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EFFICIENT DESIGN OF SET-ASIDE AUCTIONS FOR SMALL BUSINESSES: AN EMPIRICAL ANALYSIS

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Efficient design of set-aside auctions for small businesses: an empirical analysis*

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Abstract

Government support to small business enterprises (SBEs) through set-aside (SA) public procurement auctions is a common practice. The effect of the SA mechanism is, however, ambiguous. On the one hand, SA auctions can attract more SBEs to compete; on the other hand, SA auctions restrict the entry of—possibly—more cost-efficient large firms. We investigate SA auctions' effect by exploiting an original Russian database on public procurement e-auctions for granulated sugar (a largely homogeneous good) in the period 2011-2013. To identify the causal effect of SA auctions, we overcome two endogeneity issues: procurers' choice of SA format and firms' decision to bid. In an empirical setting where confounding elements are minimized, we found that SA auctions' effect largely depends on both the reserve price value and the level of competition. We found that there exists an optimal interval for the reserve price where SA auctions record lower procurement prices, as compared to non-SA auctions.

JEL Code: D44; H11; H57.

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1 Introduction

In the aim to foster small businesses' participation in public procurement and increase the related awarding of contracts to such firms, governments very often implement "affirmative action programs".[1] In the United States, the federal government explicitly recommends awarding at least 23 percent of its approximately 500 billion dollars in annual procurement contracts to small businesses [Athey, Coey, and Levin, 2013].[2] In Japan, a similar program has been in place since 2007, with the aim of allocating 50.1 percent of the government's procurement expenditure to small and medium-sized enterprises [Nakabayashi, 2013]. In Russia, an affirmative action program was originally implemented in 2006 and prescribed that each public buyer purchase at least 15% of its annual public procurement value from small business enterprises (SBEs).

Two main methods are usually adopted to implement these preferential programs in public procurement: i) "set-aside auctions", where the public buyer restricts participation in auctions only to targeted firms, and ii) "bid subsidies in auctions", where the public buyer adds a percentage discount to targeted firms' bids, thus making such firms' bids more competitive and awarding the contracts taking into consideration the adjusted bid.[3] In times of tight public budgets, "efficient" public procurement has gained new relevance, and the potential of preferential programs for redistributive aims has even increased. However, empirical analyses of their effects and optimal design are scarce.

This paper contributes to closing the gap and empirically examines an affirmative action program in the form of set-aside (henceforth, SA) auctions, according to which a fraction of public procurement contracts are reserved for SBE bids. Our starting point is the consideration that the efficiency of an SA auction depends on two opposite effects. Indeed, by adopting an SA auction, the public buyer, on the one hand, might bear losses by excluding more cost-efficient large firms; on the other hand, the public buyer may end up with a lower price, and as such, a preferential setting may stimulate SBEs' participation and aggressive bidding, given that SBEs know they are competing with similar firms. To understand which of these effects dominates, we exploit an original dataset of procurement auctions in Russia. This dataset presents two novel and relevant elements. First, our dataset contains the population of procurement auctions for a largely homogeneous good, i.e., granulated sugar. Such homogeneity reduces the confounding effects of unobserved quality, which can arise in estimating SA auctions' effect for differentiated goods/services with varieties of characteristics.[4] Moreover, the homogeneity of the good enables

[1]These programs are usually addressed to small and medium-sized enterprises (SMEs) or only to small businesses enterprises (SBEs). The Russian program—which this paper focuses on—targets the latter. Thus, this paper develops an empirical analysis specifically referring to SBEs and discusses whenever relevant the other studies on SMEs carried out on other governmental programs.

[2]In the US, "affirmative actions" in public procurement are also designed to support businesses owned by women, disabled veterans, and different economically disadvantaged business: typically, such programs have lower quantitative targets as compared to those addressing SMEs, being smaller the number of potential recipients.

[3]A further method supporting the participation of disadvantaged business in public contracts is the "subcontracting quota": this method requires that prime contractors subcontract out a mandatory percentage of the overall value of a project to target firms. For a thoughtful analysis of one such program implemented by the Texas Department of Transportation, see De Silva et al. (2012).

