Does Resorting to Online Dispute Resolution Promote Agreements? Experimental Evidence[*]

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Abstract

This paper presents the results of an experiment performed to test the properties of an innovative bargaining mechanism (called *automated negotiation*) used to resolve disputes arising from Internet-based transactions. Automated negotiation is an *online* sealed-bid process in which an automated algorithm evaluates bids from the parties and settles the case if the offers are within a prescribed range. The observed individual behavior, based on 40 rounds of bargaining, is shown to be drastically affected by the *design* of automated negotiation. The settlement rule encourages disputants to behave strategically by adopting aggressive bargaining positions, which implies that the mechanism is not able to promote agreements and generate efficiency. This conclusion is consistent with the experimental results on arbitration and the well-known *chilling effect*: Automated negotiation tends to "chill" bargaining as it creates incentives for individuals to misrepresent their true valuations and discourage them to converge on their own. However, this perverse effect induced by the settlement rule depends strongly on the conflict situation. When the threat that a disagreement occurs is more credible, the strategic effect is reduced since defendants are more interested in maximizing the efficiency of a settlement than their own expected profit.

Key words: Online Dispute Resolution, Arbitration, Experimental Economics, Electronic Commerce, Bargaining.

JEL classification: D74, C91, C78, D44.

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1 Introduction

By reducing transaction costs, the open structure of the Internet offers businesses and consumers a new and powerful tool for electronic trade (Shapiro and Varian 1998). For example, Internet technology lowers buyer search costs by providing them a wider array of products and services from different sellers than they would have in geographically defined markets. The Internet reduces seller search costs as well, by allowing them to communicate product information cost effectively to potential buyers, and by offering sellers new ways to reach buyers through targeted advertising and one-to-one marketing (Bakos 2001, Garicano and Kaplan 2001). From this point of view, electronic commerce is widely expected to increase social welfare by intensifying competition and helping the consumers to enjoy lower prices and more choices.

However, what makes the Internet such an interesting medium for exchange creates also number of legal obstacles which could hinder the full economic potential of electronic commerce from being reaped. The characteristics of the Internet make traditional dispute resolution through judicial procedures unsatisfactory for many controversies that arise in electronic commerce (Froomkin 1997). For instance, suppose that a buyer purchases a product from an auction site and something goes wrong with the sale (e.g. the seller may ship a damaged item or the item may have been incorrectly described in the auction). Such a problematic Internet-based transaction raises several issues about how disputes can be resolved in the virtual environment of electronic markets. First, such a transboundary transaction creates legal uncertainty about which jurisdiction is competent and about the applicable law. Second, given that the parties are physically distant, it seems difficult to haul them into court. Third, the low transaction value may simply discourages the parties to resort to a costly legal process. Consumers who participate in this type of commerce expose themselves to a heightened level of risk due to the anonymity and location of the individual making a sale or purchase (Johnson and Post 1996, Deffains and Fenoglio 2001).[1]

The need to regulate the electronic commerce has scurried the creation of several *on-line dispute resolution* companies that offer computer-aided bargaining forums in order to settle conflict situations. These mechanisms consist of proprietary software which utilize the Internet as a means to more efficiently engage parties in *automated negotiation* of mon-

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[1] This uncertainty can explain that buyers lack trust and confidence in online transactions. For example, 62% of the european consumers declare that the lack of legal protection is the main reason for not purchasing goods online (OCDE 2002). Furthermore, despite the rapid growth in business-to-consumer e-commerce sales, they still account for a very small share of overall transactions. For example, in United States, where most Internet transactions take place, business-to-consumer penetration is just 0.48% of retail sales (Coppel 2000).

etary sums. Automated negotiation appears to be an attractive solution to an important part of the jurisdictional challenges presented by the electronic commerce. It provides a fast, low-cost, and accessible settlement tool in which the legal location and anonymity of the parties do not matter: The resolution is crafted based on the preferences of the parties and does not require the physical presence of them (Rule 2002).[2] Let us elaborate. The resolution process begins when a claimant registers with an online dispute resolution service provider,[3] such as "Allsettle.com" or "Settlementonline.com". The provider then uses the information provided by the claimant to contact the defendant party and invite them to participate in online dispute resolution. If the other party accepts the invitation, they will then file a response to the claimant's complaint.[4] From this point, the software accepts sealed offers from the parties and determine whether a settlement occurs according to the following bargaining rule (Gabuthy 2003). Acting independently and without prior communication, plaintiff and defendant submit price offers b_P and b_D respectively. If the offers converge or crisscross (i.e. $b_D \geq b_P$), then the case is settled and the defendant has to pay the price asked by the claimant: $b = b_P$. If the offers diverge but are within a specified range (i.e. $b_D (1 + \delta) \geq b_P > b_D$), then the settlement price is determined by splitting the difference between the parties' offers:[5] $b = (b_P + b_D)/2$. Comparing to traditional bargaining, it seems that the automated negotiation procedure would be able to help the parties to reach an agreement by providing them an additional possibility to settle their dispute (i.e. when $b_D - b_P < 0$, provided that $b_D (1 + \delta) - b_P \geq 0$).

Our main concern is to investigate this issue by testing experimentally whether automated negotiation is effectively able to generate efficiency. Such an issue has important policy implications for the design of automated negotiation systems and can be of main importance for Internet companies which offer such services to resolve disputes between consumers (e.g. auction sites, insurance companies[6]). Laboratory experiments serve as a

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[2]Many organizations have called for a variety of Internet companies to integrate online dispute resolution into their practices. Participants to the Hague Conference on Private International Law (11-12 December 2000) explored how online dispute resolution can improve trust for electronic commerce by helping to resolve business-to-consumer disputes. In the same way, the OECD Guidelines for Consumer Protection in the Context of Electronic Commerce, completed in December 1999, encourages the use of online dispute resolution.

[3]The provider is simply the website delivering the online dispute resolution process.

[4]Many of the online market sites (e.g. eBay, Amazon) have developed reputation management systems that allow the trading parties to submit a rating of the counter party's performance in a specific transaction (Keser 2002). The rating is then available for future visitors of the site. In this context, the defendant party has a strong incentive to accept the provider's invitation.

[5]The parameter $\delta \in [0, 1)$ is the *compatibility factor* associated to the automated negotiation procedure and is common knowledge. Most of the online dispute resolution providers consider that $\delta = 30\%$.

[6]The insurance industry is by far the largest user of automated negotiation mechanism to resolve differences over payment obligations. Indeed, the largest online dispute resolution mechanisms that have

powerful tool for investigating many kinds of economic phenomena because they provide the means to fully control the economic environment and simulate the basic assumptions of the models under consideration (Smith 1982). Furthermore, the use of experiments to generate original data on automated negotiation is necessary for an even practical reason: The confidentiality which characterizes the online dispute resolution procedures creates important limitations to get field data. The experimental methodology offers the only way to obtain initial data on automated negotiation and therefore to shed some empirical light on how disputants respond to the incentives of this innovative bargaining mechanism.

The remainder of the paper is organized as follows. Section 2 presents the game theoretical analysis of automated negotiation which is based on Gabuthy (2003). This analysis provides the basis to understand the disputants' strategic behavior. Section 3 introduces the experimental design and describes the theoretical predictions. Section 4 analyzes the experimental data and discusses the results. Finally, Section 5 concludes.

2   Theoretical background

We consider two players, a defendant and a plaintiff who bargain over the price at which the plaintiff will sell his claim to the lawsuit, $N = \{D, P\}$. Let v_P denote the plaintiff's reservation price (i.e. the smallest monetary sum he will accept in exchange for the damage). Similarly, let v_D denote the defendant's reservation price (i.e. the greatest sum he is willing to pay for the damage). The valuations of the damage of the defendant and plaintiff are their private information: Each party knows his own reservation price, but his uncertain about his adversary's, assessing a subjective probability distribution over the range of possible values that his opponent might hold. Specifically, each bargainer i regards the opponent's reservation value v_j as a random variable drawn from an independent uniform distribution on $\left[\underline{v}_j, \overline{v}_j\right]$.[7] The automated negotiation procedure provides the following bargaining structure.

Defendant and plaintiff submit simultaneous offers, b_D and b_P respectively, which are analyzed by the computer software to see if a settlement has been reached. If the offers converge or crisscross (i.e. $b_D \geq b_P$), then the case is settled and the damage is sold at price $b = b_P$. If they are not, but differ by less than δ (i.e. $b_D(1 + \delta) \geq b_P > b_D$), then the

emerged so far, such as "Allsettle.com" and "Cybersettle.com", have focused primarily on this market (Rule 2002).

