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# Multi-bilateral Negotiations and Multi-attribute Reverse Auctions: An Experimental Study of Concession-making

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**Abstract**

Reverse auctions and multi-bilateral negotiations are two common procurement mechanisms in which concession-making plays a key role. A two-dimensional typology of concessions is proposed and empirically verified in two experiments. The results show that: (1) bidders and negotiators use all types of permissible concessions; (2) concessions are greater in auctions than in negotiations; and (3) extrinsic motivation affects concession-making.

## 1. Introduction

The popular meaning of concession is giving away something to a person who asked for it or yielding. Concession-making in negotiations has been extensively studied both experimentally and in the field [1-3]. Negotiators make concessions in order to move towards an agreement, to prevent the counterpart from leaving the negotiation, and to encourage the counterpart to reciprocate [4, 5].

There is more to negotiation than concession-making, which is focused on the substantive issues and discounts education and learning. The latter may be the key to successful negotiations [6, 7]. Such widely accepted concepts as "win-win negotiation" may rely on the negotiators' realization that they may not be in opposition and that there may be alternatives that satisfy everybody's needs [8, 9]. In many economic transactions situations, however, concessions play a key role in reaching an agreement.





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## 1.1 Concession-making

Conceptually concession-making appears to be a simple process; it is a change of the negotiator's position that reduces the level of benefit sought and is seen as an improvement by the counterpart [10]. The premise is that if both parties make concessions, then they should reach an agreement. However, the relationship between concessions and agreement is, as we show in this paper, not as straightforward as it appears.

Even if we assume that concession is the key ingredient to reaching an agreement, we need to determine when and what concessions should be made in order to achieve an agreement that is beneficial to the concession-maker and/or to both parties. There is certain ambiguity regarding concessions' contribution on the probability of reaching an agreements as well as the agreement's value (utility) to each party and to both parties jointly.

The theory of gradual reciprocation assumes that concessions should be contingent so that they can be reciprocated [11] can be contrasted with another early theory of a hardening of the concession-taker [12]. A strategic concessions model in which one party's first offer is the best possible solution for this party has been proposed [13]. The probability that it will be rejected by the counterpart is high. When this happens, then the party proceeds with next most preferred solution (i.e., makes a minimal concession), then the next one, and so on.

Concession-making is more complex when the negotiation concerns multiple issues and the negotiators have different preferences over issues and issue values. If the negotiators have no information about each other's preferences, then concession making may lead to a very bad agreement even in a single-issue negotiation [14, 15]. Such a possibility is more likely in multi-issue negotiations. One way to alleviate this problem is making concessions on a single issue at a time and asking whether the counterpart prefers the new offer over the previous one. This process can be coupled with a tit-for-tat (i.e., reciprocal) rule [16]. If, however, the negotiators do not exchange information about their preferences or provide feedback regarding concessions, then concession monotonicity cannot be assured.

## 1.2 Multi-bilateral negotiations

Based on the assumed contribution of concessions to agreements a number of algorithms have been formulated with the purpose to support human negotiators [17, 18] and to construct negotiation software agents [19-21]. To account for the lack of information that the concession-maker has about the preferences and interests of the concession-taker several methods have been proposed, including, the structural (dis)similarity of alternatives [22] and the monotonicity and strength of opposition of the preferences over the negotiated issues [23, 24]. These and other works rely on the typical, albeit inaccurate, definition of concession, which can be summed-up as "lose-win" (the concession-makers accept a loss for the benefit of the concession-takers to improve their position).

This paper builds on and extends an earlier work on concession making in auctions and negotiations [25]. In both papers concession-making is studied based on their two forms of categorization. As far as we know this is the first such specification that has been formulated and experimentally verified.

## 1.3 Reverse auctions

In addition to studying concession-making in multi-bilateral negotiations, the paper also

presents concessions made by bidders in multi-attribute reverse auctions. These two mechanisms are selected because: (1) they are the key mechanisms in procurement; and (2) they are comparable because both deal with multiple sellers and a single buyer. The multi-attribute problem is selected because this type of problems is typical for procurement [26].

Auction literature is concerned with the design of mechanisms followed by studies of their allocative efficiency, revenue maximization, fairness and other features of the mechanism [27, 28]. With the exception of the consideration of concession-making by software agents that participate in auctions [22, 29], little has been said in auction literature about concessions made by human participants.

### 1.4 Overview

The purpose of this work is to share insights into concession-making behavior in auctions and negotiations. The next section formalizes the concept of concession and discusses their categories and types. In Section III, two experiments designed to study concession-making in reverse auctions and in negotiations are introduced. General results of this experiment are also discussed in this section. In the study we focus on the sellers who bid or negotiate in order to obtain a contract. In both situations there are several sellers competing for a single contract. Comparison of concessions made by sellers in auctions and negotiations is presented in Section IV. Discussion, presented in Section V, concludes the paper.

## 2. Concession categories and types

### 2.1 Preliminaries

For the purpose of this study concession is equated with "subtraction operator" for the concession-maker and "addition operator" for the concession-taker [25]. This means that when a concession takes place, then some value is subtracted from the benefits of the maker and a value is added to the taker's utility. In price bargaining this process is straightforward: a dollar of concession made by the seller reduces the price increasing saving for the buyer. In multi-issue negotiations, the values reduced and increased represent individual utility, revenue, costs, etc. They are typically different for buyers than for sellers and also within each group.