[4]The heterogeneity of procured goods is a shortcoming of empirical studies on SA auctions' effects, as high-

us to exploit the price per unit of procured sugar to measure the efficiency of the auction mechanism, where retail price per unit on the regional market is adopted as the benchmark. Second, our dataset is made up of electronic auctions (henceforth, "e-auctions"), in the form of descending open auctions. Such electronic format of auctions imposes very low entry costs for participants, thus enabling the mitigation of the endogeneity problem related to the firms' decision to enter the auction.

Armed with these unique characteristics of our dataset, we move to the identification of SA auctions' effect. Our empirical strategy overcomes two main endogeneity challenges. First, since public procurers might have different competence, experience and goals,[5] their choice of SA auctions may be endogenously affected. Exploiting both the Russian regulation requirements for annual procurement planning and the richness of our dataset, we overcome this endogeneity problem by introducing joint procurer–year fixed effects. Second, firms' participation in auctions might depend both on the procurer's long-run reputation and/or on short-run requirements imposed by each procurer in each specific tender (e.g., delivery requirements). As a consequence, the number of bidders in each auction could also be endogenous. Following [De Silva et al., 2008] and recalling that electronic auctions record low entry costs, we use the number of applicants to the qualification phase as an instrument for the number of bidders in the auction; in doing so, we argue that the number of applicants may depend on procurers' long-run reputation but is independent of procurers' short-run behavior. Moreover, to further address the endogeneity issue, we allow for the number of bidders to impact the auction outcome nonlinearly. Thus, the standard IV approach is not applicable in our setting, and we opt to use the control function approach.

Our results show that, compared to non-set-aside (henceforth, NSA) auctions, on average, SA auctions record a rebate that is higher by 1.3% and a price per unit (kilo) of sugar that is lower by 1.9%.[6] Moreover, we found severe heterogeneity in SA auctions' effects with respect to an auction's reserve price, i.e., the price the procurer announces and on which bidders offer a rebate. For tenders with a medium reserve price (between 2-5 M RUR), compared to NSA auctions, SA auctions record a rebate that is higher by 1.7% and a price per unit of sugar that is lower by 2.7%. For tenders with a small reserve price (i.e., below 2 M RUR), the SA auctions' effect is ambiguous and depends on number of bidders. For tenders with a large reserve price (i.e., above 5 M RUR), SA auctions, on average, record lower rebates, and the price per unit of sugar is higher by 9.3%. We refer this nonlinearity in the SA auctions' effect on auction outcomes to the nonlinearity in the bidders' costs. Specifically, the supplier's average cost as a function of auction's reserve price follows a different curve for small and large firms, an evidence we gain in our empirical tests.

lighted by Denes [1997], who exploits a database about dredging services. A similar issue arises in Nakabayashi [2013], who investigates data on public construction projects, as well as in Szerman [2012] and Athey et al. [2013], who use data on off-the-shelf goods and timber sales, respectively.

[5]See [Bandiera et al., 2009, Saussier and Tirole, 2015, Best et al., 2017, Bucciol et al., 2017, Decarolis et al., 2018]. Note that procurers' competence/ability, experience and goals may also vary over time.

[6]In the price per unit variable, the percent is calculated with respect to a benchmark, i.e., regional retail price

This paper is related to three strands of the literature. The first one concerns the empirical literature on the efficient design of SA auctions. This literature has yielded mixed results. On the one hand, Athey et al. [2013], investigating SA auctions for the US Forest Service timber sale program, showed that restricting a timber sale to SBEs reduces efficiency on average by 17% and costs the Forest Service about 5% in revenue.[7] On the other hand, participation restrictions for large firms in SA auctions may well incentivize small firms to enter, and the resulting competition will be more aggressive. Using the case of procurement of off-the-shelf goods in Brasilia, Szerman [2012] estimates the SA auctions' effect locally around the reserve price threshold to implement such auctions with entry restriction. He shows that SA auctions are effective in increasing SMEs' participation, and there is no effect on prices per unit for off-the-shell goods. Exploiting the auction of public construction projects in Japan, Nakabayashi [2013] estimates the SA auctions' effect by developing a three-step empirical estimation[8]; then, he presents a simulation analysis showing that—if SA auctions were stopped—about 40% of SMEs would exit the procurement market. Accordingly, Nakabayashi [2013] stresses that the resulting lack of competition would increase government procurement costs more than what it bears by running SA auctions. By exploiting a novel database for procurement contracts where the usual confounding factors are reduced by two key features of the auction—i.e., very low entry cost and a largely homogeneous awarded product—we add to this literature original and clean results on the efficient design of SA auctions. Our results, obtained with a focus on reserve price intervals and competition in auctions, help in qualifying SA auctions' effects.

