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A Behavioral Study of Concession-making: Multi-attribute Auctions vs. Multi-bilateral Negotiations

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Abstract

Concession-making behavior is an essential process in negotiations and auctions and has a critical impact on the outcomes of an exchange. In auctions, concessions relate to deciding on the next bid by bid-makers, while in negotiations they involve proposing next offers by both parties. The purpose of this paper is to empirically investigate concession-making by parties in multi-attribute auctions and multi-issue multi-bilateral negotiations. The work proposes a formal model for categorizing concessions based on the participants' preference structures. The model is further validated using experiments with human subjects comparing concession-making behavior in auctions and negotiations. To this end, two systems implemented on the Invite e-negotiation platform were used. One of the major findings suggests that auctions induce concession-making that is more likely to lead to Pareto-optimal agreements. This study also suggests that greater transparency in negotiations is likely to lead to better agreements.

Keywords: auctions, multi-bilateral negotiations, multi-attribute reverse auctions, online auctions, e-negotiations, experimental study, decision support systems, e-procurement.

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1. Introduction

A concession is the act or process of giving something of value to a person who asked for it. A concession may also mean a thing of value that is being given. To distinguish between these two meanings we use the terms “concession-making” and “concession” the values of which can be measured. Furthermore, we note that one does not need to be asked directly in order to make a concession. A person may imply or expect that a concession be made. It is also possible that one makes a concession in order to get something in return.

Concession-making is a typical activity in both auctions and negotiations. However, there is a slight difference between concession making in auctions and in negotiations. In auctions one either makes a concession in the form of a revised bid or she drops out of the auction. In negotiations, concessions are asked for, implied or expected.

In negotiations, concession-making has been extensively studied both experimentally and in the field (Cialdini et al. 1975; Esser and Komorita 1975; Kwon and Weingart 2004). 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 (Komorita and Esser 1975; Bateman 1980).

Concession-making is focused around the issues on the table and discounts education and learning. There may be more to negotiation than concessions, with learning being the key to reaching an agreement (Zartman 1977; Spector 2007). For example, during the process the parties may realize that they are not in opposition and there are alternatives which satisfy everybody's needs (Schneider 2002; Raiffa et al. 2003). In many economic transactions, however, concessions are necessary to reach an agreement.

This paper builds on and extends an earlier work on concession making in auctions and negotiations (Kersten and Gimon 2012; Kersten et al. 2012). In both papers concession-making is studied based on their two forms of categorization. As far as we know this is the first such classification that has been experimentally verified.

In addition to studying concession-making in multi-bilateral negotiations, this 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 business exchanges, including 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 problem often occurs in business negotiations and is typical in procurement (Ferrin and Plank 2002; Beil and Wein 2003), a business domain in which auctions, including multi-attribute auctions, have been employed (Millet et al. 2004; Elmaghraby 2007; Adomavicius et al. 2012).

The purpose of this work is to share insights into concession-making behavior in auctions and negotiations. There is a vast body of research on the determinants of strategies as well as negotiators' behaviors resulting from employment of different strategies (see, e.g. Komorita and Brenner 1968; Raiffa 1982; Thompson 2005; Henderson et al. 2006). With few exceptions (Galinsky et al. 2009; Lax 2010; Subramanian 2010), negotiation literature, tends to ignore auctions. In auction literature two streams of research can be distinguished: (1) theoretical comparisons of mechanisms and protocols, and their verification regarding revenue generation, efficiency, and surplus (Bulow and Klemperer 1996; Kirkegaard 2004; Bulow and Klemperer 2009); and (2) behavioral comparisons of bidders' behavior in auctions and the impact of auction parameters on outcomes (Kamins et al. 2011; Adomavicius, Gupta et al. 2012; Kuruzovich 2012).

The richness of business transactions, the requirements of participants of business exchanges as well as their actual behavior lead to a greater formalization of negotiations as well as to the loosening of the rigors of auction protocols. Bidders may signal and collude, bid-takers may communicate with selected bidders, winners may not pay or they may not obtain the good (Pinker et al. 2003; Engelbrecht-Wiggans et al. 2007). Rule-changes due to signaling and jump bidding as

well as rule-relaxation as in winner-determined auctions occur often in procurement and other B2B transactions. Rothkopf and Harstad (1994, p. 378) summarize these changes in the following way: “While most auction models assume that the auction rules are clear, understood, and universally followed, in reality bidders often look for ways to bend, change or get around the rules.” It may be, therefore, useful to study auctions in a way similar to negotiation, especially in multi-attribute cases wherein both mechanisms are used.

Auctions are widely used and yet despite their acknowledged efficiency as well as perceived transparency - features sought by both businesses and governments - negotiations remain an accepted and commonly used exchange mechanism. *Multi-attribute auction mechanisms*, which are similar to multi-issue negotiations, have been designed and implemented (Sandholm 2007; Sandholm 2008; Kersten et al. 2012). A more detailed study of both mechanisms may help us to understand their strengths and weaknesses. It may also give us insight into some market preferences for negotiations despite the fact that the process is slow, difficult, and nontransparent. Observation of bidders and negotiators behavior provides insights into the mechanism use and the relationship between users’ actions and process outcomes.

This paper focuses on concession-making because this behavior is the key activity common to bidding and negotiating. We are primarily interested in B2B and G2B exchanges, therefore we study *reverse auction* which is the best-known type of electronic sourcing system. In order to study the behavior of the mechanism’s users, we consider the sellers’ behavior only because in reverse auctions only they actively participate in the process. A comparison of face-to-face multi-issue negotiation in which one buyer needs to interact with several sellers with multi-attribute reverse auction is inappropriate because the former is a sequential process while the latter is simultaneous. Therefore, we study *multi-bilateral multi-issue electronic negotiations* in which the buyer can simultaneously negotiate with several sellers¹.

The next section reviews auction and negotiation literature on concessions. In Section 3 we build on the common understanding of concessions and formulate concession models which allow us to propose a typology, which is based on two distinct perspectives: (1) the concession-maker and the concession-taker perspective; and (2) subjective perspective of the concession-maker vs. objective market perspective. In Section 4 we present experiments which were designed to study concession-making in multi-attribute auctions and multi-bilateral negotiations. The experiments’ general results and a comparison of theoretical and actual winners are also discussed in this section. Analysis of concession-making is given in Section 5. A comparison of subjective and objective concessions shows not only significant differences but it also gives grounds to postulate a greater transparency in multi-bilateral negotiations. In this section we also show that the types of concessions made by bidders in auctions depend on the auction rule which limits the number of bids in a round. Lastly, Section 6 summarizes the results, presents their implications, and suggests directions for future research.

2. Review of concession-making in auctions and negotiations

2.1 Face-to-face negotiations

Conceptually concession-making may appear to be a simple process - a change of the negotiator’s position that reduces the level of benefit sought by her and seen as an improvement by the counterpart (Pruitt 1981). The underlying assumption for concession-making is that when it is made by both or one party, then it leads towards an agreement. This assumption holds in single-

¹ In negotiations attributes which are the subject of negotiations are called issues. In decision sciences and economics the term “attributes” is used. In the remainder of the paper we use attributes to describe characteristics of a good or service - subject of both negotiations and auctions.

attribute negotiations when it is clear that the parties' interests are in strict opposition; in such a case every concession gets the parties closer to a Pareto-optimal agreement (Kersten and Noronha 1998). However, when negotiators have no information about each other's preferences, then concession making may lead to no agreement (or a very bad one) even in a single-attribute negotiation (Follett 1940; Fisher and Ury 1983).

In business, concession-making is often expected irrespective of the first offer. A strategy known as Boulwarism, after L.R. Boulware, VP of GE, introduced in 1957, entailed a reasonable first offer and no concessions unless the union provided factual information that would warrant it (Anonymous 1957). Even when an offer was an improvement over agreements which unions negotiated in comparable companies and there was less strife in GE than elsewhere, this strategy is seen as hard, positional and in bad faith. The significance of concession in such situations was experimentally confirmed by Komorita and Brenner (1968) who showed that if one party wishes to reach an agreement at a 'fair' price, then this party cannot make an initial offer at that level and remain firm, instead they have to make the initial offer significantly higher. If the negotiator wants to achieve a good result, she should always start from a high enough level that will allow her to make fairly large concessions (Hinton et al. 1974).

When there are multiple attributes, then the relationship between concessions and agreement is not straightforward. Raiffa (1982), in his seminal work, illustrates the concept of strategic misrepresentation with management-union negotiations. Both sides had the same preferential direction over one attribute (both want the police chief to be fired); however, the union knew the management's preferences, while the management did not know that the union wanted the same. In this situation the union asked the management to make a concession and keep the chief and only after discussion and getting the management to make concessions on other issues (that the union is really interested in) the union made an apparent concession and agreed upon firing the chief. One could say that the union made a "win-win" concession because it resulted in both sides being better off.

This example shows that in a multi-attribute negotiation, when one party's preferences are unknown to the other party a concession need not reduce the level of benefit sought. In this case such a concession was possible because of the union's "insider's knowledge", such concessions may, however, also happen when the parties do not have sufficient information about their counterparts.

A multi-attribute negotiation introduces the possibility of making trade-offs leading to logrolling (Bazerman and Neale 1992). *Logrolling* is "the exchange of loss on some issues, usually less important in priority or value, for gain in other issues, usually more important." (Tajima and Fraser 2001, p. 218). It requires that the negotiator consider several attributes at a time and change their values in such a way that the offer is better for her counterpart but only minimally worse to the negotiator.

The purpose of logrolling is to improve the offer for the concession-taker but at a minimum cost to the concession-maker (Pruitt 1983; Kersten and Szapiro 1986). In some circumstances, e.g., when both parties' offers are inefficient, logrolling may allow for "win-win" agreements (Thompson 2005). One method of logrolling is to make large concessions on issues of low importance and small concessions on issues of high importance. This method allows reaching a better agreement than the one reached in situations where negotiators split the difference on each issue (Pruitt and Carnevale 1993).