In order to define and categorize concessions, we use the following notation. Let:

$\boldsymbol{x} = [x_j, j=1, \ldots, n]$ an offer comprising $n$ issues;

$X$ – set of feasible offers, ($\boldsymbol{x} \in X \subset R^n$);

$I$ – set of participating sellers (bidders or negotiators);

$t$ – round index ($t = 1, \ldots, T$);

$u_i$ – value function (utility) of seller $I$, ($i \in I$); and

$u_b$ – value function (utility) of buyer $b$.

### 2.2 Concession bookkeeping

In concession bookkeeping we need to know who provides a concession and to whom. This gives us two different ways of calculating concessions:

Definition 1. Given two consecutive offers $\boldsymbol{x}_t$ and $\boldsymbol{x}_{t+1}$, ($t$ is round index):

1. $u_i(\boldsymbol{x}_{t+1}) = u_i(\boldsymbol{x}_t) - c_{it}$ is seller's $i$, ($i \in I$) perspective on own concession, while
2. $u_b(\boldsymbol{x}_{t+1}) = u_b(\boldsymbol{x}_t) + c_{bit}$ is the buyer's $b$ perspective on concession made by seller $i$.

While both concession parameters $c_{it}$ and $c_{bit}$ refer to the same act, i.e., seller's $i$ proposal to replace offer $\boldsymbol{x}_t$ with $\boldsymbol{x}_{t+1}$, there is an important difference between them. $c_{it}$ reflects the subjective effort of the concession-maker that he makes in order to reach an agreement. Beyond this, however, is has little effect on the process. This is because the progress of the process is determined by the buyer, who is the concession-taker.

If $c_{bit}$ is not positive, then the buyer rejects the offer associated with this concession because she prefers another offer over the one made by this concession-maker. Therefore, the buyer expects an offer made by a seller to be an improvement over the earlier offers made by this and other sellers.

In auctions, the offer made in round $t$ is considered in the next round which is the best for concession-taker, that is, $c_{bi^*t} \geq c_{bit}$, where $i, i^* \in I$, $i \neq i^*$.

In general, it is possible that the concession-maker makes reverse concession (improves his position for himself) but the concession-taker sees the change as a positive concession. The reverse situation is also possible.

## 2.3 Nine categories

Concessions made by one side need not to be considered as such by the other side because the perspective the concession-maker wishes to convey may not be visible to the concession-taker. The two perspectives on concessions taken together with the concessions' impact on the buyer's and seller's utility values allow us to distinguish nine categories of concession pairs. Let seller and buyer concessions be defined respectively by:

$c_s = c_{st} = u_s(\mathbf{x}_t) - u_s(\mathbf{x}_{t+1})$ and $c_b = c_{bst} = u_b(\boldsymbol{x}_{t+1}) - u_b(\boldsymbol{x}_t)$.

Given this formulae the nine categories are formulated as shown in Table I.

Table 1. Nine categories of concessions

| **Concession-maker** | **Concession-taker** | | |
|---|---|---|---|
| | Positive | Null | Negative |
| Positive | $c_s > 0$; $c_b > 0$ | $c_s > 0$; $c_b = 0$ | $c_s > 0$; $c_b < 0$ |
| Null | $c_s = 0$; $c_b > 0$ | $c_s = 0$; $c_b = 0$ | $c_s = 0$; $c_b < 0$ |
| Negative | $c_s < 0$; $c_b > 0$ | $c_s < 0$; $c_b = 0$ | $c_s < 0$; $c_b < 0$ |

Note that for concession-makers positive concession decreases their utility while positive concession for concession-takers increases their utility.

Some of the concessions listed in Table 1 have been discussed in negotiation literature. For

example, the pair ($c_s < 0$; $c_b > 0$) can be associated with "win-win" because it leads to both the concession-maker's and the concession-taker's improvement in their position. The pair ($c_s > 0$; $c_b < 0$) is a "lose-lose" because both sides are worse off while ($c_s > 0$; $c_b > 0$) is "lose-win" and it corresponds to what a typical concession is assumed to be.

### 2.4 Two types

In addition to the two perspectives based on the concession-maker and the concession-taker, we also distinguish the following two types of concessions:

1. *Single-issue concession* is defined by two consecutive offers (bids) made by the same seller which differ in the value of only one issue. For example, if the concession involves issue $k$, then $c^k_{it} = u_i(x_{1,t}, \ldots, x_{k,t+1}, \ldots, x_{n,t}) - u_i(x_{1,t}, \ldots, x_{k,t}, \ldots, x_{n,t})$.
2. *Multiple-issue concession* is defined by two consecutive offers (bids) made by the same seller which differ in the value of two or more issues. For example, if the concession involves issues $k$ and $n$, then $c^k_{it} = u_i(x_{1,t}, \ldots, x_{k,t+1}, \ldots, x_{n,t}, x_{n,t+1}) - u_i(x_{1,t}, \ldots, x_{k,t}, .., x_{n,t})$.

Multiple-issue concessions allow for *logrolling* which is "the exchange of loss on some issues, usually less important in priority or value, for gain in other issues, usually more important." [30, p. 218]. The purpose of logrolling is to improve the offer for the concession-taker but at a minimum costs to the concession-maker [31, 32].

