The art of negotiating: Designing competition through mechanism design theory

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Abstract

Buying organizations increasingly apply mechanism design theory in negotiations to improve purchasing prices. By designing an individual set of mechanisms, purchasers can incentivize suppliers to reveal their reservation prices. Such negotiation designs typically consist of diverse mechanisms, for instance re-quotes, auctions, and exclusive offers. However, current purchasing literature lacks an analysis of negotiation elements and associated incentive systems to provide insights into the development of optimal negotiation designs. Based on action research conducted at an automotive OEM, common negotiation elements are identified, underlying rationales are elaborated upon, and guidance is provided on how to implement these elements in practice.

Keywords: Mechanism design theory, Negotiation, Purchasing

Introduction

Western industries face increased pressure to reduce production prices (Atkin & Rinehart, 2006). In achieving this aim, the purchasing function assumes a special role since on average more than 50% of a company's turnover is directly passed through to its suppliers (Monczka et al., 2016). Previous research has shown that increased competitive intensity is associated with lower purchasing prices (Chen & Zhang, 2011; Scheffler et al., 2016). To spur competition between suppliers, game-theoretic negotiation methods grew in popularity in recent years (Berz, 2014). In particular, buying organizations increasingly apply mechanism design theory in negotiations (Schulze-Horn et al., in press). Mechanism design theory represents the inverse of game theory: the desired outcome of an interaction is analyzed and rules are designed to achieve this outcome (Hehenkamp, 2007). In practice, purchasers can use mechanisms to design negotiations with the aim to incentivize suppliers to reveal their reservation prices (Schulze-Horn et al., in press).

A key difference between mechanism design-based negotiations and traditional face-to-face (F2F) negotiations represents the negotiations design – a specified set of mechanisms or rules individualized for each negotiation (Kaufmann & Carter, 2004; Schulze-Horn et al., in press). Negotiation designs typically consist of diverse mechanisms, for instance re-quotes, procurement auctions, and exclusive offers that incentivize suppliers in a variety of ways to offer price

reductions. However, most organizations do not possess the required expert knowledge to develop these specific negotiation designs (Schulze-Horn et al., in press). Consequently, it can be observed that large organizations with sufficient financial resources rely on highly specialized consulting firms. In contrast, small and medium-sized enterprises might not have the financial background to collaborate with external consultants, somewhat making mechanism design-based negotiations a privilege for large organizations. Also, current purchasing and supply management (PSM) literature lacks a comprehensive analysis of negotiation elements and associated incentive systems to provide insights into how optimal negotiation designs consisting of several interlinked negotiation elements can be developed. The study at hand therefore aims at raising the awareness for this promising negotiation methodology. Accordingly, the central objective of this study is to identify the most common negotiation elements, to elaborate on the underlying rationales, as well as providing some guidance how to implement these elements in practice.

Theoretical background
Mechanism design theory: Game theory in reverse
Mechanism design theory represents a field in game theory that is applied to design economic incentives with the aim to achieve desired outcomes (Wang et al., 2010). Mechanism design theory is often termed reverse game theory (Singh & O'Keefe, 2016). In game theory, strategic interactions are analyzed in which the decisions of one player depend on the decisions of others (Myerson, 1991; Young, 1991). Assuming that the rules for interaction are given, game theory is used to analyze optimal outcomes of interactions and identify decision strategies helping the players to achieve those outcome (Luce & Raiffa, 1989; Lasaulce & Tembine, 2011). In mechanism design theory, the rules of the game are not considered as given (Roth, 2002; Dash et al., 2003). Instead, the optimal outcome of an interaction is taken as starting point to identify mechanisms that incentivize players to act in such a way that a desired outcome is achieved (Hehenkamp, 2007).

Applying mechanism design theory in negotiations
A negotiation is a decision-making process in which the parties involved mutually influence each other through their actions (Young, 1991). As such, negotiations between buyers and suppliers can be regarded as games. Mechanism design theory regards negotiations as non-cooperative games with incomplete information (Narahari et al., 2009). Under these circumstances, traditional bilateral negotiations can be regarded as "incompletely determined games" as the parties do not know each other's bargaining sets and rules of interaction are only loosely defined (Young, 1991, p. 2). Reaching an agreement can be an onerous and lengthy process in such situations (Eichstädt, 2008). Additionally, negotiators are likely to act strategically in order to influence the game outcome to their advantage (Jackson, 2001). In this context, mechanism design theory can help purchasers to develop rules upfront that clearly specify the negotiation procedure. Transparency about these mechanisms and the buyer's commitment that the business will be awarded based on the negotiation results lead to higher perceived competitive pressure among the supplier set (Kaufmann & Carter, 2004). In turn, increased rivalry is assumed to incentivize suppliers to reveal the lowest price point they are willing to accept (Chen & Zhang, 2011; Scheffler et al., 2016).