[7]The distribution functions are common knowledge. The incomplete information approach provides a useful framework to take into account some key features of actual negotiations: The fact that each bargainer is uncertain about its adversary's payoff and the possible occurence of "unreasonable" bargaining outcomes, such as breakdowns in negotiations, even when mutually beneficial agreements are possible.

case is also settled and the damage is sold at price $b = (b_P + b_D)/2$, where $\delta \in [0, 1)$ is the compatibility factor associated to the automated negotiation procedure. In this latter case, the rule determines the settlement price by splitting the difference between the players' offers. If the offers differ by more than δ, then the agreement is not reached. In this case, there is no settlement and no money trades hands since each player's payoff from disagreement is zero. In the event of an agreement, each player earns a profit measured by the difference between the agreed price and his reservation value ($b - v_P$ for the plaintiff and $v_D - b$ for the defendant):

$$
u_D\left(b_P, b_D; v_P, v_D\right) = \begin{cases} v_D - b_P & \text{if } b_D \geq b_P \\[2mm] v_D - \frac{b_P + b_D}{2} & \text{if } b_D\left(1 + \delta\right) \geq b_P > b_D \\[2mm] 0 & \text{if } b_D\left(1 + \delta\right) < b_P \end{cases} \tag{1}
$$

$$
u_P\left(b_P, b_D; v_P, v_D\right) = \begin{cases} b_P - v_P & \text{if } b_D \geq b_P \\[2mm] \frac{b_P + b_D}{2} - v_P & \text{if } b_D\left(1 + \delta\right) \geq b_P > b_D \\[2mm] 0 & \text{if } b_D\left(1 + \delta\right) < b_P \end{cases} \tag{2}
$$

We assume that each bargainer makes offers to maximize his expected profit and we restrict attention to strictly monotonic and differentiable strategies for the two players.[8] In this static Bayesian game, a strategy for the defendant is a function $b_D\left(v_D\right)$ and a strategy for the plaintiff is a function $b_P\left(v_P\right)$, indicating that the players' offers depend on their respective valuations.

Consider now the defendant's best reply. This is defined by the following maximization problem:

$$
\max_{b_D} E_{v_P}\left\{u_D\left(b_P, b_D; v_P, v_D\right)/v_D, b_P\left(v_P\right)\right\} \tag{3}
$$

The plaintiff's best reply is defined by the following maximization problem:

$$
\max_{b_P} E_{v_D}\left\{u_P\left(b_P, b_D; v_P, v_D\right)/v_P, b_D\left(v_D\right)\right\} \tag{4}
$$

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[8]In order to get a unique equilibrium, we restrict the analysis by considering that the players' strategies are linear. In a double auction model, Leininger et al. (1989) demonstrate that the linear Bayesian Nash equilibrium is Pareto-efficient. Furthermore, Radner and Schotter (1989) show in an experiment that the linear assumption is consistent with the observed strategies of the players. For a discussion about the additional assumptions made in this model, see Gabuthy (2003).

Then player i employs a best response strategy if for each v_i his offer is a best response against his opponent's strategy. In the automated negotiation procedure, disputants face a complex choice when choosing their offers. Both parties know that while their optimal independent behavior is to play strategically, they could both be better off by bidding truthfully (i.e. $b_D = v_D$ and $b_P = v_P$). However, they also know that each bid they place involves a trade-off between increasing the odds of a successful trade (accomplished by placing a bid closer to their reservation value) and increasing their share of the joint gain should a settlement occur (enhanced by placing a more aggressive bid). The central idea of the analysis is to investigate how the compatibility factor affects the way individuals resolve this trade-off. It would appear at first blush that an increase in the value of δ improves the efficiency of the bargaining situation by increasing the *settlement zone*. In the case where $\delta = 0$, an agreement occurs only when there is some "bargaining space" between the two offers (i.e. when $b_D - b_P \geq 0$), while a positive δ provides the parties a possibility to reach an agreement even when this "bargaining space" does not exist (i.e. when $b_D - b_P < 0$, provided that $b_D (1 + \delta) - b_P \geq 0$). The flaw in this line of reasoning is that it implicitly assumes that the bargaining strategies are unaffected by the changes in compatibility factor. This is not the case, however, since it is easy to show that changes in the compatibility factor have a drastic effect on the equilibrium behavior of the parties: *Ceteris paribus*, when δ increases, the defendant becomes more aggressive by moving away from his reservation value (i.e. by offering a lower price). Furthermore, automated negotiation induces an asymmetric interaction between players since the compatibility factor is only assigned to the defendant's proposal. Under this bargaining rule, the plaintiff's strategy is very slightly affected by the compatibility factor.[9]

Lemma 1. *Under the automated negotiation bargaining rule, the equilibrium offer strategies are*

$$b_D^* (v_D, \delta) = a (\delta) v_D \text{ and } b_P^* (v_P, \delta) = c (\delta) v_P + d (\delta) \overline{v}_D$$

where $a (\delta) = 2 (1 + \delta) / (\delta^2 + 4\delta + 2)$, $c (\delta) = 2 (1 + \delta) / (2 + \delta)^2$ *and* $d (\delta) = 4 (1 + \delta)^3 / (2 + \delta)^2 (\delta^2 + 4\delta + 2)$.

Proof. See appendix 6.1   ¥

Following these expressions, we can state that the compatibility factor has two opposite implications on the settlement zone which is defined by:

$$b_D (1 + \delta) \geq b_P \tag{5}$$

First, by providing the parties an additional possibility to reach an agreement, the compatibility factor increases the settlement zone for given bargaining strategies: It is straightforward to show that the compatibility factor has a positive impact on the left-hand side of (5).

However, at the same time, the compatibility factor leads the defendant to become more aggressive and move away from his true valuation (while the plaintiff's demand is constant):

$$\frac{\partial b_D^* \left(v_D, \delta\right)}{\partial \delta} = \frac{-2\left(\delta^2 + 2\delta + 2\right)}{\left(\delta^2 + 4\delta + 2\right)^2} v_D \leq 0, \text{ since } \delta > 0 \text{ and } v_D \geq 0$$

The defendant' offer strategy is sensitive to changes in the compatibility factor in a natural way: With an increasing compatibility factor, the marginal increment in profit associated with a slightly more aggressive offer becomes weighted more heavily than the possible loss, if as a result of the change, an agreement is precluded. Concerning the plaintiff's offer strategy, we could think intuitively that the defendant's aggressiveness would force the plaintiff to adopt a more concessionary bargaining behavior in order to increase the probability to reach an agreement. This is not the case however because the more compromising party, while enhancing its chances of reaching an agreement, does so at the expense of lowering its expected payoff.

Given these two opposite implications, the global effect of the compatibility factor on the probability that a settlement occurs is not significant, except for extreme values of δ which do not exist in the real automated negotiation procedures. The gain in efficiency due to the increase in the "potential" settlement zone is approximately offset by the efficiency loss due to the parties' strategic behavior, causing the "actual" settlement zone to be slightly affected by changes in δ. In order to illustrate the very low sensitivity of the settlement zone to changes in the compatibility factor, we consider only two extreme values of δ, that is $\delta = \{0, 0.5\}$, and assume that $\underline{v}_i = 0$ and $\overline{v}_i = 1$ $(i \in N)$. The hatched area characterizes the efficiency gain due to the increase in the compatibility factor.
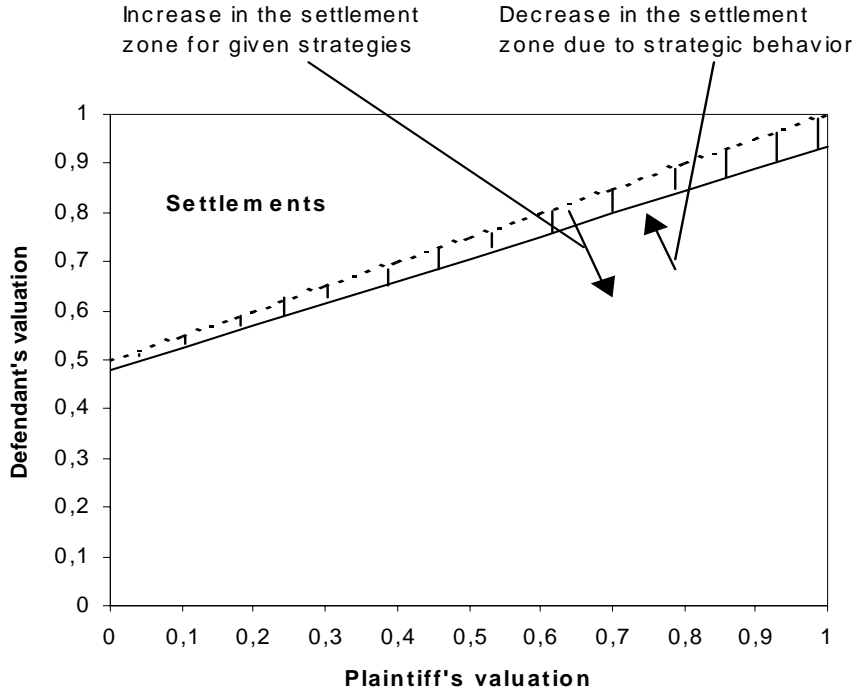
Figure 1: Settlement zones when $\delta \in \{0, 0.5\}$

In figure 1, the dash (resp. solid) straight-line corresponds to the equation $v_D = \left[\frac{\delta^2 + 4\delta + 2}{(1+\delta)(2+\delta)^2} \right] v_P + \frac{2(1+\delta)}{(2+\delta)^2} \overline{v}_D$ with $\delta = 0$ (resp. $\delta = 0.5$).