Making offers in which values of several attributes are changed is cognitively more difficult than changing value for only one attribute at a time. In addition to cognitive difficulty, discussing issues in isolation leads to a "zero-sum" perception of the process (Weingart et al. 1996). The result is that negotiators may not be able to reach a Pareto-optimal agreement (Henderson, Trope et al. 2006).

The definition of concession given by Pruitt at the beginning of this section reflects a popular understanding of concession and can be classified as a "lose-win" type. Lose-win is also associated

with the zero-sum game because loss by one side is matched by a win by the other side. However, in many situations this is not the case. Raiffa illustrates the case of “win-win” concession – making, such concessions leads to “win-win” negotiations. This example also shows that the negotiator has strategic advantage if she knows that her concession increases or decreases the benefit (e.g., revenue, value, and utility) of her counterpart. This knowledge, however, is not common because negotiators often try to hide their true preferences. In effect the negotiator’s concession may be of the “lose-lose” type, when, for example, she misjudges her counterpart’s interests.

There may also be other types of concessions, some beneficial to the concession-maker and some not. They may be made because the counterpart’s preferences are unknown or for tactical reasons. One example of tactical concessions not mentioned above is based on the “tit-for-tat” rule which requires that the negotiator reciprocates “in kind”. Reciprocity may lead to a situation where the counterpart who received a “lose-lose” concession tries to reply with a “win-lose” concession in order to penalize the negotiator and at the same time improve her own position. An illustration of these four types of concessions is given in Figure 1.

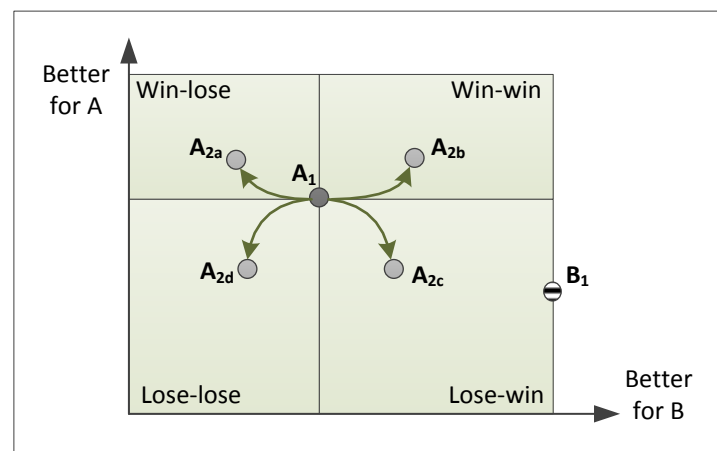


Figure 1. Illustration of four types of concessions

Negotiator A made an offer A_1 to which B replied with B_1 . Negotiator A may select an offer from one of the four quadrants; each quadrant corresponds to a different type of concessions with respect to offer A_1 and counteroffer B_1 . Offer A_{2a} yields a win-lose concession, A_{2b} yields a win-win concession, A_{2c} yields a lose-win concession, and A_{2d} yields a lose-lose concession. These different possibilities contribute to the ambiguity regarding concessions’ contribution to the probability of reaching an agreement as well as the agreement’s value (utility) for each party and for both parties jointly. While some concessions contribute to reaching an agreement, others may hinder it.

Field and experimental studies show that negotiators often enter the process with inaccurate judgments about their counterparts’ interests and preferences (Trötschel et al. 2011). Many of them, in particular the experienced negotiators, are able to correct the judgment errors early on (Thompson and Hastie 1990). These corrections, however, are not sufficient to achieve Pareto-optimal agreements unless the negotiators have accurate knowledge of their counterparts’ preferences.

Several approaches have been proposed to address this problem. The theory of gradual reciprocation assumes that concessions should be contingent so that they can be reciprocated (Osgood 1962) and contrasted with another early theory of a hardening of the concession-taker (Siegel et al. 1961). A strategic concessions model in which one party’s first offer is the best possible solution for this party has been proposed (Thompson and Hrebec 1996). 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. In general, if the

negotiators do not exchange information about their preferences or provide feedback regarding concessions, then concession monotonicity cannot be assured.

2.2 Online bilateral and multi-bilateral negotiations

Based on the assumed as well as observed contributions of concessions to agreements, a number of algorithms have been formulated with the purpose of aiding negotiators (see, e.g., Kersten 1985; Thiessen et al. 1998; Ma et al. 2006). These algorithms can be classified based on the information about the value or utility function that the negotiation aids are embedded with.

One type of negotiation support system (both off-line and online), in which information about preferences of every user is available, suggests an efficient agreement with no other user input. In such a case the users have to agree on making a single concession from an opening position to the proposed agreement. Recognizing that the users need to participate in the process systems suggest making incremental concessions rather than a single one (Foroughi 1998; Vetschera and Filzmoser 2012). The system directs the users to select an offer which decreases the distance between this offer and the counterpart's most recent offer and thus moves the process towards the efficient frontier (Kersten and Noronha 1999; Thiessen 2002).

The second type of system replaces the information about preferences with the assumption that the users have strictly opposing interests. These systems then suggest moves toward the efficient frontier and let the users choose and agree on a particular efficient alternative (Korhonen et al. 1986). If neither strong assumptions about the preferences are made nor the preferences are known, then the system lets the users decide on their moves (including concessions), and its support is limited to communication and bookkeeping (Yuan 2003; Gettinger et al. 2012).

2.3 Auctions

Auction literature has been concerned with the design of mechanisms followed by studies of their allocative efficiency, revenue maximization, fairness and other features of the mechanisms (Bichler 2000; Bichler and Kalagnanam 2005). Concession-making has been considered less important, in particular when bidders are rational agents. In English auction, the winning bid is the second-lowest cost. The process requires that the bidders make bids sufficiently small so that the lowest-cost bidder makes an offer which is at (or very close to) the second-lowest cost. Because no one can offer less than this bid, the lowest-cost bidder wins. Rational agents could avoid the bidding process altogether, if they employ Vickrey rather than English auction. The results would be the same and obtained in a very short time, with no bidding effort. However, the majority of auctions are English.

Auction theory assumes that bidders may differ in extrinsic but not intrinsic characteristics; their behavior is often represented by a known monotonic function of their private information (Rothkopf and Harstad 1994). Recently, however, the heterogeneity of bidders has been acknowledged and studied. Strong bidders may want to signal their interest to other bidders and make jump bids (Avery 1998).

Mithas and Jones (2007) studied bidders' behavior in single-attribute reverse auctions. They found that the number of bids affects the buyer's surplus (more bids lead to higher surplus) but the number of bidders does not have such impact. Field studies on bidder heterogeneity in multi-unit Yankee version of English auctions show that four types of bidder can be distinguished (Bapna et al. 2004). Bidders who are called early- and mid-evaluators place a single bid at the beginning or in the middle of the auction. Opportunistic bidders are similar to snipers as they make bids at the very end of the auction; they make a minimum possible concession. Bidders of the sip-and-dip type place one bid early on and another one at the end of the auction. Participatory bidders begin early and end late. Their behavior is similar to ratchet bidding in which bidders make minimum possible concession and which is opposite to jump bidding (Easley and Tenorio 2004).

3. Modeling concessions in auctions and negotiations

In practice, making concessions in auctions and negotiations may be very difficult because it requires that an acceptable alternative be selected and its implications assessed. Formally, a concession may appear as a simple concept because it is a difference between two values. Kersten et al. { 2012 #229} proposed concession categorization using the distinction between concession-maker and concession-taker. In this section we extend this categorization and propose concession models which are applicable to both auctions and negotiations.

3.1 Preliminaries

Both multi-attribute auction and negotiation processes can be described with a single model. Two important simplifying assumptions for modeling negotiation in this way are:

1. Only activities of the multiple sellers who negotiate with a single buyer are represented; and
2. The represented auctions are comprised solely of offers; requests, arguments and any other messages are ignored.

These two assumptions oversimplify negotiations but they are acceptable here because we do not look into the reasons why the negotiator makes a particular offer. Instead, we want to describe the sequence of offers that, if successful, ends with an agreement.

For the purpose of this study concession is equated with “subtraction operator” for the concession-maker and “addition operator” for the concession-taker. 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 savings for the buyer. In multi-issue negotiations, reduced and increased values 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:

I – set of participating sellers (bidders or negotiators);
 $t \in [0, t_K]$ – process time; t_K – deadline or process closure;
 $T_k = [t_{k-1}, t_k]$, ($k = 1, \dots, K$) – round;
 $\mathbf{x}(t) = [\mathbf{x}'(t), j \in J]$, $|J| = n$, an offer comprising n attributes at time t –time, $t \in [t_0, t_{T_K}]$;
 X – set of feasible offers, ($\mathbf{x} \in X \subset R^n, R^n$ – domain of real numbers);
 u_i – value function (utility) of seller i , ($i \in I$);
 u_b – value function (utility) of buyer b ; and
 $\{\mathbf{x}_i(t), t = 1, \dots, J_i\} = (\mathbf{x}_i(1), \dots, \mathbf{x}_i(t))$ – sequence of offers made by seller i , ($i \in I$) from the beginning; J_i is time of i ’s last offer.

