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Multi-attribute Reverse Auctions and Negotiations with Verifiable and Not-verifiable Offers

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***Abstract*—Comparative studies of auction and negotiation exchange mechanisms have typically compared the outcomes obtained from the two mechanisms. Their result are inconclusive. The question which this paper aims to address is the viability of outcome-based comparisons. Such comparisons assume that both mechanisms produce the same types of outcomes but their values differ. An argument can be made that this is not necessarily the case. Based on several experiments of multi-attribute auctions and two formats of multi-bilateral negotiations the paper argues that the two mechanisms produce some outcomes which are comparable and other outcomes which are qualitatively different. A surprising finding of our experiments is that the outcomes of the non-verifiable negotiations were more similar to the outcomes of the reverse auctions than to the verifiable negotiations, despite the fact that the latter employ rules taken from the auction mechanism.**

I. Introduction

AUCTIONS and negotiations are exchange mechanisms used by individuals and institutions including, among others businesses and governments. There are many kinds of auctions and negotiations and their underlying rules and regulations are well established, leaving however, some space for adjustment in individual cases. The opportunities created by the internet technologies and the web engaged researchers in captivating discussions about the viability of conducting business transactions over internet. Early on, arguments were made that on line auctions will replace negotiations, that there will be a paradigm shift where market forces will replace the more subtle domain of negotiation skills [1-3]. In 2000, a group of researchers gathered in Montreal to discuss the issue. They concluded that there are limits to auctions and consequently not all electronic transactions lend themselves to auctions [4]. One of the outcomes of the Montreal workshop was a framework for designing e-negotiations [5].

In order to gain some clarity about the strengths and weaknesses of these two types of transaction mechanisms it is necessary to compare them. Broadly speaking, there are two types of negotiations, i.e. bilateral and multilateral (each type can be either simultaneous or sequential). There are different types of auctions, including price-only and multi-attribute forward and reverse auctions. The discussion here is restricted to multi-bilateral reverse auctions, henceforth called auctions.

Bilateral negotiations appear to be comparable to auctions. Experimental studies [6, 7] and field studies [8-10] comparing auctions with bilateral negotiations indicated that auctions are used in different situations than negotiations, namely, auctions are used when: (1) the exchanged goods (services) have only one attribute – price; (2) there are several (possibly many) suppliers of the good (service); and (3) there is no need to communicate (exchange information). Negotiations, on the other hand, are used when: (1) one or more of the above conditions do not apply; and (2) there is a strong likelihood of future interaction.

It is difficult to compare auctions and negotiations because they are very different mechanisms—on the general level the assumptions underlying each mechanism differ significantly, on the specific level there are differences in participants' knowledge and behavior. Auctions involve multiple bidders who compete for the same good or service; it is assumed that that bidders follow a strict, fixed protocol and that they know the buyer's price (valuation). Other than submitting bids, there is no other form of communication. In contrast, negotiations rely on significantly weaker assumptions; it is assumed that the parties negotiate in good faith and that each party has preferences so that they may compare alternatives. No assumption about the sellers' knowledge of the buyer's valuation is made.

Another reason why it is difficult to compare auctions and negotiations are the differences in settings and protocols. Studies mentioned above compared auctions with *N* bidders with bilateral negotiations (i.e., 1:1). In this situation the competition among sellers, which is a key characteristics of reverse auctions, disappears in negotiations with only one seller. In order to maintain competition among sellers in negotiations, bilateral negotiations need to be replaced with

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multi-bilateral negotiations, in which a single buyer negotiates with many sellers. Furthermore, these negotiations should be simultaneous rather than sequential so that the organization of both auction and negotiation processes are similar.

Thomas and Wilson [11-13] compared auctions and multi-bilateral negotiations. They set up several experiments making sure that for the sake of comparison the mechanisms were structurally similar, namely, there were N participants in auctions and N:1 participants in multi-bilateral negotiations. The experiments lasted 4 minutes and involved a single attribute–price. Despite the particular setting, the auctions' outcomes were not significantly better than the negotiations' outcomes.

