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Designing Reverse Auctions for B-2-B Procurement - Evidence from the German Industry (preliminary draft version)

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Introduction

At the end of the 1990s online reverse auctions were proposed as a powerful tool to improve the performance of corporate procurement. However, as many of the promises of the e-Business world failed to materialize the issue received only little attention during the last years. Hence, it is not known what kind of role reverse auctions play and what kind of auction designs are used in practice. For this reason, the following article tries to answer three questions regarding the actual use of auctions in corporate procurement: 1. To what extend will reverse auctions replace traditional sourcing negotiations within B2B procurement? 2. Which auction forms and auction designs are most appropriate for procurement auctions to ensure satisfactory results? 3. What kind of complex auctions forms such as combinatorial and multiattribute auctions are successfully applied for B2B procurement purposes?

The results are based on an empirical survey among 113 companies listed at the German stock market show that reverse auctions are mainly used by large corporations and only to a very limited extend by smaller companies. Interestingly companies mainly use different variations of the standard English Auction such as Rank Auctions or Best/Not Best Auctions, which have not been studied by auction and game theorists so far. Auctions formats recommended by auction theorists such as Hybrid or Dutch Auctions are hardly used in practice. Among the more complex auction designs combinatorial auctions were not found very often, despite their attractive properties for the procurement of goods with potential synergies in production costs. Multiattribute Auctions are used much more frequently; however, they are applied for different price attributes rather than different quality attributes.

Theoretical Background and Research Hypothesis

The specific literature on online reverse auctions is mainly management-oriented and not based on a thorough analysis of auction theoretical concepts. Often it is influenced by the fact that online auctions were still a very new procurement concept in 2001/2002 . In a larger study of the CAPS Research institute it is shown that Auctions are successfully applied for procurement purposes and that they can achieve substantial price reductions (Beall et al. 2003). Furthermore some of the authors show in a following study that reverse auctions can be used to purchase complex items and not just simple and standardized items (Kaufmann and Carter 2004). However, critics of online reverse auctions claim that the savings of auctions are often overvalued (Emiliani and Stec 2002) and that suppliers are often very skeptical about fairness in auctions (Jap 2002). Summarizing these contributions, the following first research hypothesis is derived:

H1. Online reverse auctions will replace supplier negotiations to a certain extent.

William Vickrey introduced the game theoretical analysis of auctions in his seminal paper in 1961[1]. He showed, that in Firstprice and Dutch Auctions**,** each bidder calculates an optimal bid based on his individual valuation, the number of bidders, and the distribution of valuations among all bidders (which is assumed to be common knowledge). For both auction forms, bidders calculate their optimal bids in the same way, thus both auction forms are strategically equivalent. Within English and Secondprice Auctions, instead, bidders bid up to their individual valuation. For both auction forms, this is their dominant strategy, so both forms are equivalent in revenues as well. The major result of Vickrey is that under reasonable assumptions, all four auction formats yield the same revenue for the auctioneer. This finding is known as the "**Revenue Equivalence Theorem, RET**" and is one of the most fundamental concepts of auction theory. Among other aspects, the research that followed Vickrey work showed which auction forms become superior in terms of revenue when certain assumptions are relaxed. **Firstprice and Dutch Auctions** become superior when bidders are risk-averse or when there are specific asymmetries in bidders' valuations. The latter is especially important when there is one significantly stronger bidder which is expected to outbid all weaker bidders (Maskin and Riley 1998). **English Auctions** are superior to other auction forms when bidders' valuations are depended (affiliated) on the valuations of other bidders (Milgrom and Weber 1982). If this is the case, only during the English Auction bidders receive information about other bidders' valuations to update their personal valuations. Based on these results the following research hypotheses are derived:

H2. Dutch or Firstprice Auctions should be used in the case of risk-averse bidders or in the case of substantial asymmetries between bidders.

H3. English Auctions should be used if there is dependence between bidders' valuations (costs in the case of procurement). Thus, especially in very competitive markets, English Auctions should be superior.