The second branch of the literature to which we contribute refers to affirmative actions (other than SA auctions). On California Department of Transportation procurement data, Marion [2007] and Krasnokutskaya and Seim [2011] study the bid preference programme and its cost efficiency for procurer. Exploiting variation in eligibility of bid preferences in state-funded and federal-funded projects, Marion [2007] showed that the winning bids in auctions with bid preferences were, on average, higher by 3.8 percent. Investigating only auctions with bid preferences together with structural model of entry and bidding, Krasnokutskaya and Seim [2011] showed that the bid preference programme raises the average cost of procurement by 1.5 percent and it results in redistribution of 5 to 12 percent of profit from large to small firms. In line with these papers, we study the impact of affirmative action (in the form of SA) on final prices. Moreover, Krasnokutskaya and Seim [2011] state that effect of bid preference programme is heterogeneous across types of projects and they left the optimal policy design for different groups of reserve

[7] Athey et al. [2013] design and estimate a model of entry and bidding in auctions; then, they adopt it to simulate revenue and efficiency of "bid subsidies" auctions against SA auctions. Their simulations highlight that providing a bid subsidy to small bidders in all auctions might eliminate both efficiency and revenue losses, while allocating the same volume of timber to SBEs through SA auctions leads to increasing aggregate SBE profits and only slightly reducing profits of larger firms. Note that these authors, recalling the seminal contribution by Myerson [1981] on auction theory, also highlight that such a potential advantage of "bid subsidies" over SA auctions could turn out to be weak at different levels of bidders participation and entry costs.

[8] First, a nonparametric estimation procedure is used to identify bidders' behavior from observed scoring bids. Then, a regression analysis is used to find the quantitative relationship between firm size and ex ante expected payoffs in an auction. Finally, a static entry model is constructed in which the obtained relationship between expected payoffs and firm size is employed to extrapolate the payoffs from entering the procurement markets.

price value as an open and important question (page 2685). We contribute on this point by investigating the reserve price value as the main source of heterogeneity for the affirmative action's impact on cost efficiency.

Finally, we also contribute to a broader strand of the literature analyzing how the price of standardized goods varies in public procurement [Di Tella and Schargrodsky, 2003, Bandiera et al., 2009, Best et al., 2017, Bucciol et al., 2017, Tkachenko et al., 2017]. This literature studies heterogeneity in public buyers' efficiency and its source. In the present analysis we investigate the efficient design of SA auctions by taking into account public buyers' heterogeneity and its dynamics through joint procurer-year fixed effects.

The rest of the paper is organized as follows. Section 2 illustrates the institutional setting to which our empirical analysis refers. Section 3 presents our database and descriptive statistics. Section 4 illustrates the empirical strategy we adopt. Section 5 collects our results, and Section 6 provides a robustness check. Section 7 concludes the paper.

2 Institutional Setting

In 2017, in the Russian Federation (RF), there were 5.7 mln small and medium-sized enterprises (SMEs), employing 19 mln people (25% of working-age population) and contributing 19.9% of the country's GDP. Specifically referring to their size, 95.2% of all SMEs were microenterprises, 4.45% were small enterprises and only 0.33% were medium-sized firms.[9] According to Russian law, microenterprises are defined as firms employing less than 15 workers and with revenue under RUR 120 mln, while small enterprises are firms employing from 16 to 100 workers and with revenue under RUR 800 mln (see Table 1, below). Both micro- and small enterprises fall under the definition of SBEs that we adopt in our analysis.