Comparative studies of auctions and negotiations are not only difficult, they are also inconclusive. Bulow and Klemperer [14] showed that simple English auction with N+1 bidders (buyers) always yields higher revenue than a scheme they call "negotiation with N participants". Manelli and Vincent [15] demonstrated that the outcomes of auctions and negotiations depend on situations; they noted that in order to judge the effects of the two exchange mechanisms it is necessary to consider the overall context, including the goods, participants, market, and so on. They concluded that auction mechanisms are often inefficient in a procurement environment.

The above examples indicate that typically the process substantive outcomes, that is the values of the attributes, were used to compare auctions and negotiations. This paper also starts from this position. Excluding the discussion on the differences in organizing auctions and negotiations, it is important, from the pragmatic point of view, to identify the potential differences in results achieved if the same contract can be negotiated or established by means of an auction. Therefore, the first question is: *Is it worth spending time and money for often difficult negotiation rather than setting up an auction which reduces the bid-taker involvement in the process of contract designing to the minimum?*

In order to address this question, several experiments were conducted which compared multi-attribute reverse auctions and multi-bilateral negotiations. The auctions and the negotiations experiments comprise the first study discussed here.

In this first study experiments showed that the buyers received higher profits in auctions than in negotiations. Auctions were also more efficient. The possible explanation is that the negotiation protocol followed a typical rule and did not allow the sellers to obtain independent information about the best offer that the buyer received from one of the sellers. The auctions followed the rule that the winning (best) offer is displayed to all bid-makers (sellers). This makes auctions more transparent mechanisms than negotiations and could have placed auctions at an advantage over negotiations.

Thomas and Wilson [13] compared auctions and verifiable negotiations in which the best offer was displayed to all participants. Their experiments were stylized, meaning that there was no context, the sole issue was price, and the time allotted was four minutes. They used the sealed bid auction protocol which removed the dynamics of iterative multiple bids auctions and made it dissimilar to negotiations. Consequently, their results showed that for buyers, auctions produce better outcomes than both negotiation and that verifiable negotiations are better than non-verifiable. This latter result is surprising because it states "that providing sellers with more information about their rivals' price setting behavior unexpectedly leads to higher rather than lower prices" [13, p. 1030].

In our experiments the participants represent firms, their exchange problem is described in detail, there are three issues, and the allotted time is ten days. Following Thomas and Wilson's results we sought to address the following question: *Do multi-attribute verifiable negotiations produce worse results for sellers that the non-verifiable ones in a business context?*

In the second study we conducted exploratory experiment with the two types of negotiations. The result of the second study confirmed results obtained by Thomas and Wilson [13], i.e. the sellers were worse off in the negotiations with verifiable offers than negotiations with no verifiable offers. We were not able, however, to determine whether these results were statistically significant.

The third study builds on the previous two and addresses both questions formulated above. In this study we included auctions in order to compare the three mechanisms. The results of the third study confirmed the results obtained in the earlier two studies. This means that less transparent negotiations produce results which are better for the buyers (and worse for the sellers) and which are closer to the auction results than the results of more transparent negotiations.

The third study led to an observation that the buyers could run verifiable negotiations following the same protocol as the iterative auction protocol, which was not possible in Thomas and Wilson's [13] experiments. Consequently, in verifiable negotiations the buyers could achieve profits similar to the profits achieved by buyers in auctions. A possible reason for this outcome is that negotiation participants seek outcomes which are not possible to achieve in auctions. We conclude this paper with a discussion on the viability of outcome-based comparisons. When comparing outcomes, an assumption is made that both mechanisms produce the same types of outcomes and only their values differ. This is in contradiction with the social exchange theory.

II. Two Studies

Several experiments in which the participants used auction and negotiation web-based systems were conducted. These experiments and their results are briefly.

A. The case and two systems

In the Milika case a producer of perishable goods (the buyer) wants to sign a contract with one of the several logistics providers who offer their services. The minimum quantity of goods to be transported is a fixed part of the contract but three attributes must be negotiated, i.e. standard rate of transportation, rush rate for unexpected delivery, and penalty for the non-delivery or delivery of spoiled goods. Each attribute has a discrete number of options (fifteen per attribute) resulting in the total of 3375 possible agreements. All issues are specified and cannot be changed during the experiment.

The system relies on a single criterion used to compare alternative bids and offers, for example, utility, production, cost and profit functions. In the Milika case the selected function is quasi-linear and it describes profits of the buyer and the sellers. The profit function is different for different participants and its values (normalized between 0 and 100) are not disclosed to anyone.

