An Empirical Analysis of Package Bids and Stand-Alone Bids in Combinatorial Procurement Auctions

by

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Abstract

One reason for allowing combination bids in procurement auctions is that this mechanism may pass firms' potential cost synergies on to the procuring entity leading to a reduction in cost for the procuring entity. However, the option for a firm to submit bids on bundles of contracts gives rise to a strategic effect because a firm's stand-alone bids compete with its package bids. Therefore, bidders might find it profitable to inflate their stand-alone bids in order to favour their package bids. Hence, the observed discount in a package bids would not reflect the procurer's cost saving of using the combinatorial format. Using data from single-contract auctions and multi-contract auctions with the option to submit package bids, we find that firms inflate their stand alone bids in the combinatorial auctions compared to their corresponding bids in standard procurement auctions. Further, the analysis does not show significant differences in the procurer's cost by type of auction.

Key words: Combinatorial procurement auctions, Contract bidding
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1. Introduction

Auctions in which bidders are allowed to submit bids on combinations or packages of contracts in addition to their stand-alone bids have received relatively much attention in recent years, both in practice and in theory. Combinatorial procurement auctions are increasingly being employed in both the private and public sectors as an alternative to simultaneous single-item auctions. The mechanism enables suppliers to express synergies across bundles of for example public contracts, which mitigates the exposure problem and has the potential to both lower the procurer's cost and enhance efficiency. A combinatorial auction is very much an interdisciplinary issue, and there are a number of complex problems to solve when designing and implementing the mechanism. A large number of studies in this field focus upon the inherent computational difficulty of determining the winner and how to express combined bids. For a review of previous studies on the winner determination problem, the bidding language of combinatorial auctions, and previous reports from practical applications of the mechanism, see for example De Vries and Vohra (2003), Sheffi (2004), Cramton *et al.* (2006), and Abrache *et al*. (2007).

Much of the economic literature deals with the strategic implications of combinatorial auction. A couple of studies analyse the properties of the Vickrey combinatorial auction or the Vickrey-Clarke-Groves mechanism (VCG mechanism), an extension of the Vickrey auction (e.g. 1995; Holzman and Monderer, 2004; Yokoo *et al.,* 2004; Ausubel and Milgrom, 2006; Chew and Serizawa, 2007). Like the single item Vickrey auction, the VCG mechanism is rarely applied in the field. The mechanism has some disadvantages which reduce its usefulness as a real-world auction design. Other mechanisms have been proposed in the literature to overcome the drawbacks within the VCG mechanism, like the Adaptive-User-Selection-Mechanism (AUSM), the Progressive-Adaptive-User-Selection-Environment (PAUSE), the clock-proxy auction, and a three-stage auction design. For reviews of these mechanisms, see for example Banks *et al.* (1989), Kelly and Steinberg (2000), Kwasnica *et al.* (2005), Ausubel *et al.* (2006), and Day and Raghavan (2008).

Unlike single-item auctions, multiple item environments still lack theoretical guidelines for making general predictions concerning revenue ranking and efficiency ranking of various types of combinatorial auctions. Krishna and Rosenthal (1995) show in a sealed-bid second-price auction, with two objects and a single global bidder, that a simultaneous auction outperforms the combinatorial auction when synergies are present. The reason is that the global bidder engages in "overbidding", that is, the bidder is bidding above his value, facing the possibility of a loss *ex post*. [1] In a first-price multiple unit auction, there is to our knowledge no similar proof derived that a simultaneous first-price auction outperforms a first-price combinatorial auction. Intuitively, one would expect that overbidding also can be predicted in the first-price auction. Some field applications and experimental evidence, however, suggest that the combinatorial mechanism is superior to a simultaneous auction format (e.g. Epstein *et al*., 2004; Cantillon and Pesendorfer, 2006; Lunander and Nilsson, 2004, 2006).