Single-issue concessions are often associated *with sequential negotiation* in which the parties negotiate and agree on one issue then move to negotiating on another issue, etc. In contrast, *simultaneous negotiation* requires that the parties negotiate on all issues at the same time. Experimental and field studies show that simultaneous negotiations produce better agreements in terms of joint value and lower concessions than sequential [10, 33, 34].

## 3. Two Experiments

In Spring 2011 and Spring 2012 we conducted auction and negotiation experiments that allowed us to observe concession-making. The systems, case and experimental setting are described in detail in [25, 35].

In both auction and negotiation experiments concessions determine the winner. This section focuses on both theoretical and actual winners. Relevant results of Spring 2012 experiment and a summary of Spring 2012 experiments are discussed in this and the next sections.

### 3.1 General results

In 2011 a total of sixty-three negotiation instances were conducted; in each negotiation one buyer negotiated with four sellers. Eleven multi-attribute reverse auction experiments were also conducted. In both negotiations and auctions, the participants used systems which provided them with decision support aids, including, a calculator which could rate every alternative by assigning a score between zero and one hundred, generate alternatives for a given profit value, and select alternatives using graphical tools [35, 36].

In every auction and negotiation there were four sellers; in the negotiation the sellers competed for an agreement awarded from either cooperative or competitive buyer. (The buyers were trained to play these roles.)

Since in auctions buyers neither communicate with sellers nor make concessions (the buyers are auction owners), we focus on concessions made by the sellers.

Table 2. General results

| | **Auction** | **Negotiation** | |
|---|---|---|---|
| | | **Cooperative** | **Competitive** |
| *2011 experiment* | | | |
| No. of instances | 11 | 31 | 32 |
| Agreement (%) | 100 | 93.5 | 93.8* |
| Avg. seller's profit | -8.6 | 11.5* | 4.8* |
| Avg. buyer's profit | 78.8 | 63.6* | 69.8*# |
| No. of dominating alternatives | 0.1 | 1.7 | 1.0 |
| *2012 experiment* | | | |
| No. of instances | 51 | 26 | 26 |
| % of agreements | 100 | 100 | 92.3 |
| Avg. seller's profit | -0.8 | 14.9* | 13.3* |
| Avg. buyer's profit | 73.0 | 57.9* | 59.6* |
| No. of dominating alternatives | 144.4 | 43.2* | 38.5* |

Significance compared to auctions: $^{*}$ $p \leq 0.005$; $^{\wedge}$ $p \leq 0.05$, and between integrative and competitive negotiations: $^{+}$ $p \leq 0.005$; $^{\#}$ $p \leq 0.05$.

The results of the experiments which are useful for concession analysis are given in Table II. In our experimental settings the outcome of every auction is an agreement. This is not the case for the negotiation in which the buyer has to accept an offer. Therefore, the percent of agreements is generally lower in negotiations than in auctions.

Sellers profit in negotiations is significantly higher than in auctions. The difference of mean profit values in auctions and negotiations is 16.6 ($p < 0.00$); it is 20.1 when auctions are compared to integrative negotiations and 13.4 when they are compared to competitive negotiations. These results indicate that auctions are more competitive than both cooperative and competitive negotiations.

The results from the 2012 experiment differ from the 2011 experiment in the profit values and in the numbers of dominating alternatives. These differences reflect the following two modifications introduced in the 2012 experiment.

1. In the 2011 experiment the participants were asked to follow the instructions but they were

not given any reward for winning, therefore the criticism is warranted. In contrast, in the 2012 experiment the incentives were based on a formula according to which the participants were given additional points (converted to grades) for winning above the breakeven value and for losing but not incurring losses; they were given demerit points for incurring losses.

2. In both experiments the wording of the case was the same but in 2011 there were 216 feasible alternatives while in 2012 there were 3375 alternatives.

## 3.2 Theoretical winners

In our experiments the parties cannot redefine the problem or introduce new and remove current issues. Therefore, it is only through concession making that they can "win", i.e., achieve an agreement and be the auction winner. If the participants were rational and completely followed information they were given in the case, then one particular person (role) should win.

Table 3. Breakeven point and corresponding best profit for others

| **Breakeven points** | **Seller** | | | |
|---|---|---|---|---|
| | **Cres** | **Nart** | **Peeka** | **Rito** |
| - Breakeven point for Cres | ***25*** | 62 | 45 | 50 |
| - Breakeven point for Nart | 15 | ***10*** | 20 | 8 |
| - Breakeven point for Peeka | 10 | 7 | ***15*** | 4 |
| - Breakeven point for Rito | 51 | 36 | 59 | ***22*** |
| Buyer's rating of the best offer at sellers breakeven point | ***87*** | ***92*** | ***90*** | ***89*** |
| Buyer's rating of the worst offer at sellers breakeven point | 50 | 80 | 90 | 42 |

In each instance four sellers were trying to get a contract. The sellers' preferences and their breakeven points, at which profit turns into losses, differ. The result of these differences was that the sellers had different theoretical chances to get the contract. Table III shows the seller's rating corresponding to the breakeven point for each role.

There may be many alternatives associated with the same rating. Therefore, we can select an alternative for which the seller's profit is zero (i.e., corresponding to the breakeven point) but the buyer's rating assumes the highest value, i.e.: max $u_B(\boldsymbol{x}) : \boldsymbol{x} \in X^i$, $(i \in I)$, where $X^i$ $(X^i \subset X)$, is a set of breakeven offers for seller $i$.