The result illustrated in this figure is stated precisely in the following Proposition.

Proposition 1. *Under the automated negotiation bargaining rule, the compatibility factor does not improve the efficiency of the settlement zone.*

The intuition underlying this result is the following: The parties have more reluctance to concede during negotiations because the threat that a disagreement occurs is less credible for high values of δ. The upshot is that the more compromising party, while enhancing its chances of reaching an agreement, does so at the expense of lowering its expected payoff when the parties choose their equilibrium strategies. This result is consistent with the predictions of the arbitration models and the well-known *chilling effect* (Farber 1981): Automated negotiation tends to "chill" bargaining as it creates incentives for individuals to misrepresent their true valuations and discourage them to converge on their own (i.e. with $b_D \geq b_P$). In fact, the computer software seems to become a neutral third party who drives the parties' strategies outside the range of potential negotiated settlements. This

result suggests that the automated negotiation design is not a good way for increasing the likelihood of a settlement in the sense that it creates a prisoner's dilemma situation: Each party has a strong individual incentive to exploit strategically the compatibility factor and adopt aggressive positions, which leads to a collective inefficient result. However, while this result is theoretically appealing, we have no idea about whether it characterizes bargaining realities. Therefore, our main concern is now to test the empirical properties of automated negotiation and to examine whether the behavior of participants complies with the theory. The next section presents the experimental procedures and theoretical predictions before focusing on the experimental results.

3   Experimental design and theoretical predictions

Section 3.1 explains the parameters and theoretical predictions in details and Section 3.2 provides a general description of the experimental procedure.

3.1   Experimental parameters and theoretical predictions

At the beginning of each period, each subject i is assigned a private reservation value v_i $(i = D, P)$.[10] Then the defendant and the plaintiff in each group choose simultaneously a bidding price (i.e. b_D for the defendant and b_P for the plaintiff). The experiment is based on a factorial 2x2 design: There are four treatments which exclusively differ with respect to the value of the compatibility factor and the extent of the conflict:

	Conflict situation	
Compatibility factor	Low	High
$\delta = 0$	Low/$\delta = 0$	High/$\delta = 0$
$\delta = 30\%$	Low/$\delta = 30\%$	High/$\delta = 30\%$
Table 1: Overview of experimental treatments		

The basic question in our study is whether the compatibility factor affects the bargaining behavior of the parties and under which circumstances does it increase the probability of reaching an agreement. Therefore, in some of the treatments, participants play under

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[10]That is, participants know exclusively their own reservation values, but not the values of other subjects.

the conditions of "pure" negotiation in which there is no compatibility factor (i.e. $\delta = 0$) and the parties may reach an agreement only if their offers are strictly convergent (i.e. $b_D \geq b_P$). In other treatments, subjects interact under the conditions of automated negotiation where the compatibility equals 30% and the parties have the possibility to settle their dispute even when $b_D < b_P$ (provided that $1.3 b_D \geq b_P$, since $\delta = 0.3$). As mentioned above, $\delta = 30\%$ appears to be a dominant value used by the online dispute resolution providers. However, we can think intuitively that the ability of the automated negotiation mechanism to generate efficiency (if any) depends on the extent of the conflict between the parties. Therefore, the following treatments are introduced in order to analyze whether the impact of the compatibility factor depends on the conflict situation. In a first case, the private values v_D and v_P are independently drawn from a uniform distribution with supports $\{40, 41, ..., 100\}$ and $\{0, 1, ..., 60\}$ respectively, while in a second case the respective uniform distribution sets are $\{20, 21, ..., 100\}$ and $\{0, 1, ..., 80\}$. The last case characterizes obviously a high conflict situation: The dash straight-line in the following figures represents the potential conflict zone.
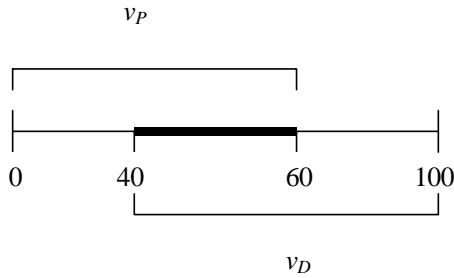

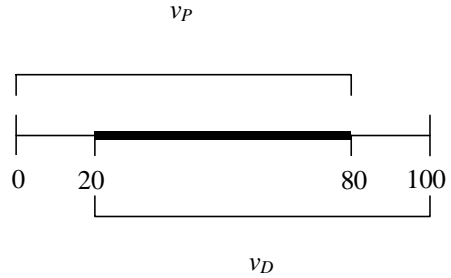Figure 2a: Low conflict situations   Figure 2b: High conflict situations

At the end of each period, the subjects were informed whether or not they have reached an agreement, about the price to be paid by the defendant, their own bid, their own payoff in the current period and their total profit up to this time. Payments were determined according to the automated negotiation rules and the submitted pricing strategies.

In table 2, we use the background developed in Section 2 to determine the theoretical predictions tested in our experiments.[11]

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[11] Recall that the settlement zone, noticed SZ, is given by $SZ = b_D^* (v_D, \delta) (1 + \delta) - b_P^* (v_P, \delta)$, where $b_D^* (.)$ and $b_P^* (.)$ are the players' equilibrium strategies.

	$\delta = 0$ Low and High conflict situations	$\delta = 30\%$ Low and High conflict situations
Equilibrium Bidding Strategies Plaintiff Defendant	$b_P^*(v_P) = 0.5v_P + 50$ $b_D^*(v_D) = v_D$	$b_P^*(v_P, 30\%) = 0.49v_P + 50.49$ $b_D^*(v_D, 30\%) = 0.79v_D$
Efficient Bidding Strategies Plaintiff Defendant	$b_P^e = v_P$ $b_D^e = v_D$	$b_P^e(v_P, 30\%) = v_P$ $b_D^e(v_D, 30\%) = v_D$
Equilibrium Settlement Zone	$SZ^* = v_D - 0.5v_P - 50$	$SZ^*(30\%) = 1.03v_D - 0.49v_P - 50.49$
Efficient Settlement Zone	$SZ^e = v_D - v_P$	$SZ^e(30\%) = 1.3v_D - v_P$
Table 2: Overview of theoretical predictions		

Recall that our basic issue is a positive question: Given that the automated negotiation procedure is designed in a particular manner, does the individuals' behavior corresponds to what the designer intended, and what causes the deviations? Therefore, summarizing the theoretical predictions, our study aims at presenting a test of the following three main hypotheses:

Hypothesis 1. *When $\delta = 0$, the defendant's equilibrium offer is efficient while the plaintiff's asking price is biased upward with respect to his valuation. The settlement zone is under-efficient since truthful bidding is not a Bayesian Nash equilibrium.*

- The defendant adopts a truth revealing behavior by proposing an offer which coincides with his reservation value: $b_D^*(v_D) = b_D^e(v_D) = v_D$.

- The plaintiff's behavior is under-efficient since his proposition is higher than his reservation value: $b_P^*(v_P) > b_P^e(v_P) = v_P$.

This implies that, even when the defendant values the damage more highly than the plaintiff, a successful settlement may be impossible: $SZ^* < SZ^e$.

Hypothesis 2. *When $\delta = 30\%$, the defendant is more aggressive by bidding a lower equilibrium price while the plaintiff's asking price is almost constant. The compatibility factor does not improve significantly the efficiency of the settlement zone and induces the agreements to lie outside the range of potential negotiated settlements, since the parties are discouraged to converge on their own (chilling effect).*

- The defendant is more aggressive which implies that he adopts an under-bidding behavior: $b_D^* (v_D, 30\%) < b_D^e (v_D, 30\%) = v_D$.

- The plaintiff's behavior is constant which involves that he adopts an over-bidding behavior: $b_P^* (v_P, 30\%) > b_P^e (v_P, 30\%) = v_P$.

This implies that not all mutually beneficial agreements can be attained *via* the automated negotiation procedure: $SZ^* (30\%) < SZ^e (30\%)$.

Hypothesis 3. *When the extent of the conflict increases, the settlement zone decreases which implies that an agreement is less likely.*

When the conflict situation is high, the distribution sets induce a reduced settlement zone and do not affect the equilibrium bargaining strategies (for given reservation values). However, we could think intuitively that this result does not characterize bargaining realities: We conjecture that a higher conflict situation should encourage more concessionary behavior by the parties in order to increase the probability to reach an agreement. In other words, the disputants should take more reasonable bargaining positions by moving closer their true values because the threat that a disagreement occurs is more credible in a high conflict situation. In this context, we believe that this concessionary behavior could compensate the perverse effect induced by the compatibility factor. Such a result would imply that the conflict situation alters fundamentally the way the individuals use the compatibility factor: In a high conflict situation, the parties could be incited to use the compatibility factor more efficiently (as a means to increase their chances to reach an agreement) and less strategically (as a means to increase their payoffs).