3.2 Concession representation

In Section 2 we gave examples of different types of concessions, e.g., win-win, win-lose and lose-lose. The two-part naming of the types indicates that there are two perspectives on a single concession: one perspective of the concession-maker and another perspective of the concession-taker. Therefore, in order to assure proper 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 $\mathbf{x}_i(t_1)$ and $\mathbf{x}_i(t_2)$, ($t_1 < t_2$), concession made by seller i ($i \in I$) from i ’s perspective is:

$$c_i(t_2) = -u_i(\mathbf{x}_i(t_2)) + u_i(\mathbf{x}_i(t_1)). \quad (1)$$

Concession made by seller i from buyer's b perspective is:

$$c_{bi}(t_2) = u_b(\mathbf{x}_i(t_2)) - u_b(\mathbf{x}_i(t_1)). \quad (2)$$

While both concession values $c_i(t_2)$ and $c_{bi}(t_1)$ in (1) and (2), respectively, refer to the same act, i.e., seller's i proposal to replace offer $\mathbf{x}(t_1)$ with $\mathbf{x}(t_2)$, there is an important difference between them. Concession $c_i(t)$ reflects the subjective effort of the concession-maker that she makes in order to reach an agreement. Beyond this, however, it 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 $c_{bi}(t)$ is not positive, then the buyer rejects (if she can) the offer associated with this concession because she prefers another offer over the one made by this seller i . In other words, the buyer expects an offer made by the seller to be an improvement over earlier offers made by this and other sellers. If this is not the case, i.e.,

$$u_b(\mathbf{x}_i(t_2)) < u_b(\mathbf{x}_{i^*}(t_1)) = \max_{i \in I} \{ u_b(\mathbf{x}_i(t)) \}, \text{ for } t_2 > t_1, (t_2, t_1, t \in T_K) \text{ and } l, i \in I, \quad (3)$$

then $\mathbf{x}_i(t_2)$ is rejected. Offer $\mathbf{x}_{i^*}(t_1)$ remains the best offer currently on the table.

We need to note here that one of the differences between auctions and negotiations is that, in a negotiation offer $\mathbf{x}_i(t_2)$ may be accepted. Buyer b may decide to accept a worse offer for a number of reasons, e.g., the seller made a promise related to this offer, because the buyer trusts this seller more than the others, or the buyer thinks that she can establish a better relationship with this seller. If the buyer does not have any information about the seller and his offer other than the offer itself, then $\mathbf{x}_i(t_2)$ given by (3) should be rejected.

In auctions, the offer made by seller i^* at time t^* is the winning offer and seller i^* is the current winner (at time t) if:

$$u_b(\mathbf{x}_{i^*}(t^*)) = \max_{i \in I} \{ u_b(\mathbf{x}_i(t)) \}, (t^* \leq t). \quad (4)$$

There are different auction protocols and different information revelation schemas. We limit our discussion here to: (1) continuous and round-based English reverse actions; (2) either single or multiple offers per round; and (3) winning offer's disclosure at the end of each round.

If the winning offer is revealed, then in continuous auction bidder i either drops out or makes an offer that the buyer prefers over the last winning offer made by i^* at time t^* , that is,

$$\forall_{i, i^* \in I} u_b(\mathbf{x}_i(t + \tau)) > u_b(\mathbf{x}_{i^*}(t^*)), \quad (5)$$

where $\tau > 0$ is such a small time interval that that no offer can be made during the period $(t, t + \tau)$.

In round-based auctions, in which bidder i can make one offer per round, she either drops out or makes an offer that the buyer prefers over the last winning offer, that is,

$$\forall_{i, i^* \in I} u_b(\mathbf{x}_i(t)) > u_b(\mathbf{x}_{i^*}(t^*)), t \in T_k, t^* \in T_{k-1}. \quad (6)$$

From (2) and (5) it follows that no bidder can make a smaller concession than the one imposed by the winning offer. In other words, the *lower bound* $\underline{c}_{bi}(t)$ for bidder's i concession measured with buyer's b utility is:

$$\forall_{i \in I} \underline{c}_{bi}(t) = u_b(\mathbf{x}_{i^*}(t^*)) - u_b(\mathbf{x}_i(t_1))$$

so that:

$$\forall_{i \in I} c_{bi}(t) = u_b(\mathbf{x}_i(t)) - u_b(\mathbf{x}_i(t_1)) > \underline{c}_{bi}(t), \quad (7)$$

where: $\mathbf{x}_i(t)$ and $\mathbf{x}_i(t_1)$ are two consecutive offers made by bidder i , ($t > t_1$);
 $\mathbf{x}_*(t^*)$ is the winning offer; and we have $t \leq t^* + \tau$ for continuous auction,
and $t \in T_k$, and $t, t^* \in T_{k-1}$ for single offer round-based auction.

Making concession which satisfies (7) is difficult if bidder i does not know the utility of bid-taker b . In such a case, the lower bound restricts admissible bids but the admissibility constraint (7) is unknown. Options to deal with this problem include: (1) disclosing buyer's utility; and (2) providing admissible sets.

Multi-attribute auction protocols in which bid-taker's utility is disclosed have been proposed (Che 1993; Branco 1997; Milgrom 2000), their usefulness is, however, limited because buyers often want to keep their preferences and trade-offs secret (Burmeister et al. 2002; Parkes and Kalagnanam 2005). When bidders know u_b , then they can submit an offer which satisfies (7).

Several protocols do not assume that bidders have perfect information of the bid-takers' utility or scoring function (Teich et al. 2006; Sandholm 2008). In this paper we use the *admissible bidding set* (ABS) protocol, which is round-based and allows for either single- offer or multiple- offer rounds (Kersten et al. 2010; Kersten, Pontrandolfo et al. 2012). In ABS bidders do not need to obtain lower bound \underline{c}_{bi} given by (7). Instead, they are given a set of offers $X_{T_k}^A \subset X$, which are admissible in round T_k , ($k = 1, \dots, K$):

$$X_{T_k}^A = \{\mathbf{x}: u_b(\mathbf{x}(t_2)) > u_b(\mathbf{x}(t^*))\}, \quad (8)$$

where $\mathbf{x}_{i*}(t^*)$ is the best offer at time t^* in round T_{k-1} ; $t^* \in T_{k-1}$; and $t \in T_k$.

Providing bidders with complete specification of set $X_{T_k}^A$ defined by (8) is equivalent to disclosing the buyer's utility. The ABS protocol avoids it by selecting several subsets of $X_{T_k}^A$ in every round. Whether or not the alternatives are dropped in this way depends on the auction parameters controlled by the bid-taker (Kersten, Wu et al. 2010).

Using (8) we can formulate lower bound \underline{c}_i for concessions in ABS protocol measured by seller's i utility:

$$\underline{c}_i(t) = -u_i(\mathbf{x}_{i*}(t^*)) + \min_{\mathbf{x}(t) \in X_{T_k}^A} u_i(\mathbf{x}(t)). \quad (9)$$

where $\mathbf{x}(t^*)$ is the best offer at time t^* ; $t \in T_k$; $t^* \in T_{k-1}$.

ABS is a round-based protocol, in which bidders may make one or multiple offers in each round. If the winning offer is announced only after the round is finished, then they may submit offers that are worse for the buyer than the best offer at that time. They may submit an offer which yields lose-lose or win-lose concession, following an earlier offer they submitted in the same round. This allows bidders to act in a similar way the negotiators do.

Allowing bidders to make multiple bids in every round may be useful in multi-attribute auctions because they may submit different options of similar value. If one of these options becomes a winning bid, then the bidder may obtain indirect partial information about the buyer's preferences.

In negotiations, in contrast to auctions, instead of a lower bound on the concession value (7) we have an upper bound defined by the buyer's offer. If at time t the most recent offer made by buyer b is $\mathbf{x}_b(t_1)$, then seller i needs not make larger concession than $\bar{c}_i(t)$, where:

$$\forall_{i \in I} \bar{c}_i(t) = u_i(\mathbf{x}_i(t)) - u_i(\mathbf{x}_b(t_1)), t > t_1. \quad (10)$$

Seller i by making concession $\bar{c}_i(t)$, accepts the offer made by buyer b , hence it the *concession upper bound*.

It is possible that the buyer does not make any offer and, instead, tries to persuade or push sellers to make offers. She rejects these offers and asks for improvements. In such negotiations there is no upper bound and instead the sellers can use their earlier offers as indicators. In practice, however, they should try getting the buyer to make an offer or disclose best offer that the buyer received. The latter case makes negotiation somewhat similar to auctions.

3.3 Typology

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. From Definition 1 we have two perspectives on concessions. Consideration of these perspectives jointly, i.e., their impact on both the buyer and seller's utility values, allows us to distinguish nine categories of concession pairs. Following the traditional perspective on concession, i.e., concession is positive if it reduces the value for the concession-maker (i.e., "lose") and increases the value for the concession-taker. For the purpose of concession classification we simplify the notation given in (1) and (2):

$$\begin{aligned} c_s &= c_s(t) = -u_s(\mathbf{x}(t)) + u_s(\mathbf{x}(t-1)) \text{ -- concession-maker's perspective (i.e., seller } s), \text{ and} \\ c_b &= c_{bs}(t) = u_b(\mathbf{x}(t)) - u_b(\mathbf{x}(t-1)) \text{ -- concession-taker's perspective (i.e., buyer } b). \end{aligned} \quad (11)$$

We note that these two perspectives arise from bilateral negotiation analysis and are based on the offers made by one negotiator. Auctions and multi-bilateral negotiation introduce competition among multiple participants representing one side (here—sellers). In (7) and (9) we introduced a lower bound on concession in auctions which is caused by the winning offer. This bound causes any concession which yields utility for the buyer that is lower than the current winning offer is not accepted. This gives us a perspective on concession that is not based solely on the concession-maker's decision but takes into consideration decisions made by her competitors. Consider, for a purpose of illustration, a simple example of seller A, who wants \$30 for an object. Then seller B offers \$ 20 for exactly the same object. From A's perspective, any value between 30 and 20 is a concession, but this concession is meaningless because the buyer rejects it. Hence, the minimum market-based (objective) concession for A is 1 ¢; that is, A offers to sell the object for \$ 19.99. In contrast, the minimum acceptable concession from A's perspective is \$10.01; this is a subjective concession.

Participation in an auction or a multi-bilateral negotiation augments the *subjective consideration* of concession given by (1) and (2) with an *objective consideration* of concession. The reason it is objective is because the past offer made by a seller becomes irrelevant when a better offer is available.