Mechanisms may take the form of a variety of negotiations elements such as re-quotes, procurement auctions, and exclusive offers. Interlinked with each other, they form a negotiation design (Schulze-Horn et al., in press). Customizing the negotiation design's composition for each negotiating situation helps to achieve best possible results. The selection of mechanisms is based on price dispersion between the suppliers' quotes as well as awarding premises applicable to the specific negotiating situation (Schulze-Horn et al., in press). Price dispersion can be regarded as an indicator of competitive intensity (Scheffler et al., 2016; Vos et al., 2016) while awarding premises represent preconditions for awarding a contract, such as maximum share allocations and single or multiple source requirements.

According to Eichstädt (2008), game-theoretic negotiations can be an alternative to F2F negotiations. However, the actual application of such approaches is still somewhat limited (see e.g. Eichstädt, 2008). Possibly, these results can be ascribed to a lack of practical guidance showing how optimal negotiation designs consisting of several interlinked negotiation elements can be developed. The following section details how this research gap is intended to be filled.

Methodology

Since the research question has an exploratory character, a qualitative research method has been chosen. More precisely, the study at hand adopts an AR approach. This paper adapts the AR research framework of Näslund et al. (2010) which divides the research approach into design, data collection, and data analysis aspects.

Design aspects: The research was carried out in cooperation with a European automotive OEM. The case company has several years of experience in conducting mechanism design-based negotiations. The development of negotiation designs, however, was mostly left to a specialized consulting firm. To extend the application of this negotiation method in the organization, the OEM wished to gain detailed knowledge on how negotiation mechanisms can be purposefully applied to improve purchasing performance. The first author has joined the case company on a full-time basis for over a year and a half and has worked on answering the research question together with process experts from the OEM.

Data collection aspects: Multiple data sources have been triangulated to increase data credibility and reduce the possibility that results have been drawn from incorrect or incomplete data bases (Yin, 2013). The primary data collection methods represent document reviews, participant-observations, and participatory workshops.

Data analysis aspects: The data analysis comprised 20 negotiation designs developed by the consulting firm. Each negotiation design was regarded a single case. First, all cases were analyzed by the researchers during a within-case analysis. A subsequent cross-case analysis helped to discover patterns across the cases (Eisenhardt, 1989). In addition, the AR results were supplemented and extended with insights from previous literature. Interim results were regularly reviewed with the case company, leading to an iterative refinement of the research results.

Results

During the intense cooperation with the OEM under study, five basic negotiation elements have been identified, namely re-quotes, English ticker auctions, Dutch ticker auctions, first-price sealed-bid auctions, and exclusive offers.

Re-quote

Definition: Suppliers are asked to submit new offers within a predetermined timeframe. Offers need to be equal to or lower than previously submitted offers. The results of re-quotes are used as price basis for subsequent negotiation phases, not to make the final awarding decision.

Negotiation environment: Re-quotes can find a widespread application independent of specific negotiation conditions. The OEM under study used this negotiation element in all of the 20 negotiation designs reviewed.

Implementation: The OEM under study applied re-quotes on a one-time basis as well as several times in sequence. If suppliers submit equal offers, a tie-situation arises. A tie can be resolved by asking those suppliers involved to hand in updated offers one more time. Alternatively, the amount of absolute price reductions offered could be compared and the supplier with higher absolute reductions wins the tie. Suppliers could also have been awarded with tie-breaker privileges in previous negotiation phases: in this case, the supplier holding the tie-breaker privilege wins the tie-situation.

Incentives: A primary incentive for offering price reductions during re-quotes was given by the case company through providing suppliers with information feedback concerning their competitive position. These feedbacks mostly took the form of rank and distance information. Distance information was always given in intervals in order to avoid communicating competitors' exact market position. Re-quote results can also build the basis for succeeding negotiation phases, for instance through determining rankings. These rankings can be used to establish qualification hurdles, for instance by specifying that only the best three suppliers qualify for subsequent phases. Moreover, suppliers can be awarded with a variety of privileges, for instance a tie-breaker privilege (i.e. if the supplier is involved in a tie-situation in subsequent negotiation phases, the supplier automatically wins the tie), a wild card privilege (i.e. the supplier is allowed to skip a subsequent negotiation phase), the privilege to receive an exclusive offer from the buying organization, or the privilege of obtaining a contract extension.