When estimating the cost savings of a first-price combinatorial procurement auction, one method would be to take the difference between the cost minimizing allocation based on all bids and the cost minimizing allocation based on just the bidders' stand-alone bids. The (naïve) underlying assumption would be that the stand-alone bids mirror the bids the firms would have submitted in an auction without combinatorial bids. However, one strategic problem that arises in the first-price combinatorial procurement auction is that a bidder's stand-alone bids compete with her combinatorial bids. As a result, bidders might find it profitable to inflate their stand-alone bids, or refrain from submitting any, in order to increase the probability of winning with their combinatorial bid. This effect may reduce efficiency and increase the procurer's cost. Also, the environment a supplier faces in a first-price combinatorial procurement auction resembles the multi-product monopolist problem, where the price of a product affects both the demand for the product and the demand for other products.

[1] A similar result is found in Kagel and Levin (2005), in which they derive and analyze bidding behavior in a sealed-bid uniform price auction when synergies are present. They find that a bidder with multi-unit demand has, for some intervals of values, an incentive to submit bids above her valuation. Testing their prediction in an experiment, they find that subjects exhibit no reluctance to overbidding.

Cantillon and Pesendorfer (2006) refer to the results obtained in McAfee *et al.* (1989) and show that the presence of a combination bid does not necessarily indicate that the bidding firm is facing synergies. The submission of a combination bid can be equally motivated by strategic price discrimination. Cantillon and Pesendorfer conclude that the welfare consequences of first-price combinatorial procurement auctions are an open empirical question. However, the more that bidders' unit costs are negatively correlated in the number of contracts won, the more likely it is that the combination bids reflect synergies across contracts rather than strategic price discrimination.

The aim of this paper is to empirically test two issues raised in the discussion above. First, we investigate whether bidders tend to raise their stand-alone bids in sealed-bid combinatorial procurement auctions of public service contracts compared to the bids submitted in a standard procurement auction. This is done by comparing the stand-alone bids in combinatorial auctions with the single bids in standard auctions. In order to control the potential effect from overbidding in standard multi-contract auctions, two complementary tests are performed. By comparing bidding behaviour in standard auctions of single contracts with that in standard auctions of multiple contacts, we may test whether bidders have engaged in underbidding in the latter auctions. Also, to exclude the potential impact of underbidding, we compare the stand-alone bids in combinatorial auctions with the bids submitted only in standard auctions of single contracts. Secondly, we analyze the question whether combinatorial auctions lowers the procurement cost. Making use of the winning bids in both combinatorial and standard procurement auctions, we test whether there is a difference in procurement cost explained by auction format.

The empirical study is based on a data set which consists of single bids in standard auctions, stand-alone bids and package bids in combinatorial auctions. The bids originate from the procurement of an identical service, internal regular cleaning contracts, with identical set of bidding firms found in the standard and combinatorial auctions.

To our knowledge, this study is the first to compare a firm's observed bidding behaviour in procurement auctions both with and without the option to submit package bids. It is our access to bidding data where the same set of firms has submitted stand-alone bids for identical objects under the two auction mechanisms that has enabled the study. A policy implication of our findings is that due to strategic bidder behaviour the discount expressed in the package bids is likely to be overstated, which should be accounted for in the procurement process.

The paper is organized as follows: In Section 2, we very briefly describe different types of combinatorial public procurement auctions that we are aware of having been applied in Sweden in recent years. In Section 3 we describe the design of the three combinatorial auctions from which we have collected part of our data set. Referring to scatter plots, we claim that the firms' motives for submitting package bids in these auctions are related to synergies and not to strategic price discrimination. The full data set is presented in Section 4. Section 5 presents our results, and Section 6 is the conclusion. Figures and Tables are found in the Appendix.

2. Combinatorial public procurement auctions in Sweden

Since the enforcement of the EU procurement directives in Sweden in 1994, procurement auctions are held on a regular basis, and, as in most OECD countries, they comprise a substantial part of the economy. About 15 percent of the gross national product is believed to be explained by public procurement.[2] Public procurement auctions in Sweden are regulated by legislation (following the EU directives)[3] that stipulates sealed bidding where the contract is awarded either to the bidder with the lowest bid, or, when weight is also given to other qualities than price, the bidder who is considered to have submitted the most economically advantageous bid. In the former setting the procurement auction takes the form of a first-price sealed-bid auction. The procurement auctions can either be single-contract auctions or involve multiple contracts. The option to submit bids

[2] See the Swedish Competition Authority (www.kkv.se)
[3] Directive 2004/17/EC and Directive 2004/18/EC

on public contracts is announced by a “call for tenders” and the announcement is accompanied by detailed descriptions of the services to be performed and the conditions to be stipulated in the contracts.