It is not a necessary condition for auctions to reveal winning offers, albeit it is often done in order to increase the mechanisms transparency. It is unusual for a negotiator (buyer) to inform her counterparts (seller) about the best offer she received; however, it can be done. We use the lower bounds given by (7) and (9) assess concessions. This gives us two categories of perspectives on concessions;

1. Subjective individual-oriented perspective coming from bilateral negotiation tradition and it is given by (10); and
2. Objective market-oriented perspective coming from auctions.

In Figure 2 we show the perspectives and how they may be put together. To assess and classify concessions into types we need to know the perspective, but every perspective can give us the same type. For example, to objectively assess a concession from the concession-maker's

perspective we use (9) and to subjectively assess a concession from the concession-taker's perspective we use (2).

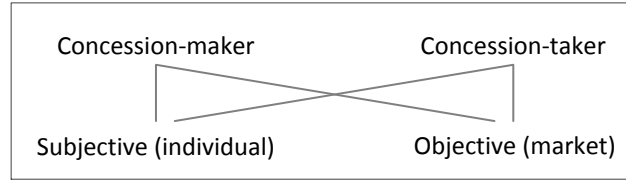


Figure 2. Perspectives on concessions

Definition 2. Given two offers $\hat{x}(t)$ and $x_i(t)$, where $\hat{x}(t)$ is the best offer at time t , objective concession made by seller i ($i \in I$) at time t , from i 's perspective is:

$$c_i(t) = -u_i(x_i(t)) + u_b(\hat{x}(t)). \quad (12)$$

Objective concession made by seller i from buyer's b perspective is:

$$c_{bi}(t) = -u_b(x_i(t)) + u_b(\hat{x}(t)). \quad (13)$$

From the above it follows that using (1) we obtain a different value than if we use (12), (similarly for (2) and (13)) in each formula the base is different—own offer vs. best offer on the table. Notwithstanding the numerical difference we can assess if a particular concession is positive, negative or null. To use the same notation as in (11), in Table 1 we replace (12)-(13) with:

$$c_s = c_s(t) \text{ and } c_b = c_{bs}(t). \quad (14)$$

We can now identify nine types of concessions—they are shown in Table 1. From (11) and (12) it follows that every particular concession has two different values and therefore may be of a one or two types. However, using one of the formulae we can use Table 1 to classify every concession.

Table 1. Nine types of concessions

Concession-maker	Concession-taker		
	Positive	Null	Negative
Positive	$c_s > 0; c_b > 0$ lose-win	$c_s > 0; c_b = 0$ lose-neutral	$c_s > 0; c_b < 0$ lose-lose
Null	$c_s = 0; c_b > 0$ neutral-win	$c_s = 0; c_b = 0$ neutral-neutral	$c_s = 0; c_b < 0$ neutral-lose
Negative	$c_s < 0; c_b > 0$ win-win	$c_s < 0; c_b = 0$ win-neutral	$c_s < 0; c_b < 0$ win-lose

We mentioned that some of the concessions listed in Table 1 have been discussed in negotiation literature. We have also mentioned that designers of decision and negotiation aids and support systems sought ways to advise users to make win-win concessions as long as they are possible and then move to lose-win concessions when the negotiators need to traverse the Pareto-optimal frontier. The recognition that there are nine types of concessions, some of which can move

the parties closer to an agreement but others that can move them farther from it, may equip the system designers and their users with additional capabilities to support and manage negotiations. Furthermore, the introduction of nine types of objective concessions defined by (12)-(13) allows for a direct comparison of concession-making in auctions and negotiations.

4. Experiment

In the fall of 2011 we conducted auction and negotiation experiments that allowed us to observe concession-making behavior in multi-attribute auctions and multi-issue multi-bilateral negotiations using a single procurement case. Buyers participated in negotiations but not in auctions; therefore we study here only sellers' concession behavior.

4.1 System, case and the systems

The case and the two systems used in this experiment are described in detail elsewhere (Kersten et al. 2012; Kersten, Pontrandolfo et al. 2012). Here we provide a brief overview of both. The case involves signing a contract between a producer of perishable goods (the buyer) and several logistics service providers for transporting goods from a single depot to multiple customers. The contract should be awarded only to a single provider, i.e. the services cannot be split between several transportation companies. The minimum quantity of goods to be transported is a fixed part of the contract. Additionally, there are three attributes to negotiated, including 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, i.e. fifteen per attribute, which resulted in the total of 3375 possible agreements.

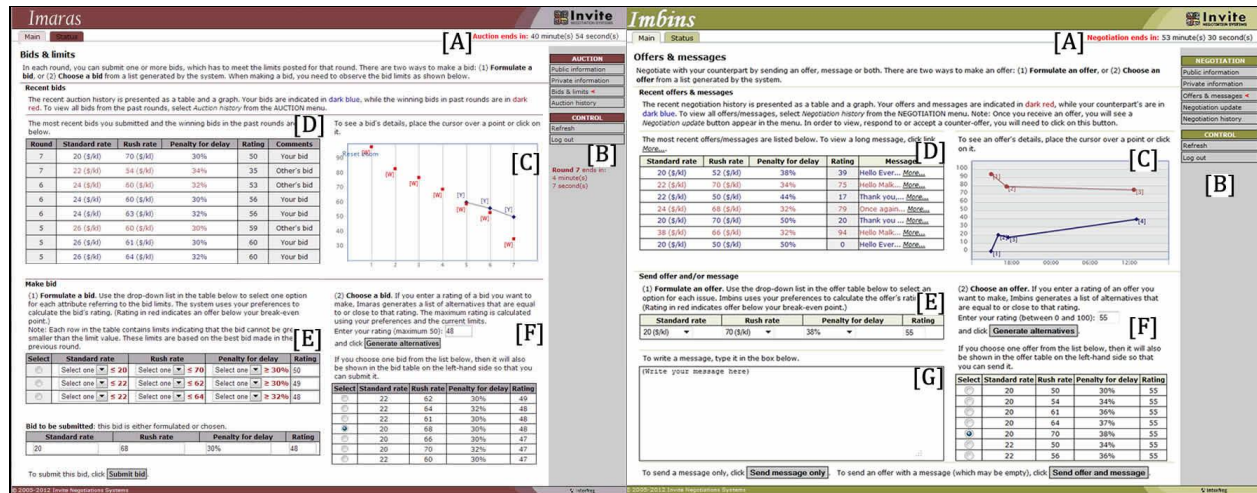
Up to six providers can participate in the auction or negotiation.

The system relies on a single criterion used to compare candidate alternatives and offers; this can be utility, production, cost and profit functions. The selected function, which may be different for different users, is private throughout the process (e.g., utility function is based on private preference and tradeoff schemas).

The case also specifies the reservation levels for the sellers, i.e. the levels below which their companies would incur losses. Thus, the sellers should be careful not to cross these levels. The buyer utility schema is used by the buyer in the negotiations to assess the attractiveness of an offer, or by auction mechanism to generate the next admissible set of bids.

The systems used in the experiments were: (1) Imaras (InterNeg multi attribute reverse auction system) to conduct auctions; and (2) Imbins (InterNeg multi-bilateral negotiation system). Both systems were implemented using the Invite e-negotiation system platform (Strecker et al. 2006).

The systems' interfaces are very similar so that the impact of the IT artifact on the process is minimized. These are feature-rich systems reminiscent of situations one can encounter in real-life. The systems, together with a realistic scenario provide a business-like context. We briefly describe both systems from the user perspective. The two screens, the most important for users, are shown in Figure 3. These screens are described in more detail in (Kersten, Pontrandolfo et al. 2012); here we highlight their main components.



a. Multi-attribute auction system (Imaras)

b. Multi-bilateral negotiation system (Imbins)

Figure 3. Two interfaces for offer construction, submission, and assessment

The bidding screen of Imaras is shown in Figure 3a. In this screen the user can see her bids as well as the winning bids; she can also construct and submit bids here. The Imbins offer screen is shown in Figure 3b. In each screen we can distinguish several components.

The clock [A] shows the time from the beginning of the auction (negotiation) and the time left to the deadline. For auctions the number of each round and time left to the end of the round are also given. The systems' navigation bars are located on the right-hand side [B] where links to active pages are listed.

Component [C] on both screens is the graph showing offers in the user's rating. Component [D] contains the list of the most recent offers. In auctions these are winning offers (in red) and offers made by the user (in blue). In negotiations the list contains offers made by the user (in red) and by the buyer (in blue). The complete list of own and winning bids and offers requires that the users open other pages using links located in [B].

Bids and offers are constructed and submitted using components [E] and [F]. In auctions component [E] contains drop-down lists from which the user may select attribute values; the number of rows containing these lists corresponds to the number of acceptable sets (three sets of limits are shown in Figure 3a). In each row limits for each attribute are also listed (in red) and the user cannot select attribute value greater than the assigned limit.

In negotiation, component [E] contains a single row of drop-down lists from which the user may select attribute values. The two systems have an identical component [F], which is used to generate bids (offers) based on the utility value. The user enters utility value that she would like to obtain and seven alternatives are generated which yield this or a similar value.

In negotiations there is an additional component [G] which is used to write a message; a message may accompany an offer or it can be sent on its own.

Demonstration videos of Imbins (different for buyers and sellers) and Imaras (for sellers) are available online².

4.2 Experiment settings and procedure

The experiment was conducted in a Canadian university in two labs simultaneously. In total, there were 182 sellers and 23 buyers. Participants' demographic information is given in Table 2.

² The videos are available on the systems' home pages. For Imbins it is at: <http://invite.concordia.ca/imbins> and for Imaras: <http://invite.concordia.ca/imaras>.