The highest buyer's rating for every seller is also shown in Table II.

We may also select an alternative from these yielding breakeven values for a given seller and the highest is highest rated for another seller. There were four sellers in the experiment: Cres, Nart, Peeka and Rito (in the case they were known by their full names). The breakeven rating for Cres is 25; the best alternative for the buyer, which for Cres has rating 25, has rating 87. The best alternative for Nart, from among breakeven alternatives for Cres, yields rating 62. Ratings

for other sellers are given in Table III.

We see that Nart is the theoretical winner for both auctions and negotiations. This is because Nart may offer an alternative that is at her reservation level of 10 and which yields the rating 92 for the buyer that is higher than what other sellers could offer without violating their breakeven values.

The auction procedure which has been used in the experiments may cause that another theoretical winner is also possible. This is because: (1) Peeka may make a bid that yields 15 for him and, (2) following this bid, the procedure may remove the alternatives which are above Nart's reservation level even though they are better for the buyer. This need not happen because the buyer is able to control the removal of alternatives making them infeasible in further bids. However, the control parameters' values are set prior the auction; hence a reduction that makes Nart unable to make bids above or at her reservation level is possible. Therefore, we have to assume that Peeka may also be a theoretical winner. Because the buyer makes decisions during the negotiation process, only Nart is the theoretical winner in negotiations.

## 3.3 Auction and negotiation winners

Table II lists theoretical winners: Nart and Peeka under the condition that no seller was willing to incur losses. In Table IV results from two experiments are given.

Table 4. Distribution of winners (2011)

| | **Auctions** | **Negotiations** | |
|---|---|---|---|
| | | **Cooperative** | **Competitive** |
| *2011 experiment* | | | |
| Cres (%) | 3 (27) | 8 (27) | 15 (50) |
| Nart (%) | 4 (36) | 7 (24) | 6 (20) |
| Peeka (%) | 2 (18) | 8 (27) | 6 (20) |
| Rito (%) | 2 (18) | 6 (21) | 3 (10) |
| No. of agreements | 11 | 29 | 30 |
| *2012 experiment* | | | |
| Cres (%) | 6 (12) | 2 (8) | 1 (4) |
| Nart (%) | 24 (47) | 12 (27) | 5 (11) |
| Peeka (%) | 14 (28) | 6 (23) | 3 (13) |
| Rito (%) | 7 (14) | 6 (23) | 15 (63) |
| No. of agreements | 51 | 26 | 24 |

We checked if in any auction the two conditions making Peeka the 2nd theoretical winner were fulfilled. Because this was not the case, only Nart is the theoretical winner. From Table IV we see that Nart won in 36% of auctions, which is more than any other bidder, but much less than

we expected. This difference is even greater in negotiations: Nart won 27% of cooperative and only 20% of competitive negotiations.

These results indicate that majority of both bidders and negotiators' desire to win is strong enough to forgo profits and accept losses. Because these results are obtained from experiments, one can rightly point out that the profits and losses are illusory and the reward for good results was insufficient.

Recall that in the 2012 experiment reward for winning and demerit points for incurring losses were introduced. These changes resulted in a different distribution of winners; they are also shown in Table IV.

In the 2012 auctions and cooperative negotiations Nart won more frequently than in 2011, however in the competitive negotiations the most frequent winner (63%) is Rito.

# 4. Concession-making

The distribution of winners in auctions and negotiations indicates that auctions may be more competitive than negotiations. This section focuses on the process of concession-making and its results in both auctions and negotiations.

## 4.1 Concessions in auctions and negotiations

The results of the experiments related to the sellers' concession-making are shown in Table V.

Table 5. Sellers' behavior in actions and negotiations

| | **Auctions** | **Negotiations**[1] | |
|---|---|---|---|
| | | **Cooperative** | **Competitive** |
| *2011 experiment* | | | |
| Total concession (seller rating) | 58.2 | 34.0* | 36.2* |
| Total concession (buyer rating) | 62.7 | 37.3* | 36.6* |
| No. of offers/bids (avg.) | 4.9 | 6.3* | 6.5* |
| - Submitted by winners | 5.6 | 6.8 | 7.1 |
| Concession per offer/bid (sellers) | 14.9 | 6.4* | 6.6* |
| Concession per offer/bid (buyer) | 16.1 | 7.0* | 6.7* |
| No. (%) of null concessions [2] | 3 (2) | 50 (8) | 57 (9) |

| | | | |
|---|---|---|---|
| No. (%) of negative concessions | 15 (9) | 92 (16) | 106 (17) |
| *2012 experiment* | | | |
| Total concession (seller rating) | 36.6 | 20.8* | 18.9* |
| Total concession (buyer rating) | 37.7 | 22.1* | 18.2* |
| No. of offers/bids (avg.) | 7.1 | 2.6* | 2.6* |
| - Submitted by winners | 10.2 | 3.4* | 5.0* |
| Concession per offer/bid (sellers) | 6.0 | 10.6* | 9.7* |
| Concession per offer/bid (buyer) | 6.1 | 11.32* | 9.4* |
| No. (%) of null concessions [2] | 219 (16) | 23 (6) | 19 (6) |
| No. (%) of negative concessions | 215 (15) | 31 (8) | 30 (9) |

[1] Significance compared to auctions; * $p \leq 0.01$; ^ $p \leq 0.05$.