Also the systems give the sellers breakeven points. Anything below these points means losses for the sellers' companies. This implies that the sellers should be careful not to cross these levels as their objective in both the auction and the negotiation is to obtain a contract that maximizes profit.

Two systems were used in the experiments—both implemented on the Invite e-negotiation system platform [16] -- (1) Imaras (InterNeg multi attribute reverse auction system); and (2) Imbins (InterNeg multi-bilateral negotiation system).

B. Study 1

There were six different lab and online auction and negotiation experiments. The results of these experiments are hardly comparable because of differences in: (1) the controlled variables, e.g., number of sellers (from two to six), number of alternatives (360 vs. 3375), and the participation of software agents (in one experiment); and (2) the process design, (e.g., fixed and flexible rounds, introduction of video, tests, and handouts). The results showed that, with the exception of one experiment, in auctions the sellers achieved very low and the buyers' very high profit. Table 1 illustrates two selected experiments.

TABLE 1.
STUDY 1: AUCTION AND NEGOTIATION EXPERIMENTS.

	Experiment 1		Experiment 2	
	Auction	Negotiation	Auction	Negotiation
No. of instances	17	40	27	23
No. of sellers	74	151	95	89
No. of offers (avg.)	4.4	3.0	**5.6**[*]	3.1
Agreement (%)	—	95	—	96
Seller's profit	3.9	19.9	**-7.4**[*]	23.4
Buyer's profit	66.9	52.6	**75.7**[*]	47.1
Dominating alt. (%)	6.4	1.9	4.0	4.0

[*] Significance compared to negotiations, $p < 0.01$

Sellers in the auctions made more offers than sellers in the negotiations. Their average profit was low, 3.9 in Experiment 1 and -7.4 in Experiment 2. In the latter experiment, the sellers' winning bid was (on average) a little below their breakeven value. In comparison, successful negotiators achieved a profit of 19.9 and 23.4, respectively in Experiment 1 and 2. In Table 1 we show that buyers achieved higher profit in auctions than they did in negotiations.

Table 1 also shows that the efficiency of the two mechanisms' is measured by the percent of alternatives which dominate the agreements. These results are not conclusive. In Experiment 1, auctions were less efficient than negotiations (6.4% of alternatives dominated the winning bids vs. and 1.9% of alternatives dominated agreements), while in Experiment 2 the two mechanisms were equaly efficient.

C. Subjective and objective concessions

An analysis of the results in Experiment 2 led to verification of the concession-making model in the auctions and the negotiations in which subjective and objective concessions were proposed [17]. The difference between these two types of concessions is the basis of comparison. A subjective concession is determined by two consecutive offers, i.e., made at t_1 and t_3 as shown in Fig. 1, both made by the same concession-maker. An objective concession is determined by two offers, the best offer on the table (market), which the concession-taker received at time t_2 from any concession-maker and the offer made at time t_3.

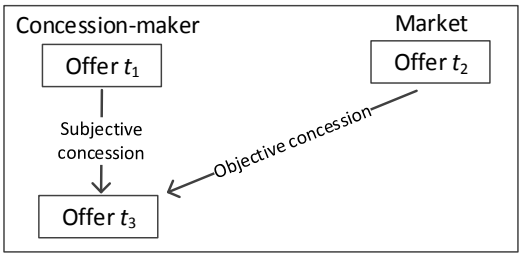

Fig. 1 Objective and subjective concessions

Subjective concessions occur in bilateral negotiations, in which both the concession-maker and the concession-taker can compare offers made by the same concession-maker. In multi-bilateral negotiations, in which one side is represented by many and the other side by a single negotiator (the case presented in Section II, A), objective concessions are possible. Their use requires significant transparency of the process and a fixed protocol, which typically are not employed. We know of only one negotiation study—done by Thomas and Wilson [13], in which objective concessions were made possible. In their study both the process and the systems were highly stylized and devoid of context.

Objective concessions are typical for these auctions in which the winning bid is shown to the bidders. Every bidder either submits a bid that is better (for the bid-taker) than the winning bid or drops out from the auction. The difference between the winning offer (on the market) and the submitted bid is the objective concession.