Table 2. Participants' demographics and other information

	Auctions	Negotiations
No. of students - sellers	109	73
No. of students - buyers	--	23
<i>Demographics (%)</i>		
Age group		
25 and less	90	89
26-30	6	8
31 and more	4	3
Gender (female)	51	48
English skill (good or excellent)	71	82
Experience (No)		
- With system	84	82
- With task	87	81
<i>Expectations</i>		
Task difficulty (scale 1-7)	3.6	3.8
Aspiration level rating	61.8	58.9
Reservation level rating	29.5	29.8

Sellers in negotiations and bidders in auctions were junior undergraduate business students; most of them were 25 years old and younger. The female/male ratio was close to 1 and most participants had good-to-excellent language skills. Most sellers did not have experience with the system and the case.

The experiment was part of the coursework worth 5% of the total grade. The students worked in labs and could not communicate with each other.

Buyers were senior undergraduate business students in distributed locations (e.g., in the library or at home). Their participation was a part of a B2B assignment in an elective course "E-business models". If needed, the experimenters communicated with the buyers via phone and chat. Senior undergraduate students were selected as buyers, because their role was more complicated; they needed to communicate with several sellers. Buyers were given training that required viewing a 25 min. demo of the negotiation system, following which they had to pass an online test.

About a week before the experiment, every seller was given public information of the case together with explanation of the overall process. At that time the sellers were also shown a 20 min. demo of the system (auction or negotiation), which was followed by a short test. In the lab they were given instructions, read private information about the case and did a test about the case. After passing the test they had to fill-in the pre-activity questionnaire followed by 110 minutes of the negotiation or auction activity. In the questionnaire sellers were asked about their expectations (Table 2). The mean expected task difficulty for the prospective negotiators and bidders was, respectively, 3.8 and 3.6 (on the 1-7 scale). The sellers were also asked about their aspiration and reservation levels. The replies were similar for both activities.

The auction process consisted of rounds each lasting five minutes or less. Every seller could submit one offer per round. If all bidders submitted their offers before the round deadline, then this round closes and a new opened. Sellers were shown the winning offer in the new round and they had to submit an offer that was better for the buyer than the winning offer. The limits (see Figure 3a, component [E]) assured that the sellers obeyed this rule.

There were no rounds in the negotiation; both sellers and buyers could exchange offers and messages when they wanted to do so.

4.3 General results

There were 28 auction and 26 negotiation instances; every instance was expected to have either three or five sellers. One auction was considered an outlier and was thus removed from the dataset;

it had two sellers who moved through 38 rounds while no other auction had longer than 17 rounds (average number of rounds was 7.4). The remaining 27 auctions were analyzed.

In every analyzed instance there were between two and five sellers. There were several reasons for the varying number of sellers in the instances. The experiment plan called for only 3- and 5-seller instances. There were five no-shows which forced us to set three two-seller instances and four four-seller instances. There were also two instances in which only one seller submitted offers. In one instance sellers did not make any concession. These instances were excluded from further analysis; the remaining 23 negotiations were analyzed.

Because of the unequal number of sellers per instance we needed to determine if the number and composition of buyers in an instance affected the process and its outcomes. A significant portion of the resulting measures (i.e., process and outcome variables) were not normally distributed, therefore in the first step we conducted Kolmogorov-Smirnov non-parametric test. We tested every pair of groups of instances, each having the equal number of sellers. And we did these tests for all groups, e.g., 2-seller group vs. 3 seller group, and 2-seller group vs. 4 seller group. All but one test results showed no significant difference in the distribution of the process and outcome variables. For the variable "seller rating of the last offer" the distribution was significantly different when three sellers were compared with four and five sellers. Shapiro-Wilk test for normality showed that, this variable in each of these samples was normally distributed ($p = 0.193$). Therefore, we used t-test, which demonstrated that there was no significant difference in the average buyer's rating of the last seller's offer for those two samples ($p = 0.126$). Therefore we analyzed all negotiation instances as one sample and all auction instances as the other.

Descriptive statistics of both auctions and negotiations are given in Table 3. By design every auction concluded with a winner. Furthermore, an agreement was reached in every negotiation.

Table 3. Descriptive statistics

	Auctions	Negotiations
No. of instances	27	23
% of agreements	100	100
Avg. no. of offers	5.6*	3.1
- Submitted by winners	7.4*	3.1
Avg. no. of messages w/o offers	--	0.6
- Submitted by winners	--	0.5
No. (%) of offers made with messages	--	2.2 (76)
No. (%) of offers made without messages	--	0.9 (24)
Offers made by buyers	--	4.7
- No. (%) of offers made with messages	--	3.4 (73)
- No. (%) of offers made without messages	--	1.3 (27)
Avg. seller's profit	-7.4*	23.4
Avg. buyer's profit	75.7*	47.1
No. (%) of Pareto-optimal agreements	20 (74)	1 (4)
No. (%) of non Pareto-optimal agreements	7 (26)	22 (87)
No. (%) of dominating alternatives	118 (4)	143 (4)

Significance compared to negotiations: * $p \leq 0.01$.

Table 3 shows that sellers in the negotiations made significantly ($p < 0.001$) fewer offers (3.1) than those in the auctions (5.6). This difference is even higher if only winners are considered: one can see that the winners worked harder in the auctions than other bidders (7.4 vs. 5.6 bids on average). However, in the negotiations there was no difference between winners and non-winners in terms of the number of offers submitted (3.1 vs. 3.1).

Arguably, making offers in a negotiation is more difficult because of the counterpart's expectation that an offer is accompanied by a reasoned message. Indeed, 76% of offers made by the

sellers were accompanied by messages. In negotiations buyers also made offers; a buyer made 4.7 offers on average and 73% of them were accompanied by messages. Note that the number of buyers' messages does not imply that every seller received them. Buyers could broadcast an offer to all sellers or address it to only one seller or they could send an offer to any combination of sellers.

Sellers' profit in auctions (-7.4) was significantly ($p < 0.001$) lower than in negotiations (23.4). Buyers' profit in auctions (75.7) was significantly ($p < 0.001$) higher than in negotiations (47.1). In total, 52% of agreements in auctions and 13 % of agreements in negotiations were Pareto-optimal. This large difference indicates that most of the negotiators "left value on the table". The non Pareto-optimal agreements were similar in both auctions and negotiations in the sense that they were similarly far from the efficient frontier; on average 6% of alternatives dominated the agreements in auctions, while for negotiations this number was 7%.

4.3 Theoretical and actual winners

The sellers' objective is to obtain a contract that maximizes their revenue function. Each function is piecewise-linear and it is different for every seller in a given instance.

Sellers have different breakeven points. This difference results in different theoretical chances to win. Table 4 shows the breakeven points for each role and the corresponding ratings for other roles. There could be several alternatives that correspond to a seller's breakeven point, which is why in the table the maximum rating for every seller's breakeven point is shown. The highest buyer's rating (92) corresponds to Cres's, Nart's and Rito's breakeven points. That makes them theoretical winners. Once a theoretical winner submitted an offer at the level of her breakeven point, the remaining two roles (Peeka and Swes) could not submit a better offer for a buyer that would not cause loss for them.

Table 4. Breakeven points and corresponding best ratings for other roles

Breakeven points (b.p.)	Seller				
	Cres	Nart	Peeka	Rito	Swes
- for Cres	25	64	45	53	35
- for Nart	25	10	22	24	15
- for Peeka	33	30	15	32	20
- for Rito	55	35	62	22	47
- for Swes	41	55	42	51	23
Buyer's rating of the best offer at sellers b.p.	92	92	90	92	83
Buyer's rating of the worst offer at sellers b.p.	47	80	75	44	62

Table 5 shows the distribution of actual winners by roles. Sellers who were theoretical winners won 74% and 65% of the auctions and the negotiations respectively. Correspondingly, sellers who were not theoretical winners won more often in negotiations (35%) than in auctions (26%).

Table 5. Distribution of winners in experiment.

	Auctions	Negotiations
<i>Cres</i> (%)	5 (19)	9 (39)
<i>Nart</i> (%)	12 (44)	5 (22)
<i>Peeka</i> (%)	2 (7)	8 (35)
<i>Rito</i> (%)	3 (11)	1 (0)
<i>Swes</i> (%)	5 (19)	0 (0)
All winning sellers	27 (100)	23 (100)
Theoretical winners (%)	20 (74)	15 (65)

Not theoretical winners (%)	7 (26)	8 (35)
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The likely reasons for a sizable portion of non-theoretical winners who won are different for each mechanism. Table 3 demonstrates that in the auctions the winning produced a loss of -7.4 on average. This means that for many bidders winning was more important than avoiding losses; in such a situation the breakeven ceases to be a limitation. In the negotiations, on the other hand, the average profit was 23.4, which implies that many winners did not need to reach their breakeven value before the buyer accepted their offer. Alternatively, the buyer could make an offer which was above this value and the seller could accept it.

There is a difference between the theoretical winners' breakeven value, which contributed to Nart winning more auctions than anyone else. Nart's breakeven value is 10 and it is lower than other sellers'. Although at Nart's breakeven value other sellers could find alternatives, which yielded higher value than their breakeven point, this was difficult as there were only a few such alternatives. Alternatively, the Imaras protocol made these alternatives inaccessible because they were removed during the sequence of the winning offers.

5. Concessions in auctions and negotiations

In Section 3 we introduced different types of concessions. In this section we use the experimental data to verify if these types can be identified in auctions and negotiations.

5.1 Subjective and objective concession values

In Section 3.3 we distinguished between subjective and objective concessions. They differ in the reference value; in subjective concessions the value is the most recent offer of the concession-maker, while in objective (market) concessions the reference value is the most recent best offer. In Table 6 we show subjective and in Table 7—objective concessions.