[2] Per cent of the total no. of all concession.

The average total concession in auctions (58.2) is significantly higher than in both cooperative (34.0, p = 0.000), and competitive (36.2, p = 0.000) negotiations. Mean concession per bid in auction is equal to 14.9, while in negotiations they are equal to 6.4 and 6.6 for cooperative and competitive processes respectively.

There are several reasons why—from the singular perspective of the buyer's profit—auctions appear to be a much better transaction mechanism than negotiations. For example, in negotiations the sellers may ask the buyer to make concessions; also they do not know what other sellers are proposing except for the information conveyed by the buyer. Another possibility is that because buyers are not competing among themselves for a contract, they are in monopolistic situation, while sellers are not. Although in negotiations, buyers are also in a monopolistic situation they are socially present allowing the buyers to raise their concerns, ask for explanations, refer to fairness or compassion, and make promises.

Another interesting observation coming from this experiment is that there is little difference between competitive and cooperative buyers in terms of the sellers' concessions and, accordingly, their substantive outcomes. The average number of bids in auctions is smaller than the average number of offers in negotiations. This difference is significant for all sellers.

Sellers made greater concessions per bid in the auctions than in the negotiations but they submitted fewer bids on average than the average number of offers made in the negotiations. Because the average profit made by the winner was smaller in the auctions than in the

negotiations (Table II), the winner had to make greater concessions per bid in an auction than in a negotiation.

In the auctions null concessions were less frequent than in the negotiations. The reason is that the auction mechanism forces bidders to submit one round of bids with ratings higher for the buyer than in the previous round. While in general this did not assure that the sellers must make concessions when they move from one round to another, it took place frequently.

There is no significant difference in the average number of offers made in cooperative and competitive negotiations.

For the purpose of comparison, results of the 2012 experiment are also shown in Table VI.

## 4.2 Observed concession categories

Our proposition (see Section II) to distinguish positive, null and negative coupled with two perspectives led to nine possible configurations shown in Table I. The number of concessions made by all participants (both winners and non-winners) in each category is shown in Table VI.

A standard feature of auctions is that bidders can make *progressive bids*, i.e., that are better for the buyer. This feature has been implemented in our action mechanism; therefore, bidders could make only positive concessions from the buyer's point of view (see Table VI).

Typically, concessions are positive for sellers and buyers. However, the remaining two categories in auctions and eight in negotiations also occur. This provides empirical evidence for the concession categorization formulated in Section II.

Table 6. Categorization of all concessions (Spring 2011)

| **Concession-maker:** | **Concession-taker: buyer** (buyer's profit) | | |
|---|---|---|---|
| **seller** (seller's profit) | **Positive** | **Null** | **Negative** |
| *Auctions* (total: 168 concessions) | | | |
| Positive (%) | 150 (89) | n/a | n/a |
| Null (%) | 3 (2) | n/a | n/a |
| Negative | 15 (9) | n/a | n/a |
| *Cooperative negotiations* (total: 588 concessions) | | | |
| Positive (%) | 382 (65) | 3 (0.5) | 61 (10) |
| Null (%) | 10 (2) | 31 (5) | 9 (1) |
| Negative (%) | 29 (5) | 4 (1) | 59 (10) |
| *Competitive negotiations* (total:613 concessions) | | | |
| Positive (%) | 410 (67) | 4 (1) | 54 (9) |

| | | | |
|---|---|---|---|
| Null (%) | 12 (2) | 33 (5) | 12 (2 ) |
| Negative (%) | 20 (3) | 1 (0.2) | 85 (14) |

In auctions 11% of concessions were not positive-positive (i.e., lose-win). They were 9% negative-positive (i.e., win-lose) concessions meaning that bidders were able to submit a new bid with a better rating for themselves than their last bid and 2% of null concessions for the seller.

In negotiations the sellers' negative-positive concessions were less frequent (5% and 3% respectively in cooperative and competitive negotiations) than in auctions. The likely reason is the different information available to sellers in auctions and in negotiations. Sellers know that the auction mechanism allows them to make progressive bids and they are able to select a bid that meets this condition and yields maximum utility for them. In negotiations, the mechanism is replaced by the buyers who typically do not inform the sellers about this condition. Consequently, the percent of seller-negative concessions seems quite high.

In the negotiations the number of concessions that were not positive-positive (i.e., lose-win) is high: 35% in cooperative and 33% in competitive negotiations. This implies that what negotiation theory and practice considers to be a typical concession in practice may not be that typical. There are many concessions which are null for both sides and also concessions which are positive-negative (i.e., lose-lose) and negative-negative (i.e., win-lose).

The relatively high percent of positive-negative (lose-lose) concessions in negotiations is surprising because these concessions are bad for both sides. The participants were provided with decision aids (including, profit (loss) calculation, offer generators, interactive and dynamics charts) which they could use in deciding on a concession [35]. One may expect that these aids should help negotiators in the process analysis and concession-making. These aids are, however, of limited use if the parties do not exchange relevant information, primarily information about their preferences (profits and losses). Surprisingly, cooperative buyers did not appear to provide sellers with better information than competitive buyers; in the cooperative negotiations the sellers made 10% of lose-lose concession of the total concession made and in the competitive negotiations they made 9% of the total.