In Sweden, combinatorial auctions have been used relatively scarcely in public procurement auctions of multiple contracts. The generally applied mechanism has been the standard sealed-bid format, with the character of first-price sealed bid auctions, and in most of these auctions the contracts have been more or less substitutes. The design of the combinatorial auctions has varied as to the restrictions imposed on bidding.[4] In most auctions, bidders have been obliged to submit a stand-alone bid for every contract that made up a package bid. To enable bidders to express diseconomies of scale, in most auctions bidders could in various ways indicate that they had limited capacity, i.e., submit so called XOR bids (see Nisan, 2006). Such a bid could look like “We bid 10 for contract A, 15 for contract B, and 25 for contract C, but we can only fulfil one of them” or “We bid 10 for contract A, 15 for contract B, and 25 for contract C, but we can only fulfil contracts up to a value of 25”. In some auctions, the bidding firms could express their limited capacity in terms of a physical value. To exemplify, when the Swedish National Road Administration procured multiple contracts for road maintenance (asphalt surface), the bidding firms could, apart from their stand-alone and package bids, also state the maximum number of tons of asphalt they were willing to supply. In some auctions, there has been a restriction on the maximum number of contracts that a package bid was allowed to have.

3. Combinatorial auctions of cleaning services

The data analysed in this paper are bids from sealed bid public procurement auctions of internal regular cleaning services in Sweden. The auctions have the character of first-price sealed bid auctions and are either organized as single-contract or multi-contract auctions. Within the multi-contract procurements, auctions that both allowed and did not

[4] The majority of the public combinatorial procurement auction that has been carried out since the year 2000 where firms have been free to submit package bids on any bundle of contracts, has used the computational technology provided by the firm Trade Extensions in Sweden.

allow package bidding and auctions are found. Three of the multi-contract auctions were carried out as combinatorial auctions, and these refer to the years 2005, 2006, and 2007. The data from the non-combinatorial auctions originates from the period 1992 to 1998 and 2006 to 2007, respectively. Basically the same set of bidding firms is identified in all sub samples. This enables us to compare the bidding behaviour given the design of the auction (package bidding allowed or not) contingent on the bidders submitting all types of bids and also contingent on the identity of the bidder.

3.1 Combinatorial Auctions A and B (Local governments)

Two of the combinatorial procurement auctions were held in 2005 and 2006, respectively. The procuring entity was in both cases a local government. The auctions comprised nine (Auction A) and seven (Auction B) separate contracts respectively, with a total cleaning area of 105 000 m^2 and 400 000 m^2. The premises to be cleaned are either public offices or public schools. In both auctions bidders were free to submit bids on any bundle of contracts. This was, however, contingent on some restrictions. In Auction B a restriction was that a package bid could at most contain three contracts. In both auctions bidders had to submit a stand-alone bid for every contract included in a package bid. The package bids had to be non trivial; that is, the package bid had to be lower than the sum of the stand-alone bids making up that package. In Auction A, a bidding firm could, in addition to the various bids, declare the maximum area in terms of m^2 it could accept being contracted for in the event the firm would be awarded too many contracts. In Auction B, a firm could express its capacity constraint by stating the maximum contract sum it could be awarded.