Before analyzing whether these hypotheses are supported by the empirical results, the following section is devoted to details of the experimental procedure.

3.2   Experimental procedure

In all experimental conditions described below, subjects were participated as a defendant or as a plaintiff, one defendant and one plaintiff forming a group, in a *sealed-bid double*

auction. Role assignment remained the same throughout the entire session.[12] Each pair of participants had to agree on the exchange price of a good. The experiments were run in the GATE experimental laboratory with 160 participants and consisted in 8 sessions, with each session comprising 40 periods. The participants were randomly recruited from a subject pool of students of several universities and the graduate school of management (Lyon). All of them were inexperienced in auction experiments and no subject participated in more than one of the sessions. In each of the 40 periods, the defendant-plaintiff pairs were re-matched such that the same defendant-plaintiff pair did never interact in two consecutive periods. Therefore, in our setup, all the theoretical results hold for all periods: Since interaction is anonymous and one-shot the 40 periods are repetitions of static games and not a dynamic game giving rise to further equilibria.[13]

Upon arrival, participants were randomly assigned to a specific computer terminal.[14] In the beginning of each session, instructions were distributed and read aloud (see Appendices 6.2 and 6.3 for an English translation). Clarifying questions were asked and answered privately. Then, we asked the participants to fill in a control questionnaire in order to check for understanding. Only after all questions had been correctly answered, the experiment started. The experiment was computerized using the REGATE software (Zeiliger 2000). On average, each session lasted one hour, excluding payment of subjects. All amounts were given in ECU (*Experimental Currency Units*), with conversion into Euros at a rate of 2 euros for 100 ECUs upon completion of the session. The total payment was the sum of the single payoffs of the 40 periods plus a 2 Euros show-up fee. The average payoffs per round (in ECUs) and the standard deviations (in brackets) are reported in the following table:

| Compatibility factor | $\delta = 0$ | | $\delta = 30\%$ | |
Conflict situation	Low	High	Low	High
Plaintiffs	15.65	7.50	13.71	9.95
	(3.70)	(3.40)	(3.81)	(3.77)
Defendants	21.96	14.58	18.98	12.13
	(4.43)	(4.48)	(4.43)	(4.24)
Table 3: Average payoffs according to role and treatment				

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[12]In the experiment, we used a more neutral terminology: A buyer (the defendant) and a seller (the plaintiff) bargain over the transfer of an indivisible good (the claim). A successful trade is determined by the automated negotiation mechanism.

[13]All together, we collected 6400 observations and our matching procedure provides us 4 independent observations (two per session) for each treatment.

[14]The GATE experimental laboratory has privacy conditions sufficient to assure that participants could not observe each others' decisions.

For each treatment, defendants earn on average more ECUs than plaintiffs. For defendants, the compatibility factor reduces their earnings in both conflict situations, while this parameter influences differently the plaintiffs' payoffs. Furthermore, whatever the value of the compatibility factor, the players' payoffs are lower in the high conflict situation than in the low one.

4 Experimental results

After a discussion about the participants' observed strategies, we focus our analysis on settlements depending on the extent of the conflict and the value of the compatibility factor.

4.1 Individual behavior

Main differences arise from a comparison of price choices made by parties, especially in our benchmark treatments (i.e. $\delta = 0$). This analysis is a reference point which allows us to study the trade-off faced by individuals and isolate the impact of the settlement rule on their behavior. Furthermore, the objective is then to compare behavioral differences related to an increase in the extent of the conflict and/or the introduction of a compatibility factor. The econometric analysis evaluates the impact of treatment variables on individual proposals.

4.1.1 The impact of the settlement rule

As a benchmark, we consider the case where there is no compatibility factor. In order to compare the observed behaviors with our theoretical predictions, we build the following index:

- Index of deviation from the equilibrium - This index (I_i^*) measures the difference between average proposals made by individuals ($\overline{b}_i$) and the equilibrium bidding strategy (b_i^*):

$$I_i^* = \frac{\overline{b}_i - b_i^*}{b_i^*} \times 100 \quad (i = D, P)$$

A positive value of I_i^* implies that participants propose, on average, an amount higher than the equilibrium prediction. In other words, the plaintiff (resp. defendant) follows a more (resp. less) aggressive pricing strategy than the Nash equilibrium. On the other hand, a negative value means that the observed proposals are lower than the equilibrium. The plaintiff (resp. defendant) adopts a less (resp. more) aggressive behavior than equilibrium one.

- Index of deviation from the efficiency - This index (I_i^e) measures the difference between average proposals made by individuals ($\overline{b}_i$) and the efficient bidding strategy (b_i^e):

$$I_i^e = \frac{\overline{b}_i - b_i^e}{b_i^e} \times 100 \quad (i = D, P)$$

A positive value of I_i^e implies that participants propose, on average, an amount higher than efficiency requires. In other words, the plaintiff (resp. defendant) adopts an over-bidding behavior which consists to ask (resp. offer) a higher compensation than his reservation value. A negative value of I_i^e means that proposals are lower than the efficient amount. The plaintiff (resp. defendant) adopts an under-bidding behavior by asking (resp. offering) a lower compensation than his reservation value.

Following the experimental results, the defendants' proposals are relatively efficient. Indeed, their strategies consist of offering compensations very closed to their reservation values, such that both indexes are low: $I_D^* = I_D^e = -5\%$ or -6%, depending on the conflict situation.[15] On the other hand, plaintiffs' behavior is largely under-efficient since they require amounts strongly higher than their reservation values: $I_P^e = 73\%$ or 32%, depending on the conflict situation. These results are illustrated in figures 3a and 3b:

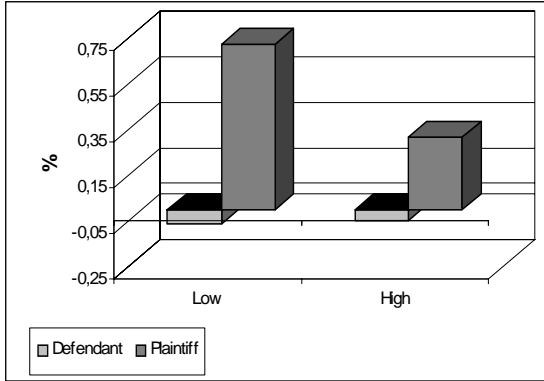Efficiency and equilibrium deviations without a compatibility factor
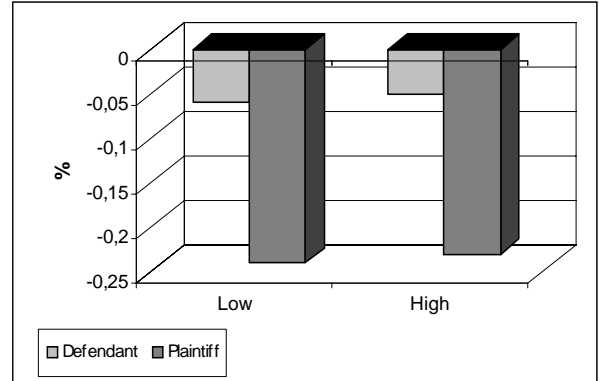

Figure 3a: Efficiency deviation

Figure 3b: Equilibrium deviation

On the individual level, figures 4 and 5 report the proposals made by participants depending on their reservation values. All points located on the dash straight-line correspond to the efficient bids (i.e. the player bids his reservation value $b_i^e = v_i$), while the solid straight-line indicates the equilibrium strategy (b_i^*).

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[15]When $\delta = 0$, $I_D^* = I_D^e$ because $b_D^* = b_D^e = v_D$.