Negative-negative concessions are *reverse concession* because they make the concession-maker better-off and the concession-taker worse off. A significant per-cent of this category was made in both types of negotiations: 10% in cooperative and 14% in competitive, indicating that in the former the sellers might want to punish the buyer less frequently than in the later.

In both types of negotiations there was relatively high number of the null concessions for the sellers (8% in cooperative and 9% in competitive negotiations). This may suggest that the sellers sought offers which did not reduce their profit. (Note that the number of null-null concessions includes cases when a seller resubmitted the same offer two or more times.)

Table 7. Categorization of all concessions (Spring 2012)

| **Concession-maker:** | **Concession-taker: buyer** (buyer's profit) | | |
|---|---|---|---|
| **seller** (seller's profit) | **Positive** | **Null** | **Negative** |

| | | | |
|---|---|---|---|
| *Auctions* (total:1369 concessions) | | | |
| Positive | 871 (64%) | 28 (2%) | 36 (3%) |
| Null | 49 (4%) | 154 (11%) | 16 (1%) |
| Negative | 79 (6%) | 18 (1%) | 118 (9%) |
| *Cooperative negotiations* (total:178 concessions) | | | |
| Positive | 145 (81%) | 2 (1%) | 7 (4%) |
| Null | 2 (1%) | 11 (6%) | 1 (1%) |
| Negative | 2 (1%) | 1 (1%) | 7 (4%) |
| *Competitive negotiations* (total:177 concessions) | | | |
| Positive | 140 (79%) | 6 (3%) | 12 (7%) |
| Null | 2 (1%) | 6 (3%) | 1 (1%) |
| Negative | 4 (2%) | 1 (1%) | 5 (3%) |

In the 2012 experiment we modified the auction protocol to provide participants with greater flexibility in their bid submission. Rather than setting up a fixed-length and number of rounds, two rules were introduced which moved the process from one round to another: (1) after all participants submitted their bid, the auction moved to the next round; and (2) after two participants submitted bids, there was a short delay period (4hrs.) after which the auction moved to the next round. In addition, the bidders were also able to submit multiple bids in the same round in this experiment.

The results of the 2012 experiment support the results of the 2011 experiment, i.e., the majority of the concessions were positive for both the buyers and the sellers. Because, in the latter experiment bidders could submit multiple bids in a single round, they could make null or negative concessions for the buyer. This was observed in 14% and 13% of the cases respectively.

In the auctions negative-negative (win-lose) concessions were observed more often (9%) than in the negotiations (4% and 3%). In the auctions they could only be made with 2$^{nd}$, 3$^{rd}$, etc. bid in one round. There was no risk in doing it, because the buyer did not evaluate the bids. This was not the case for negotiations, in which the buyers viewed and assessed all offers.

## 4.3 Observed concession types

Single- and multiple-issue concessions are the two types discussed in Section II. Multiple-issue concessions are cognitively difficult activities in both auctions and negotiations. While such concessions allow for logrolling and hence joint improvements, they also require an assessment of changes caused by two or more issues. In particular, the seller seeks concessions that may increase the buyer's profit but do not decrease his own profit.

Tables VIII and IX show concession types made by winners in 2011 and 2012 experiments. The

average relative concession type (ARCT) is the average percent of one type of concession made by the winner of an auction (negotiation).

Table 8. Winners' single- and multi-issue concessions (2011)

| Average relative concessions type (ARCT) made by sellers | Auctions | Negotiations | |
|---|---|---|---|
| | | Cooperative | Competitive |
| *Only multiple-issue concessions (0% of single-issue)* | | | |
| No. of sellers (%) | 3 (27) | 7 (32) | 7 (30) |
| ARCT multiple-issue (%) | 100 | 100 | 100 |
| ARCT multiple-issue (%, buyer) | 100 | 100 | 100 |
| Winner's profit | 6.0 | 7.0 | 9.4 |
| Buyer's profit | 66.0 | 66.6 | 66.6 |
| *Both single- and multiple-issue concessions* | | | |
| No. of sellers (%) | 8 (73) | 22 (68) | 23 (70) |
| ARCT multiple-issue (%) | 71* | 60* | 85 |
| ARCT multiple-issue (%, buyer) | 80* | 65* | 84 |
| Winner's profit | -14.0 | 12.9# | 3.4# |
| Buyer's profit | 83.6 | 62.7# | 70.8# |

# Significance compared to auctions: $p < 0.01$; ^ $p < 0.05$;
* Significance compared to multiple-issue concessions: $p < 0.01$.

In 2011 only about a third of winners made multiple-issue concessions. This was also the case for auctions in 2012 but not the for the negotiations' winners. In the 2012 negotiation 76% of winners in cooperative and 48% in competitive negotiations made multiple-issue offers. We know of no other studies which would experimentally compare frequency of single- and multiple-issue concessions, therefore we cannot claim that these frequencies are high. It appears however, that offer (bid) generator which is included in the systems used by the auction and negotiation participants was useful. It allowed the users to enter a desired profit value and then the system generated seven alternatives yielding the requested or similar value [35].

For the sake of comparison Tables VIII and IX give ARCT in both the winner's and the buyer's ratings as well as their profit values. We can see that in both 2011 and 2012 experiments winners who made only multiple-issue concessions achieved significantly higher profits in auctions and in competitive negotiations than winners who made mixed type of concessions. In cooperative negotiations, however, making multiple-issue concessions had negative effect on profit value. The latter is a surprising result requiring further analysis. A possible explanation is that in

cooperative negotiation the sellers may engage in trading-off with the buyers on an issue-per-issue basis.