The sellers' profits given in Table 1 are the results of the concessions they made; the sellers made significantly greater concessions in the auctions than in the negotiations. The reason could be attributed to transparency: in the auctions the sellers knew the best bid, however, not in the negotiations. In the negotiations, even if the buyer sent information about the best offer she had received, this offer could not have been verified, hence the sellers may have considered it as a ploy. Realization of the above led us to a design of a negotiation experiment in which a version of the Imbins system displays the best offer on the table in the same way the Imaras does.

D. Study 2

Table 2 shows the results of the second study (Experiment

3). The column "Non-verifiable" results shows instances, when the Imbins system did not display the best offer; that is, the buyer could have shown the best offer but it could not have been verified by the sellers. The "Verifiable" column shows the results of the multi-bilateral negotiations, in which the system displayed the best offer.

TABLE 2.
STUDY 2: NEGOTIATION EXPERIMENT WITH VERIFIABLE AND NON-VERIFIABLE OFFERS.

	Experiment 3	
Best offers:	Verifiable	Non-verifiable
No. of instances	12	13
Sellers		
No. of sellers	33	35
No. of offers (avg.)	4.0	4.4
No. of offers w/out message (avg.)	1.0	1.2
No. of messages w/out offers (avg.)	1.3	0.6
Agreement (%)	100	92
Seller's profit	19.1	22.3
Dominating alt. (%)	4.0	4.0
Buyers		
No. of offers (avg.)	7.4	7.2
No. of offers w/out message (avg.)	1.0	1.5
No. of messages w/out offers (avg.)	2.9	1.4
Buyer's profit	53.3	48.0

Contrary to our expectations there were no significant differences between the two types of negotiations. We thought that the negotiations with verifiable offers would result in a significantly higher profit for the sellers than the negotiations with non-verifiable offers.

E. Discussion

The restrictions imposed on the negotiation protocol were severe but necessary. A fluid and evolving negotiation process with issues coming and going and preferences changing, cannot be compared with fixed protocol auctions. Verifiable offer negotiations have the same degree of transparency as auctions but they differ in the following three aspects:

1. The negotiating sellers are not forced to make positive objective concessions, i.e., make offers which are better for the buyer than the best offer on the table;
2. The negotiators can exchange messages with and without accompanying offers; and
3. The buyer can make offers.

The impact of the first difference needs to be further studied, but it does not appear to have potential for changing the process because both sides know about the best offer. Hence, sellers who (would) submit a worse offer than the best offer (make negative objective concessions) would do it knowing that the buyer has a better offer on the table. There may be, however, a good reason for these seller to do so, for example, if they offer some additional benefits for the buyer in the message that accompanies the offer.

The free-text communication with the buyer and the buyer's interaction with the seller are the remaining two key differences between auctions and negotiations (with fixed issues and options). Table 2 shows that in both the verifiable and the non-verifiable negotiations the sellers sent messages to the buyers (there were as many buyers as instances). About 75% of offers were accompanied by messages. In addition, every seller sent, on average, 0.6 messages in the non-verifiable negotiations and 1.3 messages to which no offer was attached.

The buyers used their ability to communicate with the sellers, as shown in Table 2. In the negotiation with non-verifiable best offer they made 7.2 offers, of which, on average, only 1.5 were without a message attached. They also sent 1.4 messages without an offer. The results are similar in the verifiable negotiation, with the exception of messages sent with no offer attached—2.9 on average, i.e., over twice as many as in the non-verifiable negotiation. This difference is attributed to two sellers who sent about four times more messages than other sellers. If we remove these two sellers from the dataset, then the averages are similar for both types of negotiations.

The number of offers made by the buyers is much greater than the number of offers made by the sellers because buyers made offers to three sellers, per instance (the number of sellers shown in Table 2 is smaller because inactive sellers were removed from the analysis). The buyers could make an offer and send a message to any subset of sellers (one, two or three), but they often addressed their communique to a single seller.

III. STUDY 3

Experimental comparison of the verifiable and non-verifiable negotiations done in Study 2 did not result in statistically significant results. Although there were some notable differences (e.g., in the buyers' and the sellers' profits), the number of instances was small and the distribution too large to obtain significant results. While there is an indication that, in terms of profits, verifiable negotiations can be positioned in-between auctions and non-verifiable negotiations, we were not able to test this result. Therefore, we conducted a third study that looked at auctions and the two types of negotiations.