Table 6. Subjective concessions in auctions and negotiations

Average subjective concession	Auctions	Negotiations
<i>Seller's rating</i>		
Sellers' concession	60.4*	23.1
Concession per offer	12.1^	9.1
Winners' concession	70.1*	21.3
Concession per winner's offer	11.0	8.0
<i>Buyer's rating</i>		
Sellers' concession	62.8*	25.8
Concession per offer	12.6	10.2
Winners' concession	70.6*	27.3
Concession per winner's offer	11.0	10.2

Significance compared to negotiations: * $p \leq 0.01$; ^ $p \leq 0.05$.

Total subjective concession in the sellers' rating was significantly higher ($p < 0.01$) in the auctions than in the negotiations (60.4 vs. 23.1). Using the average number of offers given in Table 3 we calculated the average concession per offer. Table 6 shows that the average bidders' concession (in sellers' rating) per offer was 12.1 while for the negotiators it was 9.1. This difference is significant ($p = 0.025$).

The total subjective concession made by winners was significantly higher ($p < 0.01$) in the auctions than in the negotiations (70.1 vs. 21.3). There was no significant difference for winners' concession per offer made in the auctions vs. the negotiations either in sellers' ratings ($p = 0.22$) or buyers' rating ($p = 0.75$). The significant difference in the total concession value (Table 6) is almost exclusively due to the larger number of offers made by winners in auctions than in the negotiations.

In Table 6 we show subjective concessions in the buyers' rating. The sellers' average concession was significantly higher ($p < 0.001$) in the auctions than in the negotiations (62.8 vs. 25.9). The average concession in the buyer's ratings was not significantly different. Because the sellers made significantly more offers in the auctions than in the negotiations (see Table 3) the difference in the total concession was significant but it was not significant in the average concession. Average winners' concession in buyer's rating was also significantly ($p < 0.001$) lower in the negotiations than in the auctions (27.3 vs. 70.6).

We proposed to distinguish between subjective and objective concessions; the latter are shown in Table 7. As expected, the objective concessions are much lower than the subjective ones because in the former we use the best offer on the table and in the latter we use the seller's previous offer.

Table 7. Objective concessions in auctions and negotiations

Average objective concession	Auctions	Negotiations
<i>Seller's rating</i>		
Sellers' concession	7.9*	-12.1
Concession per offer	6.6*	-11.3
Winners' concession	8.1	4.8
Concession per winner's offer	6.5	3.9
<i>Buyer's rating</i>		
Sellers' concession	24.5*	-26.5
Concession per offer	4.9*	-9.4
Winners' concession	28.0^	14.6
Concession per winner's offer	6.0	5.2

Significance compared to negotiations: * $p \leq 0.01$; ^ $p \leq 0.05$.

Average sellers' concessions in sellers' rating in negotiations were significantly lower ($p < 0.001$) than in auctions (-12.1 vs. 7.9). The same concession in the buyers rating was also significantly ($p < 0.001$) lower in negotiations than in auctions (-26.5 vs. 24.5). Average winners' concession in sellers' rating in negotiations (4.8) did not significantly differ from the one made in auctions (8.1) ($p = 0.268$). Average winners' concession in buyers' rating in negotiations was significantly ($p = 0.013$) lower than in auctions (14.6 vs. 28.0). From the comparison of Tables 6 and 7 we see that the average objective concessions made by the sellers and the winners are smaller than their subjective equivalents if they are measured in the sellers' rating and they are much larger when measured in the buyers' rating.

The difference between the average concession per offer is significant (6.6 vs. -11.3; $p < 0.01$). However, while in the auctions the average concession is positive; in the negotiations it is negative. This means that sellers in the negotiations made offers that, on average, were worse than the best offer the buyer had on the table. The fact that the buyers' profit was significantly lower in the negotiations than in the auctions (see Table 3), may be important for the way multi-bilateral negotiations are set up. Buyers should consider increasing the transparency of the negotiation protocol; providing sellers with information about the best offer may help them to increase profits. When sellers see the best offer they are not likely to submit a clearly worse offer.

Average objective concessions per winner's offer are smaller than the subjective ones but they are also positive; otherwise winning offers would be worse than the best offer on the table.

5.2 Categorization of subjective and objective concessions

In Section 3.3 (Table 1) we proposed nine types of concessions. The results of the experiments, which are given in Table 8 show that there were three types of concessions in the auctions and nine types in the negotiations. Our experiment settings (Section 4.2) required that in auctions sellers submit offers that were better than the winning offer in the previous round and that they submit only one offer per round. Therefore, they had to make concessions, which were positive for the buyers. In theory, they could make a “null for the buyer” concession; however, our auction protocol requires that the offer made in the new round is marginally better than the previous round winning offer.

Table 8. Types of subjective concessions

Concession-maker: seller (seller's profit)	Concession-taker: buyer (buyer's profit)		
	Positive (win)	Null	Negative (lose)
<i>Auctions (total: 493 concessions)</i>			
Positive (lose) (%)	430 (87)	n/a	n/a
Null (%)	20 (4)	n/a	n/a
Negative (win) (%)	43 (9)	n/a	n/a
<i>Negotiations (total: 152 concessions)</i>			
Positive (lose) (%)	125 (82)	1 (1)	8 (5)
Null (%)	2 (1)	0 (0)	2 (1)
Negative (win) (%)	3 (2)	0 (0)	11 (7)

Most concessions were positive-positive (i.e. lose-win). The results show that in the auctions, 4% of concessions were null-positive and 9% were negative-positive (i.e., win-win). This also means that in the 13% offers the bidders did not need to lower their ratings. This relatively large percent is remarkable because it shows that users of such a competitive mechanism are able to seek joint improvements, and in many cases, were successful.

The negotiations produce a significantly different picture; there are very few win-win concessions (2%) and more lose-lose (5%) and win-lose (7%) ones. While these are not large percentages the comparison of win-win concessions in the auctions and in the negotiations suggests that the former mechanism supports cooperative behavior to a greater extent than the latter. While this is not a right conclusion because the two sides cannot cooperate in auctions, the implication is that it is difficult for the sellers to obtain information, which they could use to make win-win concessions. There may be two reasons here: (1) sellers in the auctions but not in the negotiations are given winning offers, they are able to use these offers to make advantageous concessions; and (2) information which the buyers give is detrimental; the sellers who use it are less likely to make win-win concessions. In effect, the higher percentage of win-win concession may be one reason for the higher percentage of Pareto-optimal agreements in auctions than in negotiations (see Table 3).

Next, we determined the types of objectives concessions; they are given in Table 9. Note that the number of concessions differs from the one given in Table 8 because an objective concession may be calculated even for the first offer, as long as someone made an earlier offer, while a subjective concession requires that the same seller makes two offers.

Table 9. Types of objective concessions

Concession-maker: seller (seller's profit)	Concession-taker: buyer (buyer's profit)		
	Positive (win)	Null	Negative (lose)
<i>Auctions (total: 503 concessions)</i>			
Positive (lose) (%)	489 (79)	n/a	n/a
Null (%)	106 (21)	n/a	n/a
Negative (win) (%)	0 (0)	n/a	n/a
<i>Negotiations (total: 201 concessions)</i>			
Positive (%)	57 (28)	1 (1)	15 (8)
Null (%)	3 (2)	2 (1)	3 (2)
Negative (win) (%)	12 (6)	2 (1)	106 (53)

The distribution of the objective concession types is quite different from the subjective types. In the auctions and negotiations alike the percent of positive-positive (lose-win) concessions is much smaller for the objective than for the subjective concessions. Lose-win concessions were made in 79% of cases as compared with 87% (Table 8). The remaining 21% of concessions were null-positive, which means that a seller made an offer that was better for a buyer and it had the same worth for this seller.

It is the drop from 82% to 28% (respectively Tables 8 and 9) of these concessions that is remarkable. Similarly, is the increase of negative-negative (win-lose) concessions from 7% to 52% (respectively Tables 8 and 9). They both show how difficult it was for the sellers to make offers that would be better for the buyer than the best offer the buyer already obtained. This corresponds to the differences discussed in Section 5.1 and it demonstrates the effort that sellers make to no avail. On the more positive side, the percentage of the win-win concessions increased from 2% to 6% for the subjective and objective concessions respectively.

5.3 Subjective concession categorization revisited

In our experiment the bidders could make only one offer per round. Therefore, as it is shown in Tables 8 and 9, they could only make concessions that were positive for the buyers. Making one concession per round is reasonable when the rounds are very short so that bidders need not wait for a long time for the next round. In addition to the auctions in labs we also conducted online auctions which required much longer rounds because of students' different schedules and obligations. Long rounds, however, caused that some participants forgot, dropped out and became disinterested. In order to address these drawbacks, we revised the auction mechanism and allowed bidders to make multiple offers in a single round.

Every offer made had to follow the auction rule and be better for the buyer than the winning offer from the previous round. However, within each round offers could be better or worse. For example, given that the winning offer yielded 48 for the buyer, the seller submitted an offer which would yield 52 in the next round. Then, if the seller submits an offer yielding 50 for the buyer, she makes a negative concession. As we can see, the mechanism revision made bidding somewhat similar to negotiating: the limitation imposed on the number of offers was removed and all nine types of concessions were made possible.

We conducted another experiment in the spring of 2012 with a revised auction mechanism in which bidders could make several offers in every round. This experiment was conducted online rather than in the lab, therefore rounds had to be long enough for bidders to be able to submit offers. In order to give the bidders the ability to control their moves through the rounds (i.e., they

did not have to wait until a round ends), a round ended two hours after the second bidder submitted an offer. In this experiment there were 55 auction instances.

Table 10 shows the types of subjective concessions made by bidders in the spring of 2012 online experiment. The change in the auction mechanism allowed the bidders to make concessions of every type.