English ticker auction

Definition: In the reviewed negotiation designs, the case company always organized procurement auctions as ticker auctions. Also known as Japanese auction, ticker auction refers to an auction form in which the buying organization specifies the quotations steps and the suppliers have to indicate whether they accept or reject the offered quotation step (Berz, 2014). English ticker auctions are characterized by falling quotation steps, implying that prices become cheaper with every step. The supplier who is the last one to accept a quotation step is the auction winner.

Negotiation environment: In line with literature findings, the case company only applies English ticker auctions for making the final awarding decision if there are at least two equally 'strong' suppliers, implying that the price dispersion between the best and second-best supplier is low (Li & Riley, 2007). If there is a single 'strong' supplier in the auction while all other participating suppliers show significant price differences, English auction formats are likely to yield sub-optimal results: the 'weaker' suppliers will drop out at quotation steps that are still above the 'strong' supplier's reservation price (Samuelson, 2001). Consequently, the reservation price of the second-best supplier will determine the auction result.

Implementation: Tie situations can happen in English ticker auctions if at least two suppliers reject an identical quotation step. Tie situations can be resolved with the help of a re-quote: those suppliers involved in the tie submit their final offer which should be below or equal to the rejected quotation step; the supplier offering the lowest price wins the tie-situation. Alternatively, suppliers might have been awarded with tie-breaker privileges in previous negotiation phases. The case company often applied English ticker auctions based on one total turnover price (i.e. one overall price including all requested positions) although not all suppliers had provided quotes for all positions. In such situations, the OEM applied the dummy price concept: suppliers who do not offer certain positions receive a dummy price for the respective positions. The dummy price equals the lowest price offered by a competitor and is updated with a lag of one round.

Incentives: If English ticker auctions are applied in the final negotiation phase, the key incentive to improve purchasing prices is the final awarding of the business. Additionally, the case company applied English ticker auctions in negotiation phases that precede the final awarding phase. For instance, the results of an English ticker auction can be used to establish a ranking which is applied in subsequent phases. The suppliers receive ranks in the order of dropping out. Such a ranking can also be combined with a qualification, for instance the buying organization could specify that only those suppliers on the first three ranks are allowed to take part in subsequent negotiation phases. The auction winner can also be awarded with privileges for succeeding phases.

Dutch ticker auction

Definition: Dutch ticker auctions set off with very low quotation steps which are successively increased. The supplier who is the first one to accept a quotation step is the auction winner. Since the auction ends after the first acceptance of a quotation step, buying organizations have to take into account that this auction format does not reveal the reservation prices of the other suppliers.

Negotiation environment: Dutch ticker auctions allow purchasers to take advantage of suppliers' risk aversion of losing a contract (Maskin & Riley, 1984; Cox et al., 1985). As a consequence, Dutch auctions are preferable over English auctions if there is a single 'strong' supplier in the negotiation (Samuelson, 2001).

Implementation: The case company conducted Dutch ticker auctions either as parallel or as sequential auctions. When executed in parallel, all suppliers are offered an identical quotation step at the same time. In sequential auctions, a quotation step is first offered to the supplier on rank one. Only if this supplier rejects, the identical quotation step is offered to the supplier on rank two, and so on. In the case of parallel Dutch ticker auctions, tie situations arise if an identical quotation step is accepted by at least two suppliers. Tie situations can also be resolved with the help of a re-quote or a tie-breaker privilege.

Incentives: When Dutch ticker auctions were conducted sequentially, they were always applied for the final awarding of the business. The parallel design variant, however, was linked to a variety of incentives. Next to the final awarding, the case company also used the auction's results in negotiation phases preceding the final awarding phase to establish rankings. The auction's result can also serve as qualification hurdles for subsequent phases. The results of Dutch ticker auctions can also be used to award a variety of privileges.

First-price sealed-bid auction
Definition: In first-price sealed-bid auctions, suppliers are asked to submit new offers within a predetermined timeframe. The supplier who offered the lowest price is awarded with the business. Thus, first-price sealed-bid auctions work similar to re-quotes with the key difference that first-price sealed bid-auctions are used to make the final awarding decision.