A. Auctions and two negotiations experiments' settings

The experiment was conducted in spring 2013 and there were 583 students who participated in it as sellers and 83 students who were buyers. Students came from four universities (located in Canada, the Netherlands, Poland and Taiwan). Because of the differences in the student groups, the requirement that students from one group could participate either in the auction or negotiation but not both, and that students from the same group could not be buyers and sellers, the instances were formed with four and five sellers.

The experiment was conducted online and, as it is often the case, a number of participants were no-shows, dropped out or did not undertake any activity; in this experiment 21% of the students, who played the role of sellers had to be removed from the analysis.

The buyers' average profit values in Experiment 4 were lower than in the earlier experiments because in this experiment the breakeven value for buyers was increased from 16 to 48. The purpose of this change was to place buyers and

sellers on a relatively equal level; both the buyers and the sellers could achieve similar profit values. In negotiations, profit values were greater than the 50-60 units on a [0; 100] scale, which means that the buyers may have been led to make concessions which they would not have otherwise made. This is because of their expectations and the perceived fairness.

B. Results

The results of the third study (Experiment 4) are shown in Table 3. As before, the column "Verifiable" shows the results of the multi-bilateral negotiations, in which the system displayed the best offer made by a seller and the "Non-verifiable" column—where these offers were not displayed. In addition the column "Auctions" refers to the results from the multi-attribute auction experiment.

TABLE 3.
STUDY 3: AUCTIONS AND NEGOTIATIONS WITH VERIFIABLE AND NON-VERIFIABLE OFFERS.

	Experiment 4		
	Auctions	Verifiable	Non-verifiable
No. of instances	38	42	39
No. of sellers	173	147	141
Duration (days, avg.)	**3.35**	**4.63**	**6.20**
Agreement (%)	100	100	100
- Buyer's offer accepted (%)	—	30 (71)	24 (61)
- Seller's offer accepted (%)	38 (100)	12 (29)	15 (39)
Total profit	38.7	39.6	39.7
- Buyers' profit (avg.)	**45.9**	**20.8**	**27.8**
- Sellers' profit (avg.)	**-7.2**	**18.8**	**11.9**
Efficiency			
- Allocative	0.4	0.4	0.4
- Pareto	**3.5**	**81.5**	**38.1**
	Sellers		
No. of offers (avg.)	**9.6**	**5.5**	**4.9**
No. of messages (avg.)	—	**5.9**	**4.7**
Messages' length (words, avg.)	—	**219**	**182**
	Buyers		
No. of offers (avg.)	—	**10.6**	**12.2**
No. of messages (avg.)	—	**12.3**	**15.3**
Messages' length (words, avg.)	—	193	188

The data shows that the auctions took the least time to conclude, followed by the verifiable negotiations, then by non-verifiable negotiation. These differences are significant: for auctions and verifiable negotiation $p < 0.004$; for auctions and non-verifiable negotiation $p < 0.001$; and for verifiable and non-verifiable negotiations $p < 0.001$. This result places verifiable negotiation in-between auction and non-verifiable negotiation in terms of process efficiency.

In addition to the process time we used the number of offers to compare the three mechanisms and the number of messages (with and without offers) to compare the two types of negotiations.

The sellers participating in auctions made significantly more offers (9.6 on average) than the sellers participating in verifiable (5.5, $p < 0.001$) and non-verifiable negotiations (4.9, $p < 0.001$). The difference in the average number of offers made by sellers in the two types of negotiations is not significant.

The average number of messages sent by the sellers was not significantly different in the verifiable and non-verifiable negotiations (5.9 vs. 4.7). However, the average total length of messages (measured in words) was significantly ($p < 0.025$) different in the verifiable and non-verifiable negotiations (219 vs. 182 words).

The buyers participating in the verifiable negotiations made fewer offers (10.6, on average) than the buyers participating in the non-verifiable negotiations (12.2, on average). This difference is not significant ($p = 0.145$).

The average number of messages sent by the buyers is significantly different ($p < 0.05$) in the verifiable and non-verifiable negotiations (12.3 vs. 15.3). However, the average total length of messages (measured in words) is not significantly different ($p = 0.440$) in the verifiable and non-verifiable negotiations (193 vs. 188 words).