3.2 Combinatorial Auction C (The Swedish Social Insurance Agency)

The auction was conducted in 2007 and comprised cleaning service contracts in all of the agency's local offices in Sweden, divided into 42 separate contracts. Each contract comprised one or more offices in the same geographical area. The total area to be cleaned was about 445 000 m^2. A bidder was free to submit non-trivial package bids on any bundle of contracts. Also, the bidders could submit package bids in terms of a "price list" with restrictions. To exemplify, a price-list bid could be like "We bid 10 for contract

A, 15 for contract B, 18 for contract C, and 20 for contract D. The price for each contract in the price list is valid given that we are awarded contracts worth at least 25." A price list bid could also take the form of "We bid 10 for contract A, 15 for contract B, 18 for contract C, and 20 for contract D. The price for each contract in the price list is valid given that we are awarded contracts A and D." No matter what type of package bid a bidder submitted, she always was required – in line with the combinatorial auctions described above – to submit a stand-alone bid for every contract belonging to a package bid. No restriction was imposed as to the maximum allowed package bid discount. To adjust for differences in other aspects than price when evaluating the bids, the agency applied a scoring rule where bidders received discounts on their bids, given documented quality assurances. As in Auction A, bidders could submit XOR bids, that is, express diseconomies of scale by stating the maximum number of m^2 they were willing to be contracted for.

3.3 The standard procurement auctions

The bids that are used as a point of reference for comparison with the stand-alone bids from the combinatorial auctions, originate from single and multi-contract public procurement auctions of cleaning services, organized by local governments as well as government authorities. We refer to these bids as single bids. The data originates from two surveys. The first covers the time period 1992 to 1998 and includes 362 contracts. The second covers 2006 and 2007 and compromises 58 contracts. Within the standard multi-contract auctions there was no package bidding, and bids were instead submitted on separate contracts (one for each premises to be cleaned) auctioned in one and the same procurement. Bids from the standard procurement auctions are then used as contra factual to the stand-alone bids from the combinatorial auctions. Firms identified in the combinatorial auctions A, B, and C that had submitted at least one package bid followed by stand-alone bids are namely also identified in the standard procurement auctions. Hence, the data set in this study only contains stand-alone bids from those firms which have been active in the combinatorial auctions and single bids from the same firms identified in the standard auctions. A criterion for being in the data used the empirical analysis is then that firms have participated in both types of auction formats. Bids from firms that we only observe in one type of auction format are dropped. The data is described in the following section.

4. The Data

In total the data covers 1,188 bids submitted by 14 firms in 450 sealed-bid procurement auctions of cleaning contracts. The contracts are public premises that either are schools or offices. The data is based on submitted bids – a matter of open public record – requested from the procuring entities which also provided us with the documentation related to the call for tender.

The majority of the bids in the data set consist of bids collected from either single-contract auctions or multi-contract auctions, without the option to submit package bids. About 80 percent of these bids originate from standard auctions in the 1992 to 1998 period (362 contracts), and the rest are bids from either standard (30 contracts) or from combinatorial procurement auctions (58 contracts) in the years 2005, 2006, and 2007. As mentioned previously, in order to analyse bidding behaviour, we compare single bids submitted under a non-combinatorial format with stand-alone bids from combinatorial auctions for the same set of firms. Descriptive statistics for the annual bid in SEK per square meter (at the 1994 price level) are found in Table 1 and correlations are found in Table A1 in the Appendix.

The average bid is 10 percent higher in the standard auction format than the average bid in the combinatorial format. Decomposing the data into the two types of premises, we see that the difference in mean values across formats is due to differences in the bidding for offices.[5] The average contract specifies 5,735 square meters to be cleaned, and a majority of the premises are schools (74 percent). The degree of competition in these auctions is fairly good; the average number of bidders is 6.8. The bids are submitted by cleaning service firms of different sizes, ranging from larger national firms to smaller local firms. Two of the bidding firms in our data are active nationwide. They have submitted bids on

[5] There is no significant difference in mean values for schools.

almost every contract in the data. Their share of the total number of submitted bids is about 70 percent.[6]

Table 1. Descriptive statistics, stand-alone bids per square meter given format and procurement characteristics.