Table 10. Types of subjective concessions in 2012 experiment

Concession-maker: seller (seller's profit)	Concession-taker: buyer (buyer's profit)		
	Positive (win)	Null	Negative (lose)
<i>Total: 1,454 concessions</i>			
Positive (lose) (%)	1042 (72)	38 (3)	42 (3)
Null	55 (4)	9 (1)	15 (1)
Negative (win) (%)	99 (7)	20 (1)	134 (9)

When we compare the concessions made in online auction with the revised mechanism (Table 10) with those made in the lab experiment (Table 8), we see that in addition to the concession types the percent of the positive-positive concessions is also different, that is, 72% in online vs. 87% in the lab. This difference is significant ($\chi^2(1, N = 1947) = 48.307, p < 0.01$). The obvious reason for this difference is the distribution of concessions among all nine rather than three types. Note, however, that the bidders' concessions, which for the buyer were null and negative, could be only the second, third, etc. in any given round. That is the null and negative (for buyers) concessions were made only after a positive concession was made in this round.

In the online experiment null-positive and negative-positive concessions, meaning that the offer was better for a buyer and not worse for a seller, were observed in 11%, which was not significantly different from the first experiment (13%) ($\chi^2(1, N = 1947) = 1.779, p = 0.182$). Concessions that allowed a bidder to improve an offer for himself without making it worse for a buyer were observed in 8%. These concessions in the first experiment were allowed only if an offer was better for a buyer; they were observed in 9% of cases.

The distribution of concession types in online auctions (Table 10) may be seen as somewhat similar to the distribution in lab negotiations (Table 8), e.g., in both cases, the highest no. of concessions is lose-win is followed by an order of difference win-lose. This similarity does not mean that the concessions have a similar role; in the auctions they serve the sellers to learn about the buyers' preferences while in the negotiations they were mostly due to the effect of ignoring these preferences.

6. Discussion

The importance of concession-making in both auctions and negotiations is unquestionable. The major contribution of this paper is the development of the model for categorizing concession types that could be applied to both negotiations and auctions involving multiple issues/attributes. The model incorporates two distinct classifications of concessions. The experiments showed that all nine categories and the two types are employed in reverse auctions and multi-bilateral negotiations. The model can be used as a tool by researchers in the field who are interested in the study of concession-making in a wide range of exchange mechanisms.

The distinction between subjective and objective concessions is another theoretical contribution. Subjective concessions are well-known in negotiation literature. In bilateral negotiations there is no other category; negotiation studies that focus on such processes deal with such concessions by default. If, however, we consider multi-lateral and multi-bilateral negotiations then we may have a different dual perspective. In addition to comparing two consecutive offers

made by the same negotiator, we may also compare an offer made by one negotiator with the best offer that had been made earlier. These two categories of concessions are different and, as we showed experimentally, their values differ significantly.

Objective concessions are typical for auctions in which subjective concessions may be relevant for the individual who makes them but not for the market. The auction rule is that either one makes an objective concession or drops out. These concessions can be observed in multi-lateral and –bilateral negotiations when concession-makers do not know the offers that are on the table. Had they known the offers already made (and had they known that others knew it), they would not have made a worse offer.

The analysis of objective concessions in multi-bilateral negotiations results in a very different understanding of the process than when an analysis of subjective concessions. Our experiments show that the process is very inefficient and unfocused: most of the sellers' offers (i.e., 63%) could not be accepted by the buyers who were already offered better conditions. This result suggests that the typical multi-bilateral negotiations in which the one-negotiator side does not reveal offers, which she has already received, can be significantly improved. Giving information to the other side represented by multiple negotiators should make the process more efficient and the results better for the single negotiator. We plan to compare experimentally these two types of negotiations.

Another major contribution of the paper is in providing a descriptive analysis of the differences between auctions and negotiations using the proposed model. 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 higher level of restrictiveness of the auction mechanism, which imposes more constraints on the permissible bids, thus limiting 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 our results, one may conclude that buyers should refrain from negotiations in procurement because in auctions 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 determined a priori. For one or both of these reasons reverse auctions as well as multi-bilateral negotiations have been used in procurement (Kraljic 1983; Handfield and Straight 2003). Future studies should include experiments in which both buyers and sellers are able to revise the set of attributes and feasible alternatives.

Multi-bilateral negotiation in which the best offer on the table is revealed is closer to auctions than the negotiation studied in this paper. This convergence of mechanisms can be observed from both directions; buyer-determined auctions are similar to negotiations in that the choice of the winner is not a mechanism but the buyer (Engelbrecht-Wiggans, Haruvy et al. 2007). One can also envisage an auction in which the buyer and the sellers exchange information during the bidding process. It is possible to maintain the level of transparency of the mechanism making both offers and messages available to all bidders. The main difference between such auctions and multi-bilateral negotiation would be in the organization of the process (rounds vs. no-rounds). It could be interesting to compare such mechanisms and study their potential contributions to the efficacy of procurement.

Kersten et al. (2012) reported that the difference between average concessions made by sellers when comparing competitive vs. cooperative buyers was not significant and that win-win

offers were observed more often in auctions than in negotiations. Here we can add that win-lose and other categories of bids occur in auctions, if the protocol allows it.

Another significant contribution of this work is providing guidance for the designers of auction and negotiation mechanisms, as well as their hybrid forms and the systems in which they are implemented. The work has shown that auctions tend to induce concession-making behaviors that are more likely to lead to Pareto-efficient agreements. On the other hand, negotiations foster exploration of possibilities and a true joint search by active participants. This exploration/exploitation dimension can be traversed by regulating the level of mechanism/system restrictiveness. The designers, thus, could use restrictiveness as a key means of adapting to the contextual requirements. The work is also useful for the designers of auction and negotiation software agents. Effective analysis of concession-making and search for possible concessions leading to Pareto-optimal agreements is one of the main task that designers of the negotiation software agents need to undertake (e.g., Faratin et al. 2002; Endriss 2006; Baarslag et al. 2011). Concession typology presented here provides a basis for the design of methods for comprehensive concession assessment and agent concession-making decisions.

References

- Adomavicius, G., A. Gupta and P. Sanyal (2012). "Effect of Information Feedback on the Outcomes and Dynamics of Multisourcing Multiattribute Procurement Auctions." Journal of Management Information Systems **28**(4): 199-230.
- Anonymous (1957). "Boulware Bows Out." Time Magazine.
- Avery, C. (1998). "Strategic Jump Bidding in English Auctions." Review of Economic Studies **65**(2): 185-210.
- Baarslag, T., K. Hindriks and C. Jonker (2011). Towards a quantitative concession-based classification method of negotiation strategies. Agents in Principle, Agents in Practice. D. Kinny, J. Yung-jen, G. Governatori and A. K. Ghose. New York, Springer: 143-158.
- Bapna, R., P. Goes, A. Gupta, et al. (2004). "User heterogeneity and its impact on electronic auction market design: An empirical exploration." Mis Quarterly **28**(1): 21-43.
- Bateman, T. S. (1980). "Contingent Concession Strategies in Dyadic Bargaining." Organizational Behavior and Human Performance **26**(2): 212-221.
- Bazerman, M. H. and M. A. Neale (1992). Negotiating Rationally. New York, The Free Press.
- Beil, D. R. and L. M. Wein (2003). "An Inverse-optimization-based Auction Mechanism to Support a Multiattribute RFQ Process." Management Science **49**(11): 1529-1545.
- Bichler, M. (2000). "An Experimental Analysis of Multi-attribute Auctions." Decision Support Systems **29**(3): 249-268.
- Bichler, M. and J. Kalagnanam (2005). "Configurable Offers and Winner Determination in Multi-attribute Auctions." European Journal of Operational Research **160**(2): 380-394.
- Branco, F. (1997). "The Design of Multidimensional Auctions." The RAND Journal of Economics **28**(1): 63-81.
- Bulow, J. and P. Klemperer (1996). "Auctions versus Negotiations." American Economic Review **86**(1): 80-194.
- Bulow, J. and P. Klemperer (2009). "Why Do Sellers (usually) Prefer Auctions?" The American Economic Review **99**(4): 1544-1575.
- Burmeister, B., T. Ihde, T. Kittsteiner, et al. (2002). A Practical Approach to Multi-attribute Auctions. 13th Workshop on Database and Expert Systems Applications (DEXA), IEEE.
- Che, Y. K. (1993). "Design Competition through Multidimensional Auctions." The RAND Journal of Economics **24**(4): 668-680.
- Cialdini, R. B., J. E. Vincent, S. K. Lewis, et al. (1975). "Reciprocal Concessions Procedure for Inducing Compliance: The Door-in-the-face Technique." Journal of Personality and Social Psychology **31**(2): 206-215.
- Easley, R. F. and R. Tenorio (2004). "Jump Bidding Strategies in Internet Auctions." Management Science **50**(10): 1407-1419.
- Elmaghraby, W. (2007). "Auctions within E-Sourcing Events." Production and Operations Management **16**(4): 409-422.