The comparison of the three mechanisms based on profits shows a different picture. Both types of negotiations resulted in a very similar total profit; auctions yielded a smaller profit than negotiations. These differences are, however, not significant. This result is interesting because the total profit (social welfare or value allocation) has been frequently used as an indicator of mechanism efficiency [see, e.g., 18, 19, 20]. Our results, however, imply that auctions are no more efficient than the negotiations.

Profit distribution is, however, very different. The auctions were best for the buyers and worst for the sellers, who incurred losses (on average). The non-verifiable negotiations were in-between—they were worse for the buyers and better for the sellers than auctions but better for the buyers and worse for the sellers than the verifiable negotiations (Table 3). These results confirm the negotiation results obtained in Study 2 (Table 2).

The differences between the three mechanisms in terms of the achieved profit are significant. The buyers' profit significance is: for auctions and verifiable negotiations $p < 0.001$; for auctions and non-verifiable negotiations $p < 0.001$; and for verifiable and non-verifiable negotiations $p < 0.01$. The buyers' profit significance is: for auctions and verifiable negotiations $p < 0.001$; for auctions and non-verifiable negotiations $p < 0.001$; and for verifiable and non-verifiable negotiations $p < 0.02$.

Markets are evaluated based on the efficiency of their mechanisms. We used two efficiency measures (see Table 3): allocative efficiency and Pareto efficiency.

Allocative efficiency is the ratio of the average total profit achieved and the maximum total profit that is possible to achieve by the winner. In this work, we used allocative efficiency in a somewhat different way than typically used in economic literature. Rather than using the absolutely maximum total profit, which is the highest possible profit for the theoretical winner (i.e., across all bidders), we used the maximum profit available to the winning bidder. This shows the difference between what the winner achieved and what she could achieve.

The reason for using winner-dependent allocative efficiency is that it can be compared with Pareto efficiency, which is the average number of alternatives dominating the

winning offer. The dominating alternatives need to be selected from the winner's set of feasible alternatives, otherwise the Pareto efficiency is not be comparable across different instances. This is because the value depends on both the winner's and the theoretical winner's feasible sets so that an efficient winning offer can become an inefficient one.

Allocative efficiency is the same for all three mechanisms: they are 40% efficient, which is quite low. Pareto efficiency is significantly different across these mechanisms. On average, there are only 3.5 alternatives, which dominate the winning offer in auctions, but there are 81.5 and 38.1 dominating alternatives in, respectively, verifiable and non-verifiable negotiations. We find these results surprising for two reasons. The first reason is that allocative efficiency is the same but there are significantly more dominating alternatives in negotiations than in auctions. This suggests that the negotiation efficiency can be improved (particularly verifiable negotiation) but there is very limited possibility to improve auctions' efficiency.

The second reason is that auctions produce results, which are close to Pareto frontier (only 3.5 offers dominate the winning offer) but their allocative efficiency is low (0.4). This seems to contradict auction theory which posits that Pareto efficient winning offers are also allocative efficient [18, 21, 22]. This result is related to the exchange problem used in our experiments which did not have a quasi-linear evaluation function, which, in the business case, is profit.

C. Negotiations like auctions

We mentioned above that while the verifiable offer negotiations have the same degree of transparency as auctions, they also differ. The involvement of the buyer (who can present her offers and engage in discussion with individual sellers on any topic they wish) is one of the key differences between auctions and negotiations. This difference, however, need not occur in any given negotiation; because the sellers are shown winning offers the buyers may decide to be inactive. In other words, the buyers may change the negotiation process to auctions without giving any information to sellers a priori.

An analysis of the verifiable negotiations transcripts (Experiment 3) showed that some buyers behaved similarly to the buyers in auctions and did not engage in negotiation activities. This means that this type can be divided into two sub-types: (1) negotiation-like-auctions; and (2) multi-bilateral negotiations.

We investigated the negotiations in which the buyer was inactive for some period of time, analyzing the sellers' actions when they received neither messages nor offers from the buyer. There were 10 instances with 31 sellers who faced the problem of inactive buyer in Experiment 3. These sellers decided to submit new offers, even though they did not receive any answer from the buyer regarding the offers they had sent earlier. In eight instances fourteen sellers sent on average 2.7 offers before their counterpart (buyer) replied. The buyer did not respond until the negotiation deadline in the remaining two instances with nine sellers. In these instances the sellers sent 3.9 offers, on average.