During a first round of preliminary interviews with 19 suppliers of software tools for reverse auctions, it showed that different variations of the English Auction played a dominant role in the world of procurement auctions. These Variations included **Best/ Not Best Auctions** where only the best bidder is informed that he is currently the best bidder (sometimes named Blind Auction); **Best Price Auctions** where all bidders are informed about the current best bid, but nothing else; **Pure Rank Auctions** where bidders see their current rank (1st, 2nd, 3rd, …), but not the actual leading bid; **English Rank Auctions** where the actual leading bid and bidders' ranks are shown and **All Price Auctions** where all actual bids are shown. To assess the relevance of these variations and potential advantages of their application the following research question was introduced:

H4. Which variations of the English Auction (Best price, Rank, All prices) are applied in practice and to what extent is their application dependent on the specific context?

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[1] Helpful introductions to the basic concepts of auction theory can be found in McAfee and McMillan 1987 and in Klemperer 1999. The reader interested in the underlying mathematical and game theoretical models of auction theory is referred to Milgrom 2004 and Krishna 2002.

During the 1990s, researchers expanded the concept of auctions to more complex transactions with more than just the single price being the essential bargaining parameter. **Combinatorial Auctions** were developed for multi-unit auctions with potential synergies or complementarities between the units/items to be auctioned. The reasoning is, that with existing complementarities optimal bids for each unit depend on whether other units will be obtained via the auction or not (Cramton 1998 and 2006). Within Combinatorial Auctions bidders can place bids on every possible combination of the items auctioned of simultaneously, thus, allowing bidders to bid on an allocation of items, which is optimal for them. **Multidimensional/Multiattribute Auctions** were developed for purchasing goods where other parameters than price are relevant as well. They allow suppliers to differentiate from their competitors via bidding on other aspects such as qualities, delivery time, guarantees, etc. (Che 1993, Branco 1997, Bichler et al. 1999). Multiattribute Auctions are often recommended as a useful solution for the procurement of more complex goods. So far it has not been assessed, to what extend and under which circumstances these complex auctions forms are applied in corporate procurement. Thus, the following two final research hypotheses are derived:

H5. Combinatorial auctions are used frequently, they are promising for purchasing goods with synergies in suppliers' production costs

H6. Multiattribute Auctions are used frequently, they are promising for purchasing more complex goods

Empirical Research Approach

To assess the research hypotheses a series of expert interviews with suppliers of auction-tools and with auction users from companies was conducted. In a pre-phase19 suppliers of auction tools (software and know-how providers) were interviewed to test the questionnaire and to identify further research questions. Following this, a survey of 113 corporations listed in the major German stock market indices (DAX, MDAX, SDAX) was carried out to assess the overall use of online reverse auctions and to test the first Hypothesis. Finally the other hypotheses were tested during 29 in-depth interviews with auction experts from corporations using online reverse auctions. All interviews were held on the basis of a standardized questionnaire and all but 4 experts contacted had at least 2 or more years of experience in the field of online reverse auctions[2].

Results of the Empirical Study

Of the 113 companies contacted during the survey only 100 agreed to participate. Among these 100 a total of 35 companies uses reverse auctions for procurement and 65 companies reported that they don't use reverse auctions. The differentiation of the results by stock market indices shows a significant impact of company size on the likelihood of using reverse auction. Within the indices for large companies, the DAX, 83% of the companies use auctions. Within the indices of mid-size companies, the MDAX only 26%

2 For a broader discussion of the empirical approach and underlying methodological aspects see Eichstädt 2007.

of the companies use auctions and among the small companies (in the SDAX) only 14% use auctions. Having asked for the extend to which reverse auctions are used, 37% of all companies reported, that they use auctions only for an insignificantly low amount of total spent. 30% stated, that they use auctions for about 5% of their total spent and 33% declared that they use auctions for at least 10% of total spent. Summarizing we can state that the first Hypothesis is confirmed since about 35% of the companies surveyed use auctions, and over 60% of these companies use them for a significant amount (≥5%) of their total spent.

During the expert interviews with auction users it was revealed, that only about 29% of all companies use Dutch Auctions. However, all but one of these companies do apply them in the case of asymmetries between bidders or in the case of only a small number of bidders which is in accordance with theoretical recommendations. All other auction forms, however, are only used to a very limited extend, 3 companies (~10%) use Ticker or Japanese Auctions, only two companies (~7%) use Firstprice Auctions and just one company (~3,5%) uses Hybrid Auctions. Secondprice Auctions are not used at all. Since only a limited share of companies uses Dutch Auctions the second hypothesis has to be revised. However, at least the few users of Dutch Auctions do know about their advantages in the case of bidder asymmetries.