Sample	*N*	Mean	Minimum	Maximum	Standard deviation
All bids	1 188	100.75	21.08	488.11	42.20
Bids from standard procurement auctions	970	102.53	21.08	488.11	45.53
- public schools	752	102.95	21.08	488.11	41.96
- public offices	218	101.10	22.64	412.54	56.22
Bids from combinatorial procurement auctions	218	92.83	60.30	169.04	20.19
- public schools	59	111.48	73.27	169.04	22.18
- public offices	159	85.91	60.30	129.61	14.18

4.1 Combinatorial Auction A

In this auction 14 firms participated. Almost every firm placed a stand-alone bid on each of the nine contracts. Six firms submitted package bids of various sizes, from a two-contract bundle up to a nine-contract bundle. The total number of package bids was 54, of which 35 bids were submitted by one single firm. The discounts in all package bids ranged from 2 to 9 percent. No firm used the option to submit an XOR bid. All the winning bids were stand-alone bids. Figure 1 in appendix illustrates that bids are declining in the size of the single contracts, but the package bids exhibit constant prices in the number of m^2

4.2 Combinatorial Auction B

The number of bidders in combinatorial Auction B was six. All the bidding firms, except one, placed stand-alone bids on each of the seven contracts. Four of the six participating firms submitted in total 104 package bids, where the maximum number of contracts

[6] Note that the bids analyzed are bids from firms that have been active in both auction formats, that is, submitted both package bids and alone bids in a combinatorial auction and bids in a standard auction. That data is a sub-sample of the total data set which also consists of bids from firms that have not submitted both types of bids.

allowed in a package bid was three. The discount in these package bids ranged from 2 to 6 percent. Again, no bidder used the option to submit an XOR bid. The final allocation of the contracts awarded three contracts each to two firms, and one single contract to one firm. Figure 2 in appendix shows that for both types of bids, the offered price is declining in the number of m^2.

4.3 Combinatorial Auction C

Unlike the combinatorial auctions A and B, which both were local government auctions, combinatorial Auction C was a nationwide auction. The number of bidders in this auction was 22. Three firms submitted only stand-alone bids on each of the 42 contracts. Eight firms submitted a total of 69 package bids. Two of these firms also submitted, among several other package bids, a package bid comprising all 42 contracts. One of the nationwide bidders submitted three "price-list bids" all of which covered the 42 contracts. These price-list bids were formulated as follows: "We bid the following price for each of the 42 contracts, and if we are awarded contracts worth at least 17.5 million SEK from the list below, we offer the procurer the option to pick any arbitrary combination of the 42 contracts". The second and the third price-list bids were similarly formulated, with the exception that each of the prices of the 42 contracts was reduced and the threshold value (least required contract sum) was raised to 22.5 million and 30 million SEK, respectively. Such a price-list bid comprises a very large number of package bids. By submitting an XOR bid, two firms declared that they had limited capacity. These two firms bid for contracts with a total volume about 1.5 times higher than their individually declared capacity. One of the nationwide firms was awarded all 42 contracts through one package bid. The estimated cost savings from the package bids was about 6 percent. Again, stand-alone bids and package bids are declining in contracts size, suggesting the presence of synergies. As shown in figure 3 in appendix, the offered price per m2 is decreasing in volume for the stand-alone bids as well for the package bids.

5. Empirical Setting and Results

In this section we perform two tests. First, it is tested if bidders foresee the interdependency between their stand-alone and package bids in the combinatorial auctions and therefore place higher stand-alone bids in these auctions compared to their single bids in a corresponding standard auction. In order to understand to what extent this difference is due to underbidding in standard auction or to bid shading in combinatorial auctions, we conduct two complementary tests. Secondly, we test if the use of combinatorial auctions has reduced the procurement cost compared to the standard auction.

5.1 Test of Bidding Behaviour and of Procurement Cost

Bidder behaviour will empirically be tested using the annual bids per square meter in the 1994 price level (SEK) as the dependent variable. A dummy variable, *FORMAT,* is used to control for the type of auction the bid originates from. The number of contracts in each auction is captured by the variable *CONTRACT*, the size of each contract is defined as the number of square meter to be cleaned, *SQM*. A dummy variable for type of premises takes the value one if the premises is a school (*SCHOOL*) and zero otherwise. The degree of competition (*COMP*) is measured as the observed number of bidders in each auction. The regression equation used to test differences in bids across auction type is

$$(1) \qquad \begin{aligned} y_i = \alpha_i + \beta_1 FORMAT_i + \beta_2 CONTRACTS_i + \beta_3 SQM_i + \beta_4 COMP \\ + \beta_5 SCHOOL_i + \varepsilon_i. \end{aligned}$$

Equation (1) is estimated with ordinary least square and results are based on standard White-corrected standard errors to correct for heteroscedasticity.