In general, in the inactive-buyer negotiations the sellers submitted on average 2.9 offers, which were not replied to with any counteroffer of the buyer. While reviewing the sellers' negotiation transcripts and their assignment reports we could not find their motivation for doing this.

The sellers could sent offers in order to get the buyer's attention and to induce them to start messaging during which they could convince them to accept the sellers' own offers or they could get involved in the bidding game with other sellers, hoping to eliminate them by sending at this stage of the negotiation process the offers more beneficial for the buyers than the ones submitted by their competitors.

The similarity of the verifiable negotiations and auctions was also noticed by the sellers in their post-negotiation feedback. The participants of auctions described their activities and behaviour in terms of the bidding process (e.g., "I bid", "the other bidders", and "the auction rounds"). In contrast, the participants of non-verifiable negotiations used terms such as: "the counterpart", "I submitted an offer", "tried to achieve a compromise".

The participants of non-verifiable negotiations, however, did not employ negotiation terminology uniformly. In 9 out of 13 feedback messages (69%) they described the negotiation process as a bidding process with bidding rounds and bids submitted by the parties, which is typical for auctions rather than negotiations. This suggests that some participants viewed verifiable negotiations as negotiation-like auctions. Taking into account the fact that some sellers in buyer-inactive instances behaved in a way typical to bidders in auctions (they did not wait for the buyer's response before making a new offer), we may conjecture that verifiable negotiations may be seen as a mechanism in-between auctions and traditional (i.e., non-verifiable) negotiations.

D. Discussion

The purpose of Study 3 was to explore the participants' behavior and the outcomes they achieved in the two types of negotiations and in auctions. The results of this study partially confirm the results of Study 2. Some of the differences may be due to the larger sample in Study 3 and a small??? revision of the assignment which was administered. The revision concerned additional clarification of: (1) the relationship between breakeven values and profits and losses; and the requirement that students achieve profits if they can and avoid losses, for which they are penalized (bonus points are not given); and (3) the allocation of bonus points if student obtained contracts (but not at a loss) as well as if students did not achieve contracts only because making an additional offer would push them into losses. Another difference in this versus the earlier experiments was the change of the breakeven value for the buyers (from 16 to 48), so that the buyers and the sellers could achieve similar profit values.

In Study 3 we were able to determine strong relationship between a number of variables describing auctions and negotiations (Table 3). The purpose of the study was experimental comparison of the three mechanisms and we obtained interesting yet surprising results. We introduced a new negotiation

mechanism which shares one rule with auctions, namely winning offer verifiable disclosure. This rule is critical for auctions (particularly multi-attribute) because it provides guidance for the bidders.

The additional rule provided sellers in both the auctions and the verifiable negotiations with information about the winning offer (i.e., best offer on the table). In these negotiations the buyers could communicate with the sellers, while in the auctions the sellers were given information about admissible bidding sets [23]. These sets comprise alternatives, which are better for the buyer than the winning bid.

The results show that the verifiable offers improved the sellers' position, however at the process costs measured by the number and length of offers. Because the buyers were worse off than in the auctions and the non-verifiable negotiations, they were not likely to introduce the verifiable offer negotiation mechanism.

IV. Conclusions and Future Work

Auctions are *economic processes* in the sense that nothing except for the attribute values can be submitted. Auction outcomes are thus defined solely by the attributes defined by the bid-takers. In negotiation literature this type of outcomes is called "substantive"; their values are discussed over the course of the process and they constitute the agreement [24].

In negotiation literature, substantive outcomes have been contrasted with relational outcomes; the roots of this distinction are attributed to an effort to contrast the economic perspective with the psychological perspective [25, 26]. The argument which we posit here is that negotiations among market participants and businesses are *socio-economic processes* and that neither the "social" nor the "economic" aspects can be ignored.