As mentioned before, the results show, that companies use different variations of the English Auction as the main auction format. According to the interviewees the English Auction is the preferred auction format since it seems to provide the best results in most cases and unlike Dutch Auctions it provides additional information about the bids/prices of all participating suppliers. Therefore, the third hypothesis is verified, the English Auction is the dominant auction form. The Assumption that sufficient competition among bidders is an important driver in these auctions is confirmed by the fact, that there are usually 5 and more bidders participating in the auctions.

Concerning the use of different variations of the English auction, the study provides only inconclusive results. 40% of the interviewees reported that they use all different variations of the English Auction. However, those using different variations reported conflicting motives for the application of the different variations or they stated that the choice depends on the preferences of individual buyers. 25% reported that they mainly use a Rank Auction without showing the best price, whereas about 15% said they use Rank Auctions with best prices. Another 15% claimed to use a classic English Auction where all bids can be seen and 5 % reported to use a Best/Not Best Auction as the main format. Summarizing this we see that, the results of the survey give little insight into the question whether certain variations of the English Auction are superior under certain conditions. Thus, the fourth research question can not be answered on behalf of the research results. However, we will present an alternative concept of when to use which variation of the English Auction in the following chapter.

Concerning more complex auction forms, only 15% of the companies reported that they use Combinatorial Auctions. The few users, however, mentioned that they are superior in giving suppliers a chance to make optimal offers dependent on their production costs. Those who don’t use Combinatorial Auctions often reported that they want to avoid higher technical efforts for the implementation and additional complexity for suppliers.

Due to the small amount of companies using combinatorial auctions the fifth hypothesis is not confirmed.

Auctions where bidders can bid on additional parameters (quality, delivery time, etc..) are used by around 48% of the companies. However, contrary to what is promoted in the academic literature, most of these auctions are not used for quality parameters but for different price parameters. A simpler alternative to Multiattribute Auctions are Rank Auctions with a Bonus Malus rule. Bidders with inferior quality, higher transport costs or additional switching costs receive a Malus which decreases their bid automatically to incorporate the disadvantages. Bonus Malus Auctions are used by about 50% of all companies. Summarizing we state that the sixth hypothesis should be revised. Although Multiattribute Auctions are used rather frequently, they are not especially used for more complex items. Instead, they are applied to find suppliers for contracts where different price parameters are relevant.

Additionally to these findings and other results on more specific design aspects such as starting prices and ending rules (see Eichstädt 2007) the survey showed that barriers to implementation are a very important issue. According to the experts interviewed, the limited acceptance of buyers to use auctions for their purchases is the biggest problem during the implementation of auctions. Reasons for the limited acceptance are: the fear of buyers to abandon their “core competency” negotiation; the fear of having less decision power and less contact with suppliers; the low levels of buyers qualification and their narrow view of their responsibilities; the limited willingness of buyers to use modern IT-based tools and the fear of having to work more.

Some of the interviewees reported that the opposition of suppliers to auctions is a further important implementation issue. Suppliers’ opposition is mainly due to fears of unfair behavior of buyers. Unfair behavior of buyers includes auctions to screen the market with no intention of awarding a contract and the submission of fake bids.

Conclusions and Managerial Implications

1. The general use of reverse auctions
The results show that auctions are becoming a relevant tool for B2B procurement, especially in large corporations. When reverse auctions are used, they replace the distributive part of traditional price negotiations. According to the interviewees, internal resistance from buyers to the use of auctions is the major barrier for the use of online reverse auctions. Thus, measures to support the implementation of online reverse auction must accompany any internal implementation processes. Furthermore, suppliers are likely to be reluctant to use auctions. To overcome their skepticism, it is important to ensure that auctions are conducted on a fair and honest basis. An unresolved question is whether reverse auctions are a suitable tool for small companies or not. The fact that smaller companies use auctions only to a very limited extend might be explained by problems of small companies to ensure supplier participation in reverse auctions. Large companies, instead, have significantly more purchasing and market power to force suppliers to participate in reverse auctions.