Our first major test tests the hypothesis that bidders' single bids in standard auctions and their stand-alone bids in combinatorial auctions are not affected by the auction format. *FORMAT* takes the value 1 if the bid comes from a standard auction (*Test I*).

To understand whether a rejection of the hypothesis that single bids are identical under the two auction types ($\beta_1 = 0$), is caused by inflated single bids in the combinatorial auction or caused by underbidding in the standard auctions, two complementary tests are performed. First, we analyse the presence of potential underbidding by looking only on the data from standard auctions. We compare the bids generated in the auctions of a single contract with those from auctions of multiple contracts (*Test I.a*). The dummy variable *FORMAT* takes the value 1 if the bid is generated in a standard single contract auction, and 0 if the bid comes from a standard multiple contract auction. A significant positive value of β_1 would indicate underbidding.

Secondly, we exclude the bids from the standard auctions of multiple contracts and focus on the bids from auctions of a single contract. These bids are compared with the stand-alone bids from the combinatorial auctions, which removes the potential impact of underbidding (*Test I.b*). The dummy variable *FORMAT* takes the value 1 if the bid is generated in a standard single contract auction, and 0 if the bid is a stand-alone bid in a combinatorial auction. A significant negative value of β_1 would indicate inflated stand-alone bids in the combinatorial auctions.

Our second major test focuses on the difference in procurement cost across auction type. Making use of only the winning bids in our data set, we test whether the use of a combinatorial auction design lowers the procurement cost. We apply equation (1), letting the dummy variable *FORMAT* capture auction type (*Test II*)

5.2 Results

The regression results are shown in Table 2. Looking first at Test I.a, the outcome from the comparison of bids generated under the standard auctions – multiple contract auctions versus single contract auctions –, we see that the bids do not significantly differ across auction format. The test does not support the prediction that firms would engage in underbidding in standard auctions of multiple contracts.

Test I rejects the hypothesis that the stand-alone bids in combinatorial auctions are identical to the bids submitted in standard auctions. The estimate of *FORMAT* suggests that the stand-alone bids in combinatorial auctions are higher than the bids in the standard auctions. The average bid in a standard auction is approximately 10 SEK/m^2 (10%) lower than the stand-alone bid in the combinatorial auction format. On an annual basis, this means that the stand-alone bid in the combinatorial auction on the average contract (2,972 m^2), is 31,532 SEK[7] higher than the corresponding bid in the standard format. Test I also shows that the variable *COMP* is significant positive, that is, bids are increasing in the number of bidders. It is possible that is due to the presence of the stand-alone bids in the combinatorial auctions. An increased number of bidders might give the individual bidder incentives to raise her stand-alone bids in order reduce the probability that her stand-alone bids – combined with the bids of others – will interfere with her package bids.

Table 2. Estimation results from Test I, I.a, I.b, and II (t-values in parenthesis).

Variable	*Test I*	*Test Ia*	*Test Ib*	*Test II*
Format	-10.15	-3.69	-8.17	-4.22
	(-3.51)	(-1.05)	(-2.26)	(-0,93)
Number of contracts	-0.43	-	-	-0.49
	(-7.70)			(-5.71)
Square meter	-0.001	-0.00	-0.00	-0.001
	(-8.33)	(-4.99)	(-5.63)	(-5.82)
Comp	0.71	0.43	0.99	-0.71
	(2.15)	(1.15)	(1.60)	(-1.55)
School	6.70	5.81	13.53	20.49
	(1.95)	(1.34)	(2.98)	(3.93)
Constant	114.16	101.05	89.40	110.62
	(28.56)	(21.11)	(23.62)	(18.12)
N	1188	970	339	450
R^2	0.06	0.03	0.18	0.13

Test I: *FORMAT* = 1 for standard auction
Test Ia: *FORMAT* = 1 for single contract auction
Test Ib: *FORMAT* = 1 for standard auction
Test II: *FORMAT* = 1 for standard auction

Given the outcome from test I.a, we conclude that the significant difference between the stand-alone bids in the combinatorial auction and the bids in the standard auctions is due to inflated bids in the combinatorial auction and not to underbidding in the standard auction of multiple contracts. This conclusion is strengthened when looking at test I.b.