Table 1: Definition of micro and small firms in Russia

Type of firm	Number of employees	Revenue limit (2013-12.2015)	Revenue limit (since 01.2015)
Micro	Under 15	RUR 60 mln	RUR 120 mln
Small	16 to 100	RUR 400 mln	RUR 800 mln

Note: Information on revenue limits and number of employees are from the Government Decree on 09.02.2013 - N.101 and 13.07.2015 - N.702 "On limits of revenues obtained from sale of goods (works and services) for each category of SMEs".

Given the relevance of micro and small businesses in the Russian economy, in the last decade, the government has increasingly attempted to support them through two main policies, broadly classified as follows: (i) subsidies and subsidized lending provided within dedicated federal programs and supervised by the Ministry of Economic Development and (ii) preferential treatment in public procurement as defined by procurement legislation. The latter policy, which we focus

[9] Unified Register of small and medium-sized enterprises https://rmsp.nalog.ru/index.html

on in this paper, consists in set-aside awarding procedures, i.e., a mandatory quota of public procurement awarded exclusively to SBEs. This policy requires the procurement of a minimum guaranteed purchase from SBEs.

The Federal Procurement Law 94FL (in use from 2006 to 2013, and to which our dataset refers) contains compulsory provisions to support SBEs: accordingly, procurers should secure a minimum of 10% and a maximum of 20% of their annual purchase value via set-aside procedures, i.e., procedures restricted to SBE participation. The same law states that the percentage of public purchases from SBEs can be gained alternatively by using tenders in the form of a first price sealed-bid auction, electronic open auction, scoring rule auction, or request of offers, and that 15 M RUR (about 500 K USD in 2011-2013) is the cap on the awarded contract's reserve price for set-aside procedures. According to this legal framework, the public procurement of granulated sugar can be implemented by adopting open tender in the form of either electronic open auction (e-auction) or sealed-bid auction [10]. Note that according to 94FL, a sealed-bid auction is allowed if the reserve price does not exceed 500 K RUR (about 16.7 K USD), while an e-auction can be used for tenders of any reserve price. In the current paper, the variation in auctions' reserve price is crucial for estimating the heterogeneity in SA auctions' effect. Given that in this framework sealed-bid auctions do not allow for significant reserve price variation due to the 500 K RUR cap, we focus our empirical analysis only on e-auctions, and we describe them in detail in what follows.

In the aim to implement an e-auction, a public procurer should first decide which electronic platform to run the procedure on.[11] In the pre-awarding phase, on the selected platform, the procurer publishes a notification and necessary documentation. The notification contains, in particular, a "reserve price", i.e., the maximum price the procurer is willing to pay. Further selection of a winner is implemented in four stages. In the first stage, after the auction notification is published, interested firms submit their applications via the e-platform. Each application consist of two parts: Part 1 contains a formal agreement to adhere to the contract and technical details of the goods/services to be supplied, and Part 2 contains the applicant's ID (name and unique fiscal code) and qualification documents, which are required to supply the awarded item. In the second stage, the procurer screens Part 1 of each application and admits/rejects the applicant to enter the auction, by controlling the technical details of the applicant's provision with the requirements of the good/service's notification. At this stage, the e-platform does not allow the procurer to know the ID of the applicants. In the third stage, admitted applicants can enter the auction, which occurs on the day/hour shown in the notification. Each e-auction runs as a descending open auction, where the price starts from the reserve price and participants place descending bids, thus offering a "discount" over the reserve price. Bids typically descend

[10] An electronic open auction is a descending English auction conducted online on specialized electronic platforms. A sealed-bid auction is a first price sealed-bid auction, where bids are submitted in sealed envelopes and the bidder offering the lowest price wins the auction.

[11] In the period of analysis in Russia there were five e-platforms for e-auctions. Information about all e-auctions from all e-platforms is collected in the centralized open information system of public procurement: www.zakupki.gov.ru.

by discount from 0.5% to 5% of the reserve price. A new bid should be placed within 10 minutes from the previously placed bid (or of the reserve price if no bids have been placed so far). If within 10 minutes, no new bid is placed, the last bid becomes the winning bid, and the auction ends.