- Endriss, U. (2006). Monotonic Concession Protocols for Multilateral Negotiation, ACM.
- Engelbrecht-Wiggans, R., E. Haruvy and E. Katok (2007). "A Comparison of Buyer-determined and Price-based Multi-attribute Mechanisms." Marketing Science **26**(5): 629-641.
- Esser, J. and S. Komorita (1975). "Reciprocity and Concession Making in Bargaining." Journal of Personality and Social Psychology **31**(5): 864-872.
- Faratin, P., C. Sierra and N. R. Jennings (2002). "Using Similarity Criteria to Make Issue Trade-offs in Automated Negotiations." Artificial Intelligence **142**(2): 205-237.
- Ferrin, B. G. and R. E. Plank (2002). "Total Cost of Ownership Models: An Exploratory Study." Journal of Supply Chain Management **38**(3): 18-29.
- Fisher, R. and W. Ury (1983). Getting to Yes. Negotiating Agreement Without Giving In. New York, Penguin Books.
- Follett, M. P. (1940). Constructive Conflict. Dynamic Administration: The Collected Papers of Mary Parker Follett, H. C. Metcalf and L. Urwick. New York, Harper: 30-49.
- Foroughi, A. (1998). "Minimizing Negotiation Process Losses with Computerized Negotiation Support." Journal of Applied Business Research **14**(4): 15-26.
- Galinsky, A. D., G. Ku and T. Mussweiler (2009). "To Start Low or To Start High? The Case of Auctions Versus Negotiations." Current Directions in Psychological Science **18**(6): 357-361.
- Gettinger, J., A. Dannenmann, D. Druckman, et al. (2012). Impact of and Interaction between Behavioral and Economic Decision Support in Electronic Negotiations. Decision Support Systems-Collaborative Models and Approaches in Real Environments, J. E. Hernández, P. Zarate, F. Dargam et al. Berlin, Springer: 151-165.
- Handfield, R. B. and S. L. Straight (2003). "What Sourcing Channel is Right for You?" Supply Chain Management Review **7**(4): 63-68.
- Henderson, M., Y. Trope and P. J. Carnevale (2006). "Negotiation From a Near and Distant Time Perspective." Journal of Personality and Social Psychology **91**(4): 712-729.
- Hinton, B. L., W. C. Hamner and M. F. Pohlen (1974). "The influence of reward magnitude, opening bid and concession rate on profit earned in a managerial negotiation game." Behavioral Science **19**(3): 197-203.
- Kamins, M. A., A. Noy, Y. Steinhart, et al. (2011). "The Effect of Social Cues on Sniping Behavior in Internet Auctions: Field Evidence and a Lab Experiment." Journal of Interactive Marketing **25**(4): 241-250.
- Kersten, G. E. (1985). "NEGO - Group Decision Support System." Information and Management **8**(5): 237-246.
- Kersten, G. E. and D. Gimon (2012). Multi-bilateral Negotiations and Multi-attribute Reverse Auctions: An Experimental Study of Concession-making. Federated Conference on Computer Science and Information Systems, Wrocław, ACM.
- Kersten, G. E., D. Gimon and R. Vahidov (2012). Concession Patterns in Multi-issue Negotiations and Reverse Auctions. Proceedings of the International Conference on Electronic Commerce, Singapore, ACM Press.
- Kersten, G. E. and S. Noronha (1999). "Negotiations via the World Wide Web: A Cross-cultural Study of Decision Making." Group Decision and Negotiations **8**: 251-279.
- Kersten, G. E. and S. J. Noronha (1998). "Rational Agents, Contract Curves, and Inefficient Compromises." IEEE Systems, Man, and Cybernetics **28**(3): 326-338.
- Kersten, G. E., P. Pontrandolfo, R. Vahidov, et al. (2012). Negotiation and Auction Mechanisms: Two Systems and Two Experiments E-life: Web-enabled Convergence of Commerce, Work, and Social Life M. J. Shaw, D. Zhang and W. T. Yue. New York, Springer. **108**: 400-412.
- Kersten, G. E., P. Pontrandolfo and S. Wu (2012). A Multiattribute Auction Procedure and Its Implementation. HICSS 45, Hawaii, IEEE.
- Kersten, G. E. and T. Szapiro (1986). "Generalized Approach to Modeling Negotiations." European Journal of Operational Research **26**(1): 142-149.
- Kersten, G. E., S. Wu and T. Szapiro (2010). A Procedure for Multiattribute Reverse Auctions with two Strategic Parameters InterNeg Research Papers. Montreal, Concordia University.
- Kirkegaard, R. (2004). Auctions versus Negotiations Revisited. Working Paper. Aarhus, Department of Economics, University of Aarhus.
- Komorita, S. S. and A. R. Brenner (1968). "Bargaining and Concession Making under Bilateral Monopoly." Journal of Personality and Social Psychology **9**(1): 15.

- Komorita, S. S. and J. K. Esser (1975). "Frequency of Reciprocated Concessions in Bargaining." Journal of Personality and Social Psychology **32**(4): 699-705.
- Korhonen, P., H. Moskowitz, J. Wallenius, et al. (1986). "An Interactive Approach to Multiple Criteria Optimization with Multiple Decision-Makers." Naval Research Logistics Quarterly **33**: 589-602.
- Kraljic, P. (1983). "Purchasing Must Become Supply Management." Harvard Business Review **83**(5): 109-117.
- Kuruzovich, J. (2012). "Time and Online Auctions." Journal of Electronic Commerce Research **13**(1): 23-32.
- Kwon, S. and L. R. Weingart (2004). "Unilateral Concessions from the Other Party: Concession Behavior, Attributions, and Negotiation Judgments." Journal of Applied Psychology **89**(2): 263-278.
- Lax, D. (2010). "When Auctions Met Negotiations." Negotiation Journal **26**(3): 357-366.
- Ma, L., S. Showail, R. Campagna, et al. (2006). Concessions in Negotiations: The Roles of Initial Assessment and Signaling on Outcomes of a Negotiated Agreement, SSRN: 17.
- Milgrom, P. (2000). An Economist's Vision of the B-to-B Marketplace. An Executive White Paper.
- Millet, I., D. H. Parente, J. L. Fizel, et al. (2004). "Metrics for Managing Online Procurement Auctions." Interfaces **34**(3): 171-179.
- Mithas, S. and J. L. Jones (2007). "Do Auction Parameters Affect Buyer Surplus in E-Auctions for Procurement?" Production and Operations Management **16**(4): 455-470.
- Osgood, C. (1962). An Alternative to War or Surrender. Urbana, University of Illinois Press.
- Parkes, D. C. and J. Kalagnanam (2005). "Models for Iterative Multiattribute Procurement Auctions." Management Science **51**(3): 435-451.
- Pinker, E. J., A. Seidmann and Y. Vakrat (2003). "Managing online auctions: Current business and research issues." Management Science **49**(11): 1457-1484.
- Pruitt, D. G. (1981). Negotiation Behavior. New York, Academic Press.
- Pruitt, D. G. (1983). "Strategic Choice in Negotiation." American Behavioral Scientist **27**(2): 167-194.
- Pruitt, D. G. and P. J. Carnevale (1993). Negotiation in Social Conflict. Pacific Grove, Taylor & Francis.
- Raiffa, H. (1982). The Art and Science of Negotiation. Cambridge, MA, Harvard University Press.
- Raiffa, H., J. Richardson and D. Metcalfe (2003). Negotiation Analysis. The Science and Art of Collaborative Decision Making. Cambridge, Harvard University Press.
- Rothkopf, M. H. and R. M. Harstad (1994). "Modeling competitive bidding: A critical essay." Management Science **40**(3): 364-384.
- Sandholm, T. W. (2007). "Expressive Commerce and its Application to Sourcing: How We Conducted \$35 Billion of Generalized Combinatorial Auctions." AI Magazine **28**(3): 45.
- Sandholm, T. W. (2008). Expressiveness in Mechanisms and its Relation to Efficiency: Our Experience from \$40 Billion of Combinatorial Multi-attribute Auctions, and Recent Theory, Computer Science Department.
- Schneider, A. K. (2002). "Shattering Negotiation Myths: Empirical Evidence on the Effectiveness of Negotiation Style." Harvard Negotiation Law Review **7**: 143-403.
- Siegel, S., L. E. Fouraker and D. Ellsberg (1961). "Bargaining and Group Decision Making: Experiments in Bilateral Monopoly." American Economic Review **51**(3): 420-421.
- Spector, B. (2007). Negotiation as Learning: Pedagogy and Theory. Annual Conference of the International Studies Association. Chicago.
- Strecker, S., G. E. Kersten, J. B. Kim, et al. (2006). Electronic Negotiation Systems: The Invite Prototype. Proceedings of the Collaborative Business MKWI'06, Potsdam, Germany, GITO.
- Subramanian, G. (2010). Negotiauctions: New Dealmaking Strategies for a Competitive Marketplace. New York, Norton.
- Tajima, M. and N. M. Fraser (2001). "Logrolling Procedure for Multi-issue Negotiation." Group Decision and Negotiation **10**(3): 217-235.
- Teich, J. E., H. Wallenius, J. Wallenius, et al. (2006). "A Multi-attribute E-auction Mechanism for Procurement: Theoretical Foundations." European Journal of Operational Research **175**(1): 90-100.
- Thiessen, E. M. (2002). "SmartSettle described with the Montreal Taxonomy." Group Decision and Negotiation **2**(12): 165-170.
- Thiessen, E. M., D. P. Loucks and J. R. Stedinger (1998). "Computer-Assisted Negotiations of Water Resources Conflict." Group Decision and Negotiation **7**(2): 109-129.
- Thompson, L. (2005). The Mind and Heart of the Negotiator. Upper Saddle River, NJ, Prentice Hall.
- Thompson, L. and R. Hastie (1990). "Social Perception in Negotiation." Organization Behavior and Human Decision Processes **47**(1): 98-123.

- Thompson, L. and D. Hrebec (1996). "Lose-lose Agreements in Interdependent Decision-Making." Psychological Bulletin **120**(3): 396 - 409.
- Trötschel, R., J. Hüffmeier, D. D. Loschelder, et al. (2011). "Perspective taking as a means to overcome motivational barriers in negotiations: when putting oneself into the opponent's shoes helps to walk toward agreements." Journal of Personality and Social Psychology **101**(4): 771.
- Vetschera, R. and M. Filzmoser (2012). Standardized interpolated path analysis of offer processes in e-negotiations. Proceedings of the 14th Annual International Conference on Electronic Commerce, ACM.
- Weingart, L. R., E. B. Hyder and M. J. Prietula (1996). "Knowledge Matters - the Effect of Tactical Descriptions on Negotiation Behavior and Outcome." Journal of Personality and Social Psychology **70**(6): 1205 - 1217.
- Yuan, Y. (2003). "Online Negotiation in Electronic Commerce." International Journal of Management Theory and Practices **4**(1): 39-48.
- Zartman, W. (1977). "Negotiation as a Joint Decision-Making Process." Journal of Conflict Resolution **21**(4): 619-638.