Table 9. Winners' single- and multi-issue concessions (2012)

| Average relative concessions (ARC) made by sellers | Auctions | Negotiations | |
|---|---|---|---|
| | | Cooperative | Competitive |
| *Only multiple-issue concessions (0% of single-issue)* | | | |
| No. of sellers (%) | 10 (20) | 16 (76)[#] | 11 (48)[^] |
| ARCT multiple-issue (%) | 100 | 100 | 100 |
| ARCT multiple-issue (%, buyer) | 100 | 100 | 100 |
| Winner's profit | 18.1 | 14.1 | 13.1 |
| Buyer's profit | 57.0 | 58.9 | 59.9 |
| *Both single and multiple concessions* | | | |
| No. of sellers (%) | 39 (80) | 5 (24)[#] | 12 (52)[^] |
| ARCT multiple-issue (%) | 68* | 88* | 21 |
| ARCT single-issue (%) | 32* | 14* | 79 |
| ARCT multiple-issue (%, buyer) | 73* | 64 | 54 |
| ARCT single-issue (%, buyer) | 27* | 36 | 45 |
| Winner's profit | -4.9[+] | 18.0 | 13.8 |
| Buyer's profit | 76.6[+] | 57.0 | 59.6 |

[#] Significance compared to auctions: $p < 0.01$; [^] $p < 0.05$;
[*] Significance compared to multiple-issue concessions: $p < 0.01$; [+] $p < 0.05$.

From the information shown in Table II we may conclude that buyers do better in auctions than in negotiations; the opposite is true for sellers. From Table VIII and IX we can observe that the difference in both the buyers' and the sellers' profits is much smaller when the sellers make multiple-issue concessions. This type of concessions equalizes the difference between auctions and negotiations while making both types makes the difference more pronounced.

## 5. Conclusions

The importance of concession-making in both auctions and negotiations is unquestionable. This paper proposes two distinct categorizations of concessions and empirically shows that all nine categories and two types are employed in reverse auctions and multi-bilateral

negotiations.

One of the findings is that in auctions sellers make bigger concessions, and, subsequently the winners end up with relatively unfavorable agreements as compared to negotiations.

One explanation for this result is the auction mechanism imposing more constraints on the permissible bids and thus restricting the space of feasible offers for the sellers. In multi-bilateral negotiations, however, there is more space for the search of joint solutions, and there is also a possibility of using concessions as means of eliciting reciprocal steps from the buyers. Thus, the average concessions by the seller may be smaller, and the outcomes are relatively more favorable.

Another possible explanation is the buyers' active participation in negotiations but not in auctions. This participation allows the sellers to explain their needs and ask for better contract conditions.

Based on these results, one may conclude that buyers prefer employing reverse auctions in procurement because they can extract more from the sellers. Such a conclusion is only partially correct for two key reasons: (1) There are situations in which both buyers and sellers have interests (e.g., relationship and commitment) the value of which cannot be determined through an auction; and (2) There are goods and services which need to be negotiated because their specification cannot be a priory determined.

Therefore both reverse auctions and multi-bilateral negotiation have been used in procurement [37, 38].

In [25] we reported that the difference between average concessions by the sellers when comparing competitive vs. cooperative buyers was not significant and that win-win bids were observed more often in auctions than win-win offers in negotiations. Here we can add that win-lose and other categories of bids occur in auctions if the protocol allows it.

Lastly, we see that extrinsic motivation in terms of reward (penalty) for achieving good (bad) results impacts concession-making in both auctions and in negotiations.

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## References

R. Cialdini, J. Vincent, S. Lewis, J. Catalan, D. Wheeler, and B. Darby, "Reciprocal Concessions Procedure for Inducing Compliance: The Door-in-the-face Technique," *Journal oj Personality and Social Psychology,* vol. 31, pp. 206-215, 1975.

J. Esser and S. Komorita, "Reciprocity and Concession Making in Bargaining," *Journal of Personality and Social Psychology,* vol. 31, pp. 864-872, 1975.

S. Kwon and L. R. Weingart, "Unilateral Concessions from the Other Party: Concession Behavior, Attributions, and Negotiation Judgments," *Journal of Applied Psychology,* vol. 89, pp. 263-278, 2004.

T. S. Bateman, "Contingent Concession Strategies in Dyadic Bargaining," *Organizational Behavior and*

*Human Performance,* vol. 26, pp. 212-221, 1980.

S. S. Komorita and J. K. Esser, "Frequency of reciprocated concessions in bargaining," *Journal ol Personality and Social Psychology,* vol. 32, pp. 699-705, 1975.

B. Spector, "Negotiation as Learning: Pedagogy and Theory," presented at the Annual Conference of the International Studies Association, Chicago, 2007.

W. Zartman, "Negotiation as a Joint Decision-Making Process," *Journal of Conflict Resolution,* vol. 21, pp. 619-638, 1977.

H. Raiffa, J. Richardson, and D. Metcalfe, *Negotiation Analysis. The Science and Art of Collaborative Decision Making,*. Cambridge: Harvard University Press, 2003.

A. Schneider, "Shattering Negotiation Myths: Empirical Evidence on the Effectiveness of Negotiation Style," *Harv. Negotiation Law Review,* vol. 7, pp. 143-403, 2002.