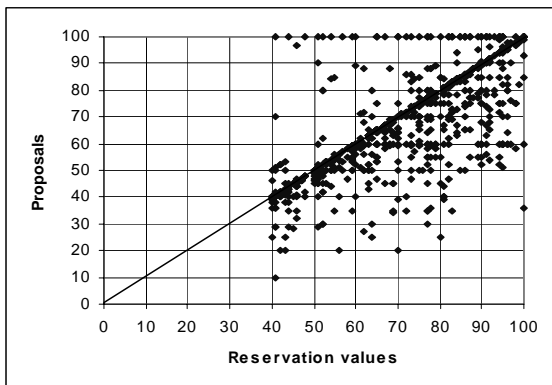Bidding behavior of defendants without a compatibility factor
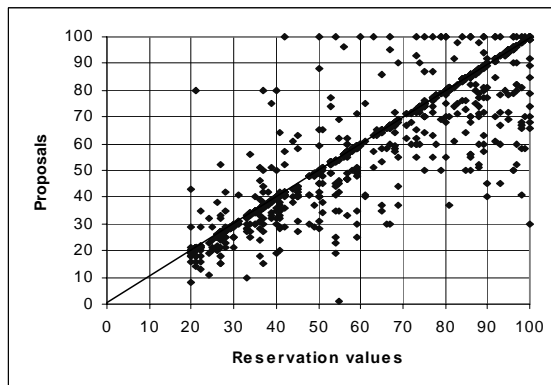

Figure 4a: Low conflict situation

Figure 4b: High conflict situation

Bidding behavior of plaintiffs without a compatibility factor
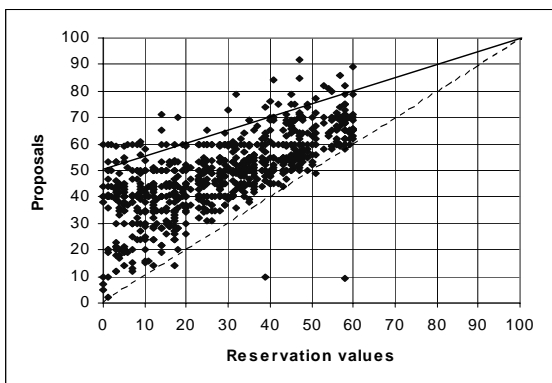

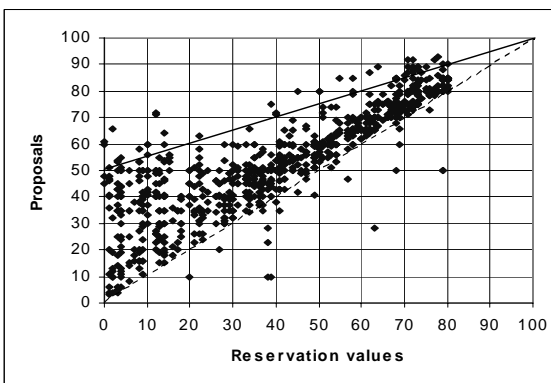Figure 5a: Low conflict situation

Figure 5b: High conflict situation

For defendants, an important mass of points is located on the equilibrium line (see figures 4a and 4b), whereas most of the plaintiffs' bids stand between the equilibrium and the efficiency lines (see figures 5a and 5b). As mentioned above, the plaintiffs' behavior is largely under-efficient since they ask for amounts strongly higher than their reservation value. However, they also adopt less aggressive strategies than the Nash equilibrium predicts, since they set prices significantly lower than predicted: $I_P^* = -24\%$ or -23% (see figure 2), depending on the conflict situation.

These observations are stated in the following result.

Result 1. *When $\delta = 0$, the defendants' behavior is efficient while plaintiffs adopt an over-bidding behavior.*

This asymmetric behavior between defendants and plaintiffs supports the first hypothesis. This result may be explained by making a parallel between our double auction game and the first- and second-price sealed-bid auctions in which several purchasers compete to obtain a good:

1. The problem confronting a defendant in automated negotiation (with $\delta = 0$) is strategically similar to the problem faced by a buyer in a second-price auction. In second-price auctions, the highest bidder gets the object and pays the second highest bid. From a theoretical point of view, this procedure is efficient since bidders have a dominant strategy of bidding up to their private valuation (Vickrey 1961). Indeed, the bid made by the player has no impact on the transaction price he pays and affects only his probability of winning (which is maximized by offering the highest price corresponding to his reservation value). This behavior has been analyzed and confirmed in experiments by Kagel et al. (1987).[16]

In automated negotiation without a compatibility factor, the settlement price is determined solely by the plaintiff's demand (i.e. $b = b_P$), therefore the settlement rule is equivalent to granting the plaintiff the right to make a first and final offer that the defendant can accept or reject. In this context, the defendant's offer serves only to determine whether there is an agreement or not. Therefore, the defendant maximizes the probability to reach an agreement by bidding an amount corresponding to his valuation. The weak deviation observed in figure 3 may be due to errors made in the first rounds by participants.

2. The problem confronting a plaintiff in automated negotiation (with $\delta = 0$) is strategically similar to the problem faced by a buyer in a first-price auction. In first-price auctions, the highest bidder gets the object and pays the amount he bid. The decision-making in first-price auctions is more complex than that in second-price auctions since each bid players place involves a trade-off between increasing the probability of winning (by placing a bid closer to their reservation value) and increasing their profit (by placing a more aggressive bid). The experimental literature shows that buyers under-bid compared to efficiency (because of this trade-off) and over-bid compared to the equilibrium (in order to improve their chances of winning). This standard result is developed in Kagel and Roth (1995).[17]

In automated negotiation without a compatibility factor, the plaintiff's proposal determines both his profit and the probability of conflict resolution. Therefore, he adopts an under-efficient behavior which consists of asking an amount higher than his reservation value. However, he tends to be less aggressive than predicted by the Nash equilibrium in order to improve the likelihood of a settlement (as buyers maximize their probability of winning in first-price auctions).

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[16]This experimental analysis has been replicated by Kagel and Levin (1993) and Harstad (2000). These studies confirm the results of Kagel et al. (1987).

[17]See also Cox, Smith and Walker (1988), and Harrison (1989).

In the following analysis, we study the impact of the compatibility factor and the conflict situation on bargaining behavior: Does the compatibility factor create a chilling effect, such as the parties exploit this parameter to increase their profits? Is this behavior influenced by the conflict situation, such that participants use this parameter more efficiently when the extent of the conflict is high?

4.1.2 The impact of the compatibility factor and conflict situation

In order to investigate the effect of our strategic and treatment variables on the individual behaviors, we run the following random effects linear regression (for each party):

$$
\begin{aligned}
y_{nt} &= X_{nt}\beta + \varepsilon_{nt} \qquad \forall n = 1, ..., N \text{ and } t = 1, ..., T \\
\varepsilon_{nt} &= u_n + v_t + w_{nt}
\end{aligned}
\tag{6}
$$

where X_{nt} is the vector of the independent variables and β the vector of the estimated coefficients.[18]

In our experiment, the various variables which characterize the model (6) are presented in the following table:

Linear regression model (6) - Party i $(i = D, P)$
Dependent variable: Proposal of the party i
Independent variables:
1. Compatibility factor
Value: 1 if $\delta = 30\%$; 0 otherwise
2. Conflict situation
Value: 1 if High; 0 otherwise
3. Compatibility factor and Conflict situation
Value: 1 if $\delta = 30\%$ and High conflict; 0 otherwise
4. Reservation value of i
Value: v_i
5. Reservation value of i (square)
Value: v_i^2
6. Reservation value of i (cube)
Value: v_i^3
7. First ten rounds (learning)
Table 4: Variables of the regression model

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[18]The number of individuals equals 80 ($N = 80$) and number of periods equals 40 ($T = 40$).

The explanatory variables 1 and 2 are the two treatment variables: These dummies study separately the impact of the compatibility factor (variable 1) and conflict situation (variable 2) on the parties' proposals. The cross-variable (variable 3) analyzes the joint influence of these two variables on bargaining behavior. This study determines whether individuals use the compatibility factor more efficiently when the conflict situation is high (by adopting a more concessionary behavior). By considering the variables 4, 5 and 6, we attempt to test whether the bidding strategies employed by both plaintiffs and defendants are linear, as assumed in our theoretical model.[19]

Dependent variables: Proposals	Plaintiff	Defendant
Constant	35.6334***	1.8913
	(1.6212)	(3.4202)
Compatibility factor ($\delta = 30\%$)	3.3052	-14.9866***
	(2.1283)	(2.4562)
High conflict situation	-3.5680*	$-.3027$
	(2.1317)	(2.4586)
Compatibility factor×High conflict situation	2.9659	9.3029***
	(3.0096)	(3.4736)
v_i	.3808***	1.1147***
	(.0680)	(.1613)
v_i^2	.0025	$-.0018$
	(.0020)	(.0027)
v_i^3	.0001	$-.0001$
	(.0001)	(.0001)
Learning in first ten rounds	-2.9854***	-5.1823***
	(.4610)	(.7875)
R^2	62.22%	71.13%
Log-likelihood	-12227.25	-12321.17
Number of observations	3200	3200
Table 5 : Determinants of proposals by plaintiffs and defendants		

This table provides the following main results.[20]

Result 2. *The proposals of the parties are increasing in their reservation values.*

This result is straightforward: The higher the value placed on the damage by the plaintiff (resp. defendant), the higher the amount he demands (resp. offers). Furthermore,

---

[19]A similar analysis is developed by Radner and Schotter (1989) which show that the behavior of the subjects is consistent with the linear equilibrium.

[20]***statistically significant at 1%, **statistically significant at 5%, *statistically significant at 10%.

in accordance with Radner and Schotter (1989), the results strongly support the linearity assumption.