The social exchange theory is concerned with the formulation and evolution of the relationship between parties engaged in giving and getting "something", and with the rules which govern exchanges between the parties [27, 28]. There are two main types of rules [29]: (1) negotiated rules; and (2) reciprocity rules. The negotiated rules are explicit and simple, they deal with bargaining in which reciprocity is not required. The reciprocity rules are implicit and govern different forms of relationships, which emerge during interactions among people (e.g., trust, empathy, and reputation).

Despite of its recognition of the reciprocity rules, the social exchange theory reduces negotiated exchanges to haggling or double auctions, noting that in negotiations "reciprocity is a trivial byproduct of a bilateral trade, and the same actions that reduce the risk of loss also increase gain." [30]. However, even this narrow perspective on negotiation identifies reciprocity as an important device used by negotiators. An action by one party calls for some kind of a response by the counterpart, it creates an obligation. If it is clear that the party makes an effort, provides explanation, proposes a significant concession, and is genuinely interested in getting the contract, then it is only natural for the counterpart to reciprocate. This is one reason why buyers accept less (lower profit) in the multi-bilateral negotiations, than in auctions.

The participants in our negotiation experiments play roles of buyers and sellers; they perform and interact with others. They may also discuss other issues (e.g., their interests, weather, and universities). The negotiations are anonymous at the outset, but the participants can exchange any information they wish to exchange. The participants' discussions may have a subjective value for them.

A person may not know her counterpart but during the ten-day long interaction may develop some affinity with him, which can lead her to make a bigger concession than she would have made if she felt animosity. This particular motivation for concession-making can be related to the experimental settings, however, in real-life situations we also observe parties trading off some substantive values in an effort to achieve higher relational values. In some job markets, for example, employers engage in multi-bilateral negotiations with several potential candidates in order to determine their trustworthiness, fit to the position and the team, as well as professional skills. If they need to determine skills only, then auction often is the preferred mechanism [31]. This implies that reciprocity need not be a "trivial byproduct" but a set of complex rules which are invoked when the negotiators realize the potential of achieving important relational outcomes.

Relational outcomes are inherently social and they can be achieved in negotiations. However, they cannot be achieved in auctions in which bid-makers do not interact with one another. This shortcoming of auctions has been recognized and led to augmentation of auction protocols, e.g., with post-auction negotiation in buyer-determined auctions [32].

While non-augmented auctions cannot produce relational outcomes, they can produce game-like outcomes, for example, excitement [33]. Auctions produce winners and losers, the outcome is a win or a loss, while negotiations result in agreement or disagreement achieved through negotiation.

Our results confirm the theory that auctions produce better substantive outcomes for the bid-takers who decide on what exchange mechanism to use. The assumption is, however, that the bid-takers are not interested in any other outcomes, relational in particular. If so, the answer to the first question formulated in Section1, is negative: For the buyers, it is not worth spending time and money for negotiation, because they achieve better results from auctions. The results also point to the necessity to study communication between negotiators. Messages affect offers; if they are ignored then the changes in offers (concessions) cannot be explained.

Notwithstanding the results obtained from Study 3 about the verifiable and non-verifiable negotiations, which confirm the results from Study 2, we consider these results as tentative and more work is required to validate them. The reason is due to the participants' different behaviors in each type of the negotiations. We mentioned above that in the verifiable negotiations there were inactive buyers during the first few days of the process; there were also a few inactive buyers during the entire process. While these negotiations concluded with an

agreement, that is, at some point the buyer accepted an offer, they were structurally different from the negotiations in which the buyer made offers and sent messages.

The data obtained from the verifiable and non-verifiable negotiation experiments (Study 2) was inconclusive; the differences in the buyers' and the sellers' profit values were not significant. However, this difference was observable and therefore it suggested that transparency could be better for buyers but not necessarily for sellers (Table 2). The results of Study 3 show that the differences are significant but not in the expected direction.

Contrary to our expectations, the verifiable negotiations did not produce better results for the buyers and worse for the seller that the non-verifiable negotiations (Table 3).

Because transparency has been found to have positive effect on trust and other relational outcomes [34], in some situations verifiable-offer negotiations may be preferred over both auctions and non-verifiable negotiations. It is possible to further augment this type of negotiation by providing information about admissible bidding (offer) sets. In multi-attribute auctions bidders can only submit a bid that is an element of one of these sets. In negotiations they could submit other bids (i.e., worse for the buyers) but this information would give them a better understanding regarding objective positive concessions.

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