[7] In May, 2009 one SEK is 10.87 EUR and 8.08 USD.

Excluding the bids from standard auctions of multiple contracts in the data, we see that the stand-alone bids in combinatorial auctions are significantly higher that the bids generated in standard auctions of single contracts.

Test II indicates that the winning bids in the combinatorial auctions are not significantly different from the winning bids in the standard auctions. Hence, our data does not provide significant evidence that the use of a combinatorial auction lowers the procurement cost. The observed discounts in the package bids are large enough to offset the increase of the stand-alone bids.

The low explanatory power of the model is not worrying since bids to a large extent are determined by square meters to be cleaned. Estimation of equation (1) using total bids instead of bids per square meters leads to the same conclusions and the explanatory power of the model is 94 percent.[8]

6. Summary and conclusions

This paper has empirically investigated two related aspects of firs-price combinatorial procurement auctions. We test whether there is a difference between a bidder's stand-alone bid in combinatorial auction and her bid in a standard auction. Lacking any clear theoretical guidance, there are reasons to believe that the stand-alone bids in the combinatorial auction are higher than the bids in a standard auction. Bidders might engage in underbidding in standard auctions for multiple contracts which would drive down their bids compared to stand-alone bids in the combinatorial auction format. Also, a bidder's stand-alone bids in the combinatorial auction will compete with her package bids, which might cause the bidders to raise her stand-alone bids in order to favour her package bids. The second test carried out in the paper is whether the use of package bidding reduces procurement cost. Given the expected difference between the stand-alone bids in both types of auctions, the observed discount in a package bids would not reflect the procurer's cost saving of using the combinatorial format.

[8] The estimation results are found in Table A2 (Appendix).

Based on data from Swedish procurement auctions of cleaning services, our findings indicate that firms do not engage in underbidding in standard auctions of multiple contracts but do raise their stand-alone bids in combinatorial auctions. Also, the increase in the stand-alone bids seems to offset the discounts expressed in the package bids, suggesting there is no differences in procurement cost across the two types of auctions.
A policy implication of the conclusions drawn in our study is that one needs to be careful when interpreting the size of the package discount in first-price combinatorial auctions. Even if package bids are motivated by synergy effects, and therefore have the potential to lower the procurer's cost, the observed package discount overstates the actual cost reduction of a combinatorial auction. The question of cost-savings needs to be carefully evaluated with analysis based on winning bids given the type of auction applied.

A preliminary analyze of bids at firm level indicates that the behaviour across firms differs. A natural next step in understanding the relation between the two auction formats would be to extend the analysis carried out in this study on a disaggregated level, that is, explain individual firm behaviour using firm specific characteristics.

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Appendix

Figure 1. Stand-alone and package bids bids in auction A (SEK)

Stand-alone bids Package bids

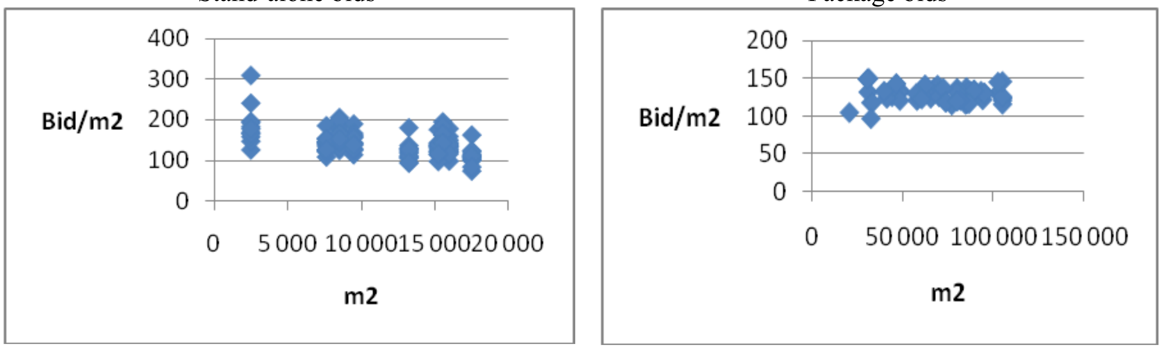

Figure 2. Stand-alone and package bids in auction B (SEK)