D. G. Pruitt, *Negotiation Behavior*. New York: Academic Press, 1981.

C. Osgood, *An Alternative to War or Surrender*. Urbana: University of Illinois Press, 1962.

S. Siegel, L. E. Fouraker, and D. Ellsberg, "Bargaining and Group Decision Making: Experiments in Bilateral Monopoly," *American Economic Review,* vol. 51, pp. 420-421, 1961.

L. Thompson and D. Hrebec, "Lose-lose Agreements in Interdependent Decision Making," *Psychological Bulletin,* vol. 120, pp. 396-409, 1996.

M. P. Follett, "Constructive Conflict," in *Dynamic Administration: The Collected Papers of Mary Parker Follett*, H. C. Metcalf and L. Urwick, Eds., ed New York: Harper, 1940, pp. 30-49.

R. Fisher and W. Ury, *Getting to Yes. Negotiating Agreement Without Giving In*. New York: Penguin Books, 1983.

M. F. Shakun, "Multi-bilateral Multi-issue E-negotiation in E-commerce with a Tit-for-Tat Computer Agent," *Group Decision and Negotiation,* vol. 14, pp. 383-392, 2005.

E. Chen, R. Vahidov, and G. E. Kersten, "Agent-supported Negotiations on E-marketplace," *International Journal of Electronic Business,* vol. 3, pp. 28-49, 2005.

G. E. Kersten, "E-negotiation Systems: Interaction of People and Technologies to Resolve Conflicts," *The Magnus Journal of Management,* vol. 1, pp. 71-96, 2005.

Y. Yang, Y. See, A. Ortony, and J. Tan, "Subjective Effectiveness in Agent-to-Human Negotiation: A Frame x Personality Account," in *Argumentation in Multi-Agent Systems*, ed, 2010, pp. 134-149.

T. Meyer, N. Foo, R. Kwok, and D. Zhang, "Logical Foundations of Negotiation: Outcome, Concession and Adaptation," in *American Association for Artificial Intelligence*, 2004.

F. Lopes and H. Coelho, "Concession Behaviour in Automated Negotiation," 2010, p. 184.

P. Faratin, C. Sierra, and N. R. Jennings, "Negotiation Decision Functions for Autonomous Agents," *Robotics and Autonomous Systems,* vol. 24, pp. 159-182, 1998.

U. Endriss, "Monotonic Concession Protocols for Multilateral Negotiation," 2006, pp. 392-399.

G. E. Kersten and S. J. Noronha, "Rational Agents, Contract Curves, and Inefficient Compromises," *IEEE Systems, Man, and Cybernetics,* vol. 28, pp. 326-338, 1998.

G. E. Kersten, D. Gimon, and R. Vahidov, "Concession Patterns in Multi-issue Negotiations and Reverse Auctions," in *Proceedings of the International Conference on Electronic Commerce*, Singapore, 2012.

B. G. Ferrin and R. E. Plank, "Total Cost of Ownership Models: An Exploratory Study," *Journal of Supply*

*Chain Management,* vol. 38, pp. 18-29, 2002.

M. Bichler, "An Experimental Analysis of Multi-attribute Auctions," *Decision Support Systems,* vol. 29, pp. 249-268, 2000.

M. Bichler and J. Kalagnanam, "Configurable Offers and Winner Determination in Multi-attribute Auctions," *European Journal of Operational Research,* vol. 160, pp. 380-394, 2005.

K. M. Sim and E. Wong, "Toward market-driven agents for electronic auction," *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on,* vol. 31, pp. 474-484, 2001.

M. Tajima and N. M. Fraser, "Logrolling Procedure for Multi-issue Negotiation," *Group Decision and Negotiation,* vol. 10, pp. 217-235, 2001.

D. G. Pruitt, "Strategic Choice in Negotiation," *American Behavioral Scientist,* vol. 27, pp. 167-194, 1983.

G. E. Kersten and T. Szapiro, "Generalized Approach to Modeling Negotiations," *European Journal of Operational Research,* vol. 26, pp. 142-149, 1986.

L. A. Froman Jr and M. D. Cohen, "Compromise and logroll: Comparing the efficiency of two bargaining processes," *Behavioral Science,* vol. 15, pp. 180-183, 1970.

L. R. Weingart, R. J. Bennett, and J. M. Brett, "The Impact of Consideration of Issues and Motivational Orientation on Group Negotiation Process and Outcome," *Journal of Applied Psychology,* vol. 78, pp. 504-517, 1993.

G. E. Kersten, P. Pontrandolfo, R. Vahidov, and D. Gimon, "Negotiation and Auction Mechanisms: Two Systems and Two Experiments " in *E-life: Web-enabled Convergence of Commerce, Work, and Social Life* vol. 108, M. J. Shaw, D. Zhang, and W. T. Yue, Eds., ed New York: Springer, 2012, pp. 400-412.

G. E. Kersten, P. Pontrandolfo, and S. Wu, "A Multiattribute Auction Procedure and Its Implementation," in *HICSS 45*, Hawaii, 2012.

R. B. Handfield and S. L. Straight, "What Sourcing Channel is Right for You?," *Supply Chain Management Review,* vol. 7, pp. 63-68, 2003.

P. Kraljic, "Purchasing Must Become Supply Management," *Harvard Business Review,* vol. 83, pp. 109-117, 1983.