Within 30 minutes of the end of the auction, the e-platform publishes the bidding protocol on the website www.zakupki.gov.ru, containing all the bids submitted, the list of bidders ordered from the lowest to the highest bid, as well as the starting and the ending time of the auction. In the fourth stage, the e-platform forwards Part 2 of each bidder's application to the procurer. Referring to this part, the procurer verifies the qualification of the bidder that has offered the lowest bid, by ensuring that the application meets the requirements imposed in the firm qualification section of the notification. In case of positive evaluation, this bidder is the winner of the auction. If the application of the bidder that has offered the lowest bid does not meet the requirements, the winner is the participant who has offered the closest bid to the lowest one among those who meet the requirements. Finally, the winner signs the contract at the price of his/her bid, and the contract's execution starts.

Note that cases may arise in which an announced e-auction is not followed by a real bidding stage, and, nevertheless, the contract is recorded as awarded in the website www.zakupki.gov.ru. This occurs when i) upon consideration of Part 1, only one firm is admitted to enter the auction, or ii) more than one firm is admitted (in the qualification stage), but then, only one firm enters the bidding stage by posing an offer. In these cases, the contract is then awarded either at the reserve price or at the price of the single bid offered during the bidding stage.[12] In this paper, we define such auctions as "unsuccessful", in contrast with the other cases of "successful" auctions, that is, cases where competition is at work, i.e., more than one bidder enters the auction and bids.

3 Data and descriptive statistics

In this section, we first present our database on granulated sugar; then, we describe our main outcome variables; and, finally, we illustrate descriptive statistics on our data.

Data collection

In the aim to estimate the impact of SA on auction outcomes, we collect the population of all procurement contracts of granulated sugar in Russia during the period 2011-2013. Namely, we make a substring search of the keyword "Sugar"[13] over the population of all public procurement contracts in Russia in the period 2011-2013 and create a sample of contracts where granulated sugar is a procured item by itself or comes along with other procured items. This constitutes the primary sample of our analysis. Granulated sugar is a very popular product bought by

[12] Usually, this single bid makes a minimal discount of 0.5% of the reserve price.

[13] "Сахар" in Russian.

many different public institutions (i.e., schools, hospitals, prison colonies, etc.) at all levels of government (municipal, regional and federal) in Russia. We focus on procurement for granulated sugar because it is a largely homogeneous product, with defined quality and divisible quantity.

Each auction in our dataset is organised either to procure sugar by itself or to procure a basket of goods where sugar has to be awarded along with a set of other goods (i.e., tea, cacao, grains, flour, salt, fruits, vegetables etc.): in what follows, we call such a basket of goods a *bundle*. Looking at the supply side of this market, we observe that it is characterized by medium concentration: the top 4 largest firms record 17% of the total market supply; the rest is covered by more than 4.5 thousand firms, which are mostly SBEs. Moreover, two out of top-4 largest firms are at the same time producers and distributors, while all the SBEs are distributors.

The primary source of information for our database is the Russian official public procurement website: *www.zakupki.gov.ru*. This website collects information on all four stages of the e-auction procurement process (that is, i. the auction announcement, ii. the admission to bid, iii. the awarding stage, and iv. the evaluation of required qualification and the signing of the contract). Accordingly, our database, from the auction announcement, includes information on the bundle's reserve price, timing for submission of application/offer, requirements for applicants, and date/timing of the e-auction procedure. From the admission to bid and the awarding stages, we obtain information on the number of applicants to the e-auction, number of applicants admitted to bid, number of actual bidders and their bids. From the screening of the winner's qualification and contract signing phases, we collect information on the ID of the winner and the start and nominal end dates for contract execution. Moreover, in the case of a contract for a basket of goods, for each item, the winner specifies quantity and price per unit in such a way that i) the quantities of items to be provided match the quantities in the auction's announcement, and ii) items' total price is equal to the winning bid. From this information, we are able to collect quantities and price per unit for each item in the awarded bundle. Referring to sugar, we refer to the *unit final price* as the price per unit (kilo). The detailed description of all available information in our data is presented in Table A1 of the Appendix.