Negotiation environment: First-price sealed-bid auctions also allow purchasers to take advantage of suppliers' risk aversion (Holt, 1980). Fear of losing the contract induces risk-averse suppliers to submit lower prices – they are willing to give a discount in return for the insurance of winning (Maskin & Riley, 1985). Therefore, the case company also preferred first-price sealed-bid auctions over English auctions if there is a single 'strong' supplier in the negotiation. The OEM under study primarily applied Dutch ticker auctions since suppliers should make well-considered choices when contracts amounting to several million euros are at stake. First-price sealed-bid auctions were only used by the case company to award remaining business that was not awarded during previous auctions or exclusive offers.

Implementation: Next to the parallel auction designs, in which all suppliers are asked simultaneously to submit updated offers, the OEM under study also conducted first-price sealed-bid auctions sequentially. The sequential design builds on a ranking established in previous negotiation phases. Here, the buying organization first approaches the supplier on the worst rank by providing him with competitive information (e.g. current share allocation) and then asking the respective supplier to submit a final quote. Next, the buying organization reaches out to the supplier on the next best rank and repeats the same procedure. The competitive information is now updated based on the new offer submitted by the supplier on the worst rank. The procedure continues until all suppliers handed in their final offers. A tie occurs, if suppliers submit equal offers. In this case, those suppliers involved can be asked to hand in updated offers one more time. Alternatively, the tie situation could also be resolved with the help of a tie-breaker privilege.

Incentives: Suppliers are incentivized to offer lower prices since the winner of the first-price sealed-bid auction gets irrevocably awarded with the respective business.

Exclusive offer
Definition: The buying organization provides one supplier with an exclusive offer for all or part of this supplier's offered positions. Upon acceptance of the exclusive offer, the supplier is awarded with the respective positions.

Negotiation environment: Providing an exclusive offer can be reasonable if the buying organization has a preference for awarding a certain supplier. Likewise, an exclusive offer can be a suitable negotiation element if the competitive intensity between suppliers is low. In this case, cooperative negotiation elements such as an exclusive offer can yield better outcomes for the buying organization than competitive elements, such as auction mechanisms. If not all suppliers provided offers for all positions or if suppliers have different share allowances (i.e. suppliers are not allowed to deliver 100% of the total business), auction mechanisms can be difficult to implement since suppliers' offers are not comparable. In this instance, exclusive offers can be useful as well.

Implementation: The likelihood that a supplier accepts the exclusive offer significantly depends on the offer's price level. If the price reductions demanded are unreasonable compared

to the supplier's previous offers, it can be expected that the exclusive offer will be declined. Buying organizations also have to decide upon the rules for accepting the exclusive offer. For instance, the supplier might only be allowed to accept the exclusive offer as a whole, alternatively the acceptance for individual positions can be permitted as well.

Incentives: The main incentive for suppliers to accept an exclusive offer and thereby to offer price reductions is to be irrevocably awarded with the respective positions. The incentive to accept the offer can be increased by developing subsequent negotiation phases in which the business, if the exclusive offer is declined, will be awarded with the help of competitive negotiation elements, such as auction mechanisms. In this way, the supplier has a greater incentive to accept the exclusive offer because competitors have good chances to secure the business for themselves during the auction.

Discussion and conclusions

In the previous section, the most prominent negotiation elements and their characteristics were presented. However, as the aim of this paper is to raise the awareness and the understanding for mechanism design-based negotiations, the discussion of the results will be enriched by the exemplary presentation of a fictitious negotiation design and its underlying mechanisms.

For our example, we assume that the negotiation comprises two packages: the first package 'Business EU' includes the required volume for a company's plants in Europe; the second package 'Business NAR' concerns the volume for the company's plants in the North American region. Three suppliers participate in the negotiation, all of them provided quotes for both packages. Supplier 2 submitted the most competitive quotes so far. An overview of the competitive situation in provided in Table 1.

Table 1 – Overview competitive situation

	Supplier 1	Supplier 2	Supplier 3
Business EU	€ 50,0 Mio.	€ 43,4 Mio.	€ 48,7 Mio.
Business NAR	€ 14,0 Mio.	€ 12,9 Mio.	€ 15,4 Mio.

The company prefers a dual source strategy, implying that one supplier is awarded with the package 'Business EU' and another supplier with the package 'Business NAR'. However, the company only wants to pursue this strategy if a single source strategy (i.e. one supplier is awarded with both packages) does not yield lower purchasing prices. Therefore, a key aim of the negotiation design is to assess the economic efficiency of the dual source strategy.

For the negotiation design, five phases have been developed (see Table 2**Error! Reference source not found.**).

Phase 1: All suppliers are asked to submit updated offers for both packages. To provide all suppliers with a focus point for subsequent negotiation phases, the ranks for both packages are communicated to the suppliers afterwards. In addition, the supplier who submitted the lowest overall offer for both packages obtains a tie-breaker privilege for Phase 2.