Result 3. *The compatibility factor does not affect the amounts demanded by plaintiffs, while defendants become more aggressive by offering lower compensations.*

This result is consistent with hypothesis 2 and shows that automated negotiation tends to "chill" bargaining as it creates incentives for individuals to misrepresent their true valuations and discourage them to converge on their own. As shown in figures 6 and 7, the plaintiff (resp. defendant) adopts an under-efficient behavior which consists of bidding an amount higher (resp. lower) than his reservation value:

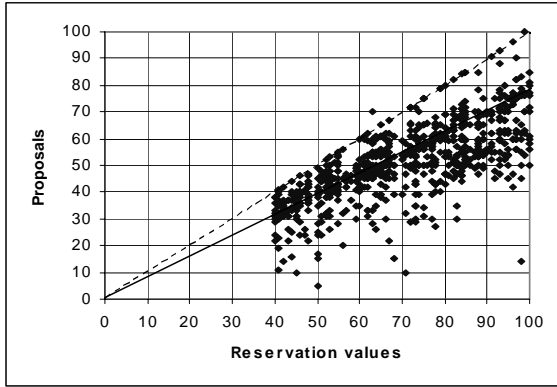Bidding behavior of defendants with a compatibility factor
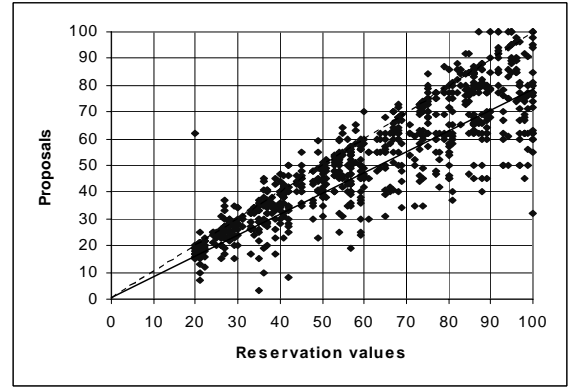

Figure 6a: Low conflict situation

Figure 6b: High conflict situation

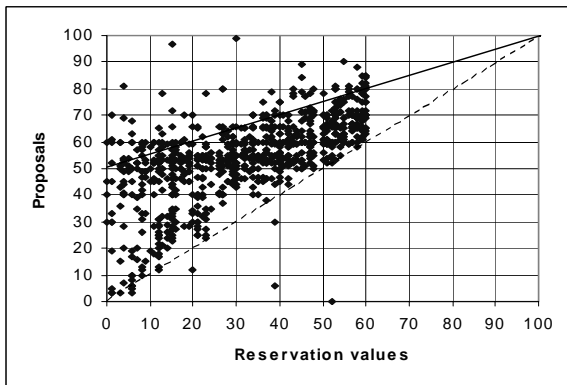Bidding behavior of plaintiffs with a compatibility factor
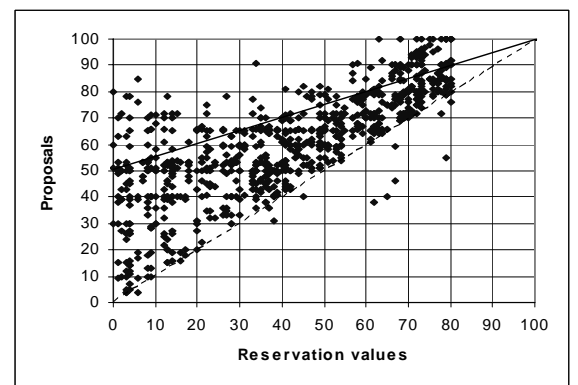

Figure 7a: Low conflict situation

Figure 7b: High conflict situation

The defendant's behavior is sensitive to changes in the compatibility factor in a natural way. When $\delta = 30\%$, if the proposals do not converge but differ by less than δ, the bargaining rule determines the settlement price by splitting the difference between the

parties' offers. Therefore, contrary to the case where $\delta = 0$, the defendant faces a trade-off between enhancing the probability to reach an agreement and increasing his expected payoff. This settlement rule incites defendants to move away from their valuations and closer to the equilibrium prediction ($I_D^e = -27\%$ or -14% and $I_D^* = -8\%$ or 8%, depending on the conflict situation). Contrary to the defendant, the compatibility factor does not affect significantly the plaintiff's behavior since the strategic problem faced by the plaintiff is not fundamentally modified by the split-the-difference rule. Indeed, when $\delta = 0$, the plaintiff faces also a trade-off since the settlement price corresponds to his demand (if the offers converge or overlap). Consequently, when $\delta = 30\%$, the plaintiffs are also encouraged to adopt an under-efficient behavior which is closer to the equilibrium prediction ($I_P^e = 69\%$ or 48% and $I_P^* = -18\%$ or -14%, depending on the conflict situation). These results are illustrated in figures 8 and 9:

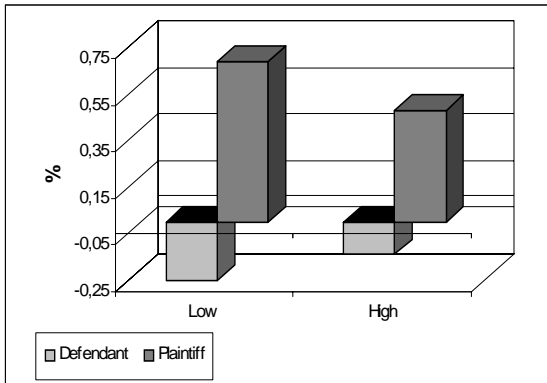<center>Efficiency and equilibrium deviations with a compatibility factor</center>
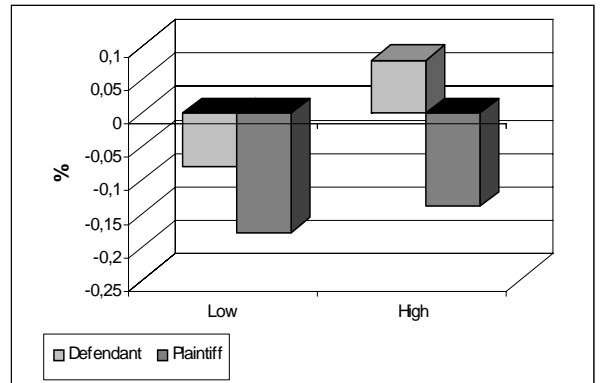

<center>Figure 8: Efficiency deviation   Figure 9: Equilibrium deviation</center>

Result 4. *The compatibility factor associated to a high conflict situation encourages defendants to adopt a more concessionary behavior.*

This result implies that the conflict situation alters fundamentally the way the defendant uses the compatibility factor: The threat of a disagreement becomes more credible in a high conflict situation which encourages defendants to use the compatibility factor less strategically. In this context, a higher conflict reduces the chilling effect related to the compatibility factor: The defendant uses the automated negotiation mechanism more efficiently in order to increase the probability to reach an agreement. This effect leads the defendants' proposals to move towards their valuations for high conflict situation ($I_D^e = -14\%$) and to become higher than the equilibrium offers ($I_D^* = 8\%$). For the reasons mentioned above, the asymmetric behavior between defendants and plaintiffs

<center>20</center>

remains effective: The plaintiffs' proposals are not affected by the compatibility factor in high conflict situation.

These results characterize the implications of the automated negotiation design on the parties' behavior. The next section analyzes how this behavior affects the probability to reach an agreement.

4.2 Conflict resolution

In order to investigate the effect of our strategic and treatment variables on conflict resolution, we run the following random effects Probit model:

$$
\begin{aligned}
y_{nt}^* &= X_{nt}\beta + \varepsilon_{nt} \qquad \forall n = 1, ..., N \text{ and } t = 1, ..., T \qquad (7) \\
\varepsilon_{nt} &= u_n + v_t + w_{nt} \\
y_{nt} &= 1 \text{ if } y_{nt}^* \geq 0 \\
y_{nt} &= 0 \text{ if } y_{nt}^* < 0
\end{aligned}
$$

where X_{nt} is the vector of the independent variables and β the vector of the estimated coefficients. Furthermore, y_{nt} equals 1 if an agreement is reached and 0 otherwise.

In our experiment, the various variables which characterize the model (7) are presented in the following table:

Probit model (7)
Dependent variable: conflict resolution
Independent variables:
1. Compatibility factor
Value: 1 if $\delta = 30\%$; 0 otherwise
2. Conflict situation
Value: 1 if High; 0 otherwise
3. Compatibility factor and Conflict situation
Value: 1 if $\delta = 30\%$ and High conflict; 0 otherwise
4. Reservation value of the plaintiff
Value: $v_P/100$
5. Reservation value of the defendant
Value: $v_D/100$
Table 6: Variables of the Probit model

The explanatory variables 1 and 2 are the two treatment variables: These dummies study separately the impact of the compatibility factor (variable 1) and conflict situation

(variable 2) on the probability to resolve the conflict. The joined effect of these treatment variables is analyzed by the introduction of a cross explanatory variable (variable 3). By considering the explanatory variables 4 and 5, we wish to test the influence of the reservation values on the probability of reaching an agreement.