Stand-alone bids Package bids

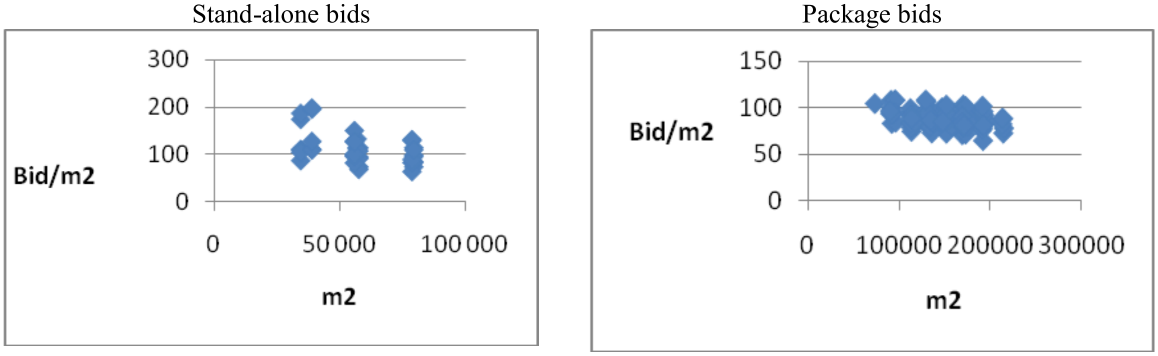

Figure 3. Stand-alone and package bids in auction C (SEK)

Stand-alone bids Package bids

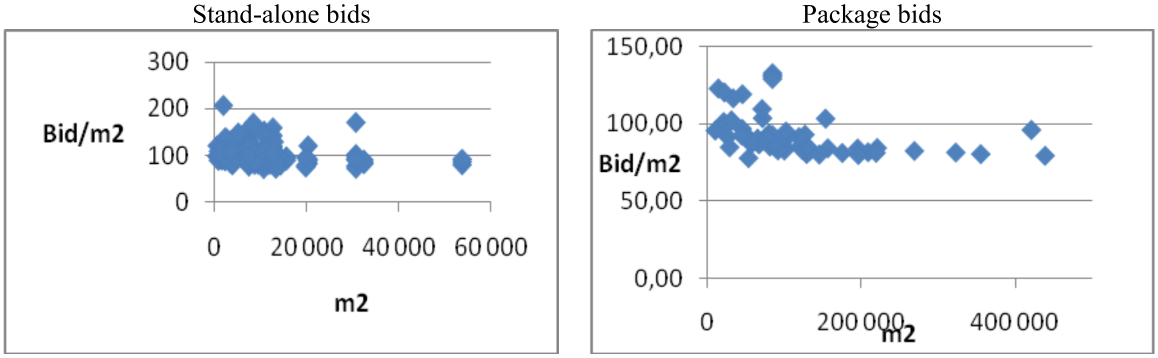

Table A1. Correlation matrix

	Contract	*Comp*	*Format*	*Sqm*	*School*	*Office*
Contract	1.00					
Comp	-0.09	1.00				
Format	-0.27	0.12	1.00			
Sqm	-0.07	-0.04	-0.49	1.00		
School	-0.28	-0.05	0.42	-0.02	1.00	
Office	0.28	-0.12	-0.42	0.02	1.00	1.00

Table A2. Estimation results, test I when the dependent variable is total bid (annual price in SEK) instead of bid per square meter.

	Coefficient	t-value
Format	-154128.30	-5.73
Number of contracts	-1872.84	-7.55
Square meter	80.59	37.28
Comp	3751.34	1.99
School	98096.11	6.01
Constant	137120.00	5.85
N		1188
R^2		0.94