Data cleaning

The primary sample of granulated sugar procurement includes the population of 40995 contracts awarded by public procurers in Russia in the period 2011-2013. From this sample, we exclude 1962 contracts that were procured directly from suppliers without running any type of auction (i.e., so-called single-source contracting). We further exclude auctions that record an unrealistically small or large *unit final price* or present missing essential information on contract characteristics (i.e., quantity of sugar, *unit final price*, number of bidders, etc.); this reduces our sample to 35297 observations. These 35297 observations include 17012 e-auctions (for the amount of 7.665 B RUR, corresponding to 255.5 M USD) and 18285 sealed-bid auctions (for the amount of 2.33 B RUR, corresponding to 77.6 M USD). Given the aim of this paper and the strict rule on the threshold value for sealed-bid auctions (i.e., sealed-bid auctions cannot be run for

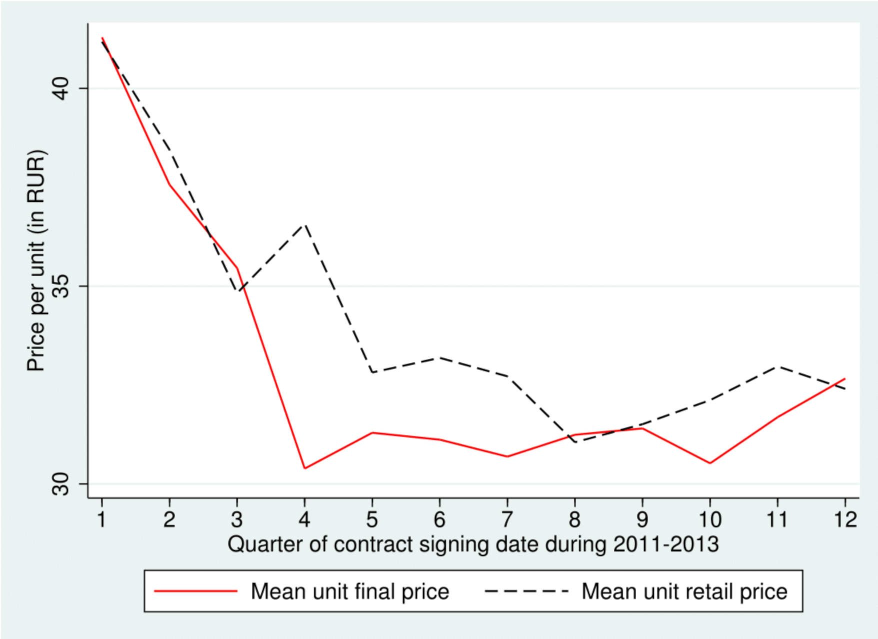

Figure 1: Figure 1: Mean price comparison for sugar prices in Russia, 2012-2013.

values larger than 500 K RUR), for the analysis, we focus only on e-auctions that present much larger heterogeneity in reserve prices than sealed-bid auctions. Accordingly, our final sample for the present analysis consists of 17012 observations of procurement e-auctions.

Trends in sugar prices and descriptive statistics

We also take into account the retail regional market price per unit of sugar, which we call the *unit retail price*. From the Federal State Statistics Service, we collect *unit retail price* on a weekly basis for the period 2011-2013 for each of the 83 Russian regions. The *unit retail price* variable enables us to control for retail market heterogeneity in prices over time and regions. For a homogeneous good such as granulated sugar, a positive difference between the *unit final price* and the *unit retail price* indicates efficiency gains from the competitive auction. Figure 1 illustrates the average (over regions) dynamics of sugar's *unit final price* and *unit retail price* in the period 2011-2013: it shows that the *unit final price* is usually below the *unit retail price*, and their trends are similar.

In our empirical analysis, we adopt the following auction outcomes:

$$Bundle\ rebate = \frac{(bundle\ reserve\ price - bundle\ winning\ bid)}{bundle\ reserve\ price} 100\%,