Dependent variable: Conflict resolution	
Constant	-1.6667^{***}
	(.1176)
Compatibility factor ($\delta = 30\%$)	$-.1361$
	(.0992)
High conflict situation	.0753
	(.0871)
Compatibility factor$\times$High conflict	.3123***
	(.1127)
v_P	-3.5672^{***}
	(.1200)
v_D	5.3213***
	(.1347)
ρ	.0602***
	(.0178)
Log-likelihood	-1207.454
Restricted log-likelihood	-1218.821
Chi-squared	22.7343
% of predicted observations	83.66%
Number of observations	3200
Table 7: Determinants of conflict resolution	

This table provides the following main results:[21]

Result 5. *The likelihood of a settlement increases (resp. decreases) with the defendant's (resp. plaintiff's) reservation value.*

This result is straightforward since the higher the value placed on the damage by the plaintiff (resp. defendant), the higher the amount he demands (resp. offers). Therefore, when v_P increases and v_D decreases, it is more difficult for participants to settle their dispute.

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[21]***statistically significant at 1%, **statistically significant at 5%, *statistically significant at 10%.

Result 6. *The compatibility factor does not affect the likelihood of a settlement.*

This result is consistent with hypothesis 2 according to which the compatibility factor does not improve significantly the efficiency of the settlement zone. The following table supports this conclusion and shows that the automated negotiation mechanism is not a relevant source of efficiency. Indeed, the compatibility factor induces a slight increase in the conflict rate:[22]

	Settlement rates	Conflict rates
$\delta = 0$	65.4%(1046)	34.6%(554)
$\delta = 30\%$	63.5%(1016)	36.5%(584)
Table 8: Settlement and conflict rates		

Furthermore, the automated negotiation procedure leads the occurrence of a "straight" settlement to be less likely insofar as the parties are discouraged to converge on their own (i.e. $b_D \geq b_P$). Figure 10 illustrates this result by plotting the average difference between proposals of defendants and plaintiffs over the 40 periods ($b_D - b_P$). Without compatibility factor, the defendants' offers are on average higher than the plaintiffs' demands (i.e. the solid curve is always within the positive part of the graph). On the other hand , when $\delta = 30\%$, the average difference is negative which shows that the parties have more reluctance to concede during negotiations. Such a result implies that the automated negotiation settlements lie outside the range of negotiated agreements, as shown in figure 11.

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[22]The numbers of settlements and conflicts are between brackets (1600 observations are available for each value of δ).
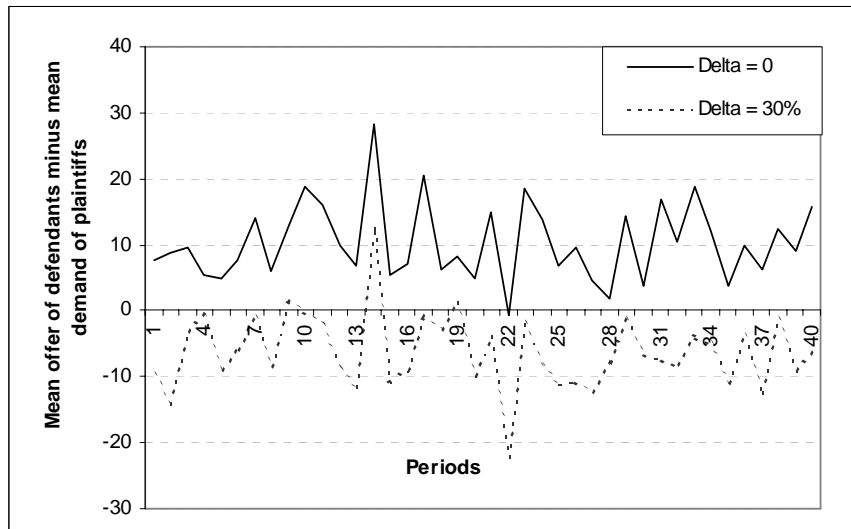
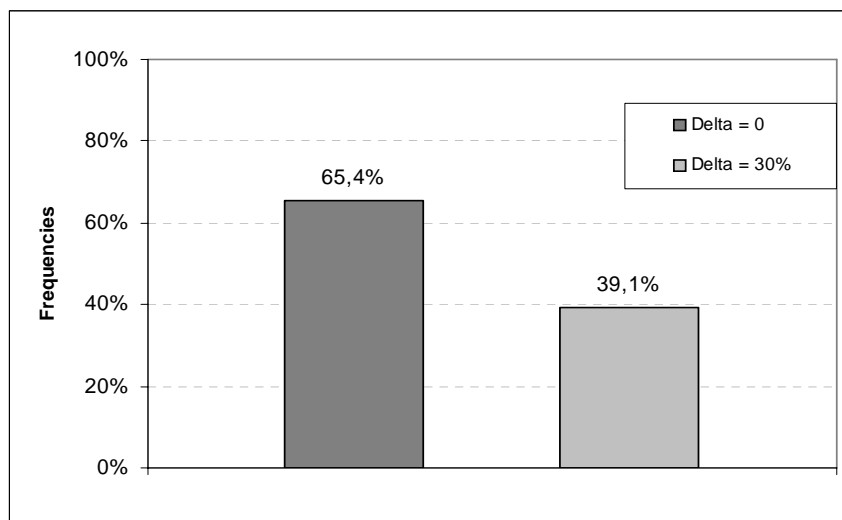Figure 10: Average proposal differencies between plaintiffs and defendants

Figure 11: "Natural" settlement rates according to the compatibility factor value

Result 7: *The compatibility factor associated to an higher conflict increases the likelihood of a settlement.*

As illustrated in the table below,[23] the ability of the automated negotiation mechanism to generate efficiency and induce the parties to reach an agreement depends on the conflict

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[23]The number of agreements obtained in each treatment is between brackets (800 observations are available for each treatment).

situation. In low conflict situations, the chilling effect associated to the compatibility factor over-compensates the positive effect of this factor on the probability to reach an agreement: The settlement rate decreases from 76.5% (when $\delta = 0$) to 69.2% (when $\delta = 30\%$). In higher conflict situations, the chilling effect is reduced since the threat that a disagreement occurs is more credible which implies that automated negotiation promotes agreements: The settlement rate increases from 54.3% (when $\delta = 0$) to 57.8% (when $\delta = 30\%$):[24]

	Settlement rates	
	Low conflict	High conflict
$\delta = 0$	76.5%(612)	54.3%(434)
$\delta = 30\%$	69.2%(554)	57.8%(462)
Table 9: Settlement rates		

5 Concluding remarks

In this paper we used the Bayesian-Nash model of noncooperative games with incomplete information proposed by Harsanyi (1967, 1968) in order to analyze the theoretical properties of the automated negotiation procedure and derive equilibrium strategies for the plaintiff and defendant. In addition, the empirical properties of this innovative bargaining mechanism are tested by performing a set of experiments.

In the single-stage bilateral bargaining game played under automated negotiation, each party faces a basic strategy trade-off: By making a more aggressive price offer, a player earns a greater profit in the event of an agreement but, at the same time, increases the risk of disagreement. The experimental results leave little doubt that most participants in the automated negotiation game behave strategically and the trade-off they faced is strongly affected by the compatibility factor and the extent of the conflict:

- Under the conditions of pure negotiation (i.e. $\delta = 0$), defendants tend to bid honestly while the plaintiffs' bid functions tend to fall between the one predicted by the Nash equilibrium and the one predicted by truth-telling behavior.

- Under the conditions of automated negotiation (i.e. $\delta = 30\%$), defendants tend to underbid and plaintiffs tend to overbid as predicted by the Nash equilibrium. Fol-

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[24]However, we have to be more precise and state that the increase in the settlement rate remains rather weak (+3.5%) which shows that the chilling effect is relatively robust.

lowing the experimental literature on arbitration (Ashenfelter et al. 1992, Dickinson 2004), the compatibility factor creates a chilling effect insofar as the settlement rule splits-the-difference between the disputants' propositions and give them incentives to adopt aggressive bargaining positions. Such a behavior implies that the automated negotiation procedure does not significantly increases the likelihood of a settlement and appears to be a limited solution to disputes arising from Internet-based transactions.

- However, this perverse effect induced by the design of automated negotiation and the disputants' strategic behavior depends strongly on the conflict situation. When the threat that a disagreement occurs is more credible, the chilling effect is reduced since defendants are more interested in maximizing the probability to settle the dispute than their own expected profit: Defendants use the compatibility factor more efficiently in order to increase the probability to reach an agreement

These conclusions have important policy implications for the regulation of electronic commerce and several Internet companies which provide automated negotiation services to resolve disputes between consumers. However, much more work remains to be done in order to understand the various matters that impinge on this issue. One can consider this paper to be a step in the investigation of computer-aided bargaining in online environments. While it is obvious that further experiments will have to be done before a clear picture of how the types of bargaining mechanism studied here perform, we think that the types of question raised by our experiment will be central to the final unraveling of the puzzles presented by these bargaining mechanisms.

