Step 1:* Subject A1 takes two successive decisions:
  - He decides which size of the pie his demand is to be based upon (either 30 or 100).
  - He then chooses the amount to demand for himself.
- *Step 2:* Subject B1 is informed of the actual size of this first pie and of A1's demand.
  - If A1's demand is greater than the size of the pie, then this demand is rejected automatically. A1's and B1's payoffs are zero for the current period.
  - If A1's demand is equal to or lower than the size of the pie, B1 must make the following decision:
    - Either he rejects A1's demand, in which case A1's and B1's payoffs are zero for the current period;
    - Or he accepts A1's demand, in which case A1 obtains the amount he claimed and B1 receives the difference between the actual amount of the pie and A1's demand.
- *Step 3:* A1 and B1 are informed each of their own payoff.
- *Step 4:* Subject A2 is informed of A1's payoff during the first pie sharing round. Then, he makes the two following decisions:
  - He decides which size of the second pie his demand is to be based upon (either 30 or 100).
  - He chooses the portion of this amount to be kept for himself.
- *Step 5:* Subject B2 is informed of the actual size of the second pie and of A2's demand.
  - If A2's demand is greater than the size of the second pie, then this demand is rejected automatically. A1's and B1's payoffs are zero for the current period.
  - If A2's demand is equal to or lower than the size of the second pie, B2 must make the following decision:
    - Either he rejects A2's demand, in which case A2's and B2's payoffs are zero for the current period;
    - Or he accepts A2's demand, in which case A2 obtains the amount he claimed and B2 receives the difference between the actual amount of the pie and A2's demand.
- *Step 6:* A2 and B2 are informed each of their own payoff.

At the end of the session, you will be paid according to the following rules:

Your earnings are equal to the sum of your payoffs all throughout the 20 periods. ECUs will be converted into French Francs at a rate of 10 ECUs to 1 FF. In addition, you will receive a show-up bonus of 20 FF. You will be paid in a separate room to preserve the confidentiality of your payoff.

* * *

If you have any questions regarding these instructions, please raise your hand; your questions will be answered in private. Once the session begins, talking is not allowed. Any violation of this rule will result in being excluded from the session and not receiving payment. Thank you for your participation.