2. The use of different variations of the English Auction

The following paragraph develops a concept for the systematic use of different variations of the English Auction. It is based on the assumption, that bidders in online reverse auctions have bidding costs, due to the time they spend bidding and due to the disclosure of sensitive information about their willingness to accept prices. Therefore we assume bidders quit auctions immediately if the prospects for winning the auction are very small. The decision to quit an auction is based upon bidders' valuations (costs), the number of bidders, and the distance to the leading bid. Whenever bidders get the impression that they have no chance to win the auction, they quit. The immediate quitting of bidders deteriorates auction results, because it reduces the number of active bidders[3]. Based on these assumptions, it is essential to **frame** auctions in a way that keeps bidders from quitting early. Therefore in a situation with many bidders and large spreads among the initial offers of bidders **Best/ Not Best Auction** should be applied to avoid daunting effects of a high number of bidders or large spreads to the best bid. When the spread of initial offers is large, but the overall number of bidders is low, a **Pure Rank Auction** without information about the best price should be used to avoid daunting effects of large spreads to the best bid. The overall lower ranks for all bidders, instead, encourage bidders to continue bidding. When both, the number of bidders and the spread of the initial offers are low **English Rank Auction** should be preferred since the information about a low rank and a close best price will encourage bidders to continue bidding. In the remaining case of a high number of bidders and low spreads between initial offers a **Best Price Auction** should be used to avoid daunting effects of a high number of bidders and low ranks. The small spread to the best bid, instead, encourages bidders to continue bidding. The following picture 1 presents the basic concept for variations of the English Auction.

Picture 1:

Spread of initial offers \ Number of Bidders	*High*	*Low*
High	**Best/Not Best Auction**	**Pure Rank Auction**
Low	**Best Price Auction**	**English Rank Auction**

3. The use of different auction forms

The following paragraph develops a concept for the systematic use of different auction

[3] It is a well known result from auction theory, that revenues improve with a raising number of bidders (Vickery 1961).

forms in a way closely related to the previous paragraph. In addition to the previous paragraph the concept is based on the assumption that a bigger spread between initial offers is an indicator for bigger asymmetries between bidders. Additionally we assume that with a rising number of bidders, the revenue/price effects of affiliation between valuations (costs) become stronger. Finally we expect bidders to be risk-averse, thus bidding slightly higher in Firstprice or Dutch Auctions, especially when they don't know how many bidders are participating. In this setting we expect **Hybrid Auctions** to provide the best results in situations with many bidders and a large spread between the initial offers. This is because a Hybrid Auction allows bidders to adapt to competitors bids in the first (English) round and is more effective to get beyond the 2nd best price in the second (Firstprice) auction round. Whenever there is only a small number of bidders with large spreads between initial offers we expect **Dutch or Firstprice Auctions** to be superior. This is because they are more effective to get beyond the 2nd best price in the case of asymmetries and they create additional insecurity because bidders must not know how many bidders are participating. The loss of benefits from possible affiliation among bidders' valuations is accepted since it is expected to be small with only a few bidders. In the case of small spreads between initial offers we refer to the recommendations in the previous chapter. Combined with a high number of bidders Best Price Auctions should be used, in the case of a small number of bidders English Rank Auctions should be applied as shown in picture 2 below

Picture 2:

Spread of initial offers \ Number of Bidders	*High*	*Low*
High	**Hybrid Auction**	**Dutch or Firstprice Auction**
Low	**Best Price Auction**	**English Rank Auction**

We find the application of Hybrid Auctions especially appealing since they combine important benefits of the English Auction (because of affiliated valuations) with the benefits of Firstprice Auctions (because of asymmetries and risk aversion). Interestingly auction theorists have not highlighted these advantages of Hybrid Auctions so far. The only exemption is Klemperer who recommends the use of Hybrid Auctions to make auctions more attractive for weaker bidders (Klemperer 2001).

4. The use of complex auction forms

The results show, that Combinatorial Auctions are only used by a limited amount of

companies (15%) so far. However, those companies using Combinatorial Auctions are convinced that they provide a superior solution to handle complex negotiation settings. The positive results of combinatorial auctions reported by interviewees, as well as the results of other empirical studies on procurement auctions[4], indicate that Combinatorial Auctions will become an increasingly important tool for B2B procurement.

Multiattribute Auctions are much more commonly used in purchasing. 48% of the companies already use Multiattribute Auctions. Contrary to the underlying theoretical concepts, however, these auctions are not used for quality parameters in practice but for different price parameters. So far the empirical analysis of Multiattribute Auctions has been based on laboratory experiments[5] comparing Multiattribute Auctions with standard auctions. The advantages of Multiattribute Auctions over traditional negotiations, however, still have to be proven in practice. Such a proof might help to convince auction users in the corporate world to employ Multiattribute Auctions instead of traditional supplier negotiations more often.

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