Phase 2: A Dutch ticker auction is conducted for the package 'Business EU'. The auction is conducted in parallel, implying that all suppliers are offered an identical quotation step at the same time. In case of a tie, the supplier holding the tie-breaker privilege wins or (if none of the

suppliers involved hold the privilege) the suppliers are asked to submit updated offers below or equal to the accepted quotation step. The first supplier who accepts a quotation step qualifies for Phase 3 and obtains rank one for Phase 3. The auction continues and the second supplier accepting a quotation step qualifies as well and receives rank two for Phase 3. The remaining supplier does not participate in Phase 3.

Table 2 – Negotiation design

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Negotiation element	Re-quote	Parallel Dutch ticker auction	Sequential Dutch ticker auction	Re-quote	Parallel Dutch ticker auction
Focus	Business EU; Business NAR	Business EU	Business EU	Business NAR	Business NAR
Participants	All suppliers	All suppliers	All suppliers	Winner Business EU	All suppliers except winner Business EU
Incentives	Information feedback (ranks) Tie-breaker privilege for Phase 2	Ranking & qualification for Phase 2	Final awarding	Threshold value for dual source strategy	Final awarding

Phase 3: A Dutch ticker auction is applied for the package 'Business EU'. This time, the auction is conducted sequentially, which means the supplier on rank one will receive the quotation steps first. Only if the supplier on rank one rejects, the quotation steps will be offered to the supplier on rank two. The supplier who is the first one to accept is irrevocably awarded with the 'Business EU'.

Phase 4: The winner of the package 'Business EU' is asked to submit an updated offer for the package 'Business NAR', thereby incorporating potential synergies due to scale effects.

Phase 5: A parallel Dutch ticker auction is conducted for the package 'Business NAR'. Only the two suppliers who did not win the package 'Business EU' will participate. The re-quote from Phase 4 is taken as hidden threshold value in Phase 5: if one supplier accepts a quotation step before the threshold value is reached, this supplier is awarded with the 'Business NAR'. In case of a tie, the suppliers are asked to hand in updated offers. If the threshold value is reached before a supplier accepts, the winner of the 'Business EU' is also awarded with the 'Business NAR'.

The previous example demonstrates how buying organizations aim at increasing their negotiation power vis-à-vis suppliers with the application of mechanism design theory. As in the case of the buying organization under study, deliberate combinations of negotiation elements are developed to increase the perceived competitive pressure among the supplier set. In line with previous research findings, increased rivalry can incentivize suppliers to offer lower purchasing prices (Chen & Zhang, 2011; Vos et al., 2016).

Implications for theory & practice
Starting with the implications for theory, to the best of the authors' knowledge, this research is the first one to provide a thorough analysis of game-theoretic negotiation designs. With these insights, the study at hand responds to researchers' calls to explore which negotiation elements

in which form of design are most suitable to a specific negotiating situation with the aim of minimizing purchasing prices (see e.g. Kaufmann & Carter, 2004).

From a managerial perspective, this research provides hands-on guidance on how to develop game-theoretic negotiation designs. The article's findings are especially addressed to purchasing managers of small and medium-sized enterprises who did not implement mechanism design-based negotiations so far. Some implications also result for the handling of suppliers in mechanism design-based negotiations. If buying organizations do not abide by the defined negotiation rules, they can lose their integrity towards suppliers and the method loses its effectiveness in the long-term.

Limitations & future research

Some limitations of this research need to be acknowledged. First, this paper only provides insights into a single case company from the automotive industry. Still, the automotive sector represents a popular research environment in PSM due to its importance to the world economy and its reputation for pioneering approaches (Thun & Hoenig, 2011; Horn et al., 2013). Additionally, the case company is a large corporation that has several years of experience with the use of mechanism design theory in negotiations. Second, the findings obtained through AR are difficult to generalize since they are embedded into the case company's negotiation environment. According to Näslund (2002), however, the best, and possibly only way, to achieve highly relevant results is to join case companies and to actively participate in day-to-day operations to solve real-world managerial problems. If PSM academia wants to lead rather than follow practice, AR methodologies can help to produce relevant research findings.

The study at hand provides interesting directions for future research. It should be explored whether there are dominating negotiation designs, which means a specific compilation of elements that fits to a variety of negotiating situations. Building on this research question, it is also interesting to analyze how suppliers act if they are repeatedly taking part in mechanism design-based negotiations.

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