6 Appendix

6.1 Proof of Lemma 1

Considering linear strategies, we assume that the plaintiff's strategy is $b_P(v_P) = a_P + c_P v_P$ and the defendant's one is $b_D(v_D) = a_D + c_D v_D$. Then b_P is uniformly distributed on $[a_P + c_P \underline{v}_P, a_P + c_P \overline{v}_P]$ and b_D is uniformly distributed on $[a_D + c_D \underline{v}_D, a_D + c_D \overline{v}_D]$. Following (1) and (2), the maximization problems (3) and (4) become

$$\max_{b_D} \left[v_D - \left(\frac{b_D + a_P + c_P \underline{v}_P}{2} \right) \right] \left(\frac{b_D - a_P - c_P \underline{v}_P}{c_P (\overline{v}_P - \underline{v}_P)} \right) + \left[v_D - \frac{b_D (4 + \delta)}{4} \right] \frac{\delta b_D}{c_P (\overline{v}_P - \underline{v}_P)}$$

$$\max_{b_P} (b_P - v_P) \left[\frac{a_D + c_D \overline{v}_D - b_P}{c_D (\overline{v}_D - \underline{v}_D)} \right] + \left[\frac{b_P (4 + 3\delta)}{4 (1 + \delta)} - v_P \right] \frac{\delta b_P}{c_D (\overline{v}_D - \underline{v}_D)(1 + \delta)}$$

The first-order conditions for which yield

$$b_D = \frac{2 (1 + \delta)}{\delta^2 + 4\delta + 2} v_D \tag{8}$$

$$b_P = \frac{2 (1 + \delta)}{(2 + \delta)^2} v_P + \frac{2 (1 + \delta)^2}{(2 + \delta)^2} (a_D + c_D \overline{v}_D) \tag{9}$$

Given the linear strategies $b_D(v_D) = a_D + c_D v_D$ and $b_P(v_P) = a_P + c_P v_P$, by manipulating (8) and (9), the linear equilibrium strategies are

$$b_D^*(v_D, \delta) = \frac{2 (1 + \delta)}{\delta^2 + 4\delta + 2} v_D$$

$$b_P^*(v_P, \delta) = \frac{2 (1 + \delta)}{(2 + \delta)^2} v_P + \frac{4 (1 + \delta)^3}{(2 + \delta)^2 (\delta^2 + 4\delta + 2)} \overline{v}_D$$

6.2 Instructions ($\delta = 0$, Low conflict situation)

You will be participating in an economics experiment in which you can earn money. The amount of your earnings will depend on your decisions, but also on the decisions of the other participants.

In the experiment, a buyer and a seller form an anonymous group. This session consists of 40 independent rounds. You will be assigned a role (either buyer or seller) and you will keep the same role throughout these 40 periods. However, at the beginning of each round, the groups are rematch randomly, with a buyer and a seller.

Each group of participant has to agree on the exchange price of a good.

Description of a round:

- Private valuations of the good -

At the beginning of each round, buyers and sellers get a private valuation for the good.

- For a buyer: His valuation corresponds to the greatest monetary sum he is willing to pay for the good. The private valuations are randomly and independently drawn from the distribution set $\{40, 41, ..., 100\}$.[25] Each integer in this distribution set has the same chance to be selected.

- For a seller: His valuation corresponds to the smallest monetary sum he is willing to accept in exchange for the good. The private valuation are randomly and independently drawn from the distribution set $\{0, 1, ..., 60\}$.[26] Each integer in this distribution set has the same chance to be selected.

- Price offers -

Once informed about their private values, sellers and buyers submit simultaneously a price offer:

- The price offered by the buyer is noticed p_A

- The price asked by the seller is noticed p_V

- Determination of an agreement -

After the price offers have been submitted, the software confronts the two propositions: An agreement occurs if the price offered by the buyer is higher or equal to the price submitted by the seller:

$$p_A > p_V$$

Otherwise, there is no agreement.

- Transaction price -

If an agreement occurs, the transaction price equals the price asked by the seller, p_V

- Computation of the earnings -

---

[25] In high conflict situation treatments, the distribution set is $\{20, 21, ..., 100\}$.

[26] In high conflict situation treatments, this distribution set is $\{0, 1, ..., 80\}$.

If an agreement is reached, the earnings of the seller and the buyer are:

- For the buyer: His private valuation minus the transaction price.

- For the seller: The transaction price minus his private valuation.

In case of disagreement, the seller and the buyer earn nothing.

- Feedback information -

At the end of each round, you will be informed about the following elements:

- Your private valuation;

- Your price offer;

- If there is an agreement or not;

- The transaction price (in case of agreement);

- Your payoff for that period,

- Your cumulated earnings.

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 40 periods. ECUs will be converted into Euros at a rate of 2 euros for 100 ECUs. In addition, you will receive a show-up fee of 2 Euros. You will be paid in a separate room to preserve the confidentiality of your payoffs. Before to start the experiment, we will ask to fill an understanding questionnaire about these instructions. To go further, all participants have to answer correctly to all the questions. At the end of the experiment, we will ask you to give us information about your age, sex, level and field of study, university or school and either or not you had already taken part in an experiment. Please, take some additional time to read again these instructions. If you have any questions regarding these instructions, please raise your hand; your questions will be answered privately. During the session, we kindly ask you to not ask question or speak loudly. Thank you for your participation.

6.3   Instructions (δ = 30%, Low conflict situation)

You will be participating in an economics experiment in which you can earn money. The amount of your earnings will depend on your decisions, but also on the decisions of the other participants.

In the experiment, a buyer and a seller form an anonymous group. This session consists of 40 independent rounds. You will be assigned a role (either buyer or seller) and you will keep the same role throughout these 40 periods. However, at the beginning of each round, the groups are rematch randomly, with a buyer and a seller.

Each group of participant has to agree on the exchange price of a good.

Description of a round:

- Private valuation of the good -

At the beginning of each round, buyers and sellers get a private valuation for the good.

- For a buyer: His valuation corresponds to the greatest monetary sum he is willing to pay for the good. The private valuations are randomly and independently drawn from the distribution set $\{40, 41, ..., 100\}$.[27] Each integer in this distribution set has the same chance to be selected.

- For a seller: His valuation corresponds to the smallest monetary sum he is willing to accept in exchange for the good. The private valuation are randomly and independently drawn from the distribution set $\{0, 1, ..., 60\}$.[28] Each integer in this distribution set has the same chance to be selected.

- Price offers -

Once informed about their private values, sellers and buyers submit simultaneously a price offer:

- The price offered by the buyer is noticed p_A

- The price offered by the seller is noticed p_V

- Determination of an agreement -

After the price offers have been submitted, the buyer's proposition is increased by 30%:

$$p_A + p_A \times 30\%$$

Then, the software confronts the two propositions.

An agreement occurs if the price offered by the buyer (plus 30%) is higher or equal to the price submitted by the seller:

$$p_A + p_A \times 30\% > p_V$$

Otherwise, there is no agreement.

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[27] In high conflict situation treatments, the distribution set is $\{20, 21, ..., 100\}$.

[28] In high conflict situation treatments, this distribution set is $\{0, 1, ..., 80\}$.

If an agreement is reached, the software determines the price at which the transaction occurs.

- Case 1: The price proposed by the buyer is higher or equal to the price submitted by the seller :

$$p_A > p_V$$

  Then, the transaction price equals the price asked by the seller, p_V

- Case 2: The price offered by the buyer is strictly lower than the price asked by the seller:

$$p_A < p_V$$

  AND the price offered by the buyer (plus 30%) is higher or equal to the price asked by the seller:

$$p_A + p_A \times 30\% > p_V$$

  Then, the transaction price corresponds to the median of the two propositions : $(p_V + p_A)/2$.

- Computation of the earnings -

If an agreement is reached, the earnings of the seller and the buyer are :

- For the buyer: His private valuation minus the transaction price.

- For the seller: The transaction price minus his private valuation.

In case of disagreement, the seller and the buyer earn nothing.

- Help to take your decisions -

The software computes automatically two "thresholds" (one for the buyer and one for the seller) depending on the price that you may want to submit.

- For the buyer: This "threshold" indicates the highest offer that the seller has to submit to get an agreement.

- For the seller: This "threshold" indicates the lowest offer that the buyer has to submit to get an agreement.

At the end of each round, you will be informed about the following elements:

- Your private valuation;

- Your price offer;

- If there is an agreement or not;

- The transaction price (in case of agreement);

- Your payoff for that period,

- Your cumulated earnings.

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 40 periods. ECUs will be converted into Euros at a rate of 2 euros for 100 ECUs. In addition, you will receive a show-up fee of 2 Euros. You will be paid in a separate room to preserve the confidentiality of your payoffs. Before to start the experiment, we will ask to fill an understanding questionnaire about these instructions. To go further, all participants have to answer correctly to all the questions. At the end of the experiment, we will ask you to give us information about your age, sex, level and field of study, university or school and either or not you had already taken part in an experiment. Please, take some additional time to read again these instructions. If you have any questions regarding these instructions, please raise your hand; your questions will be answered privately. During the session, we kindly ask you to not ask question or speak loudly. Thank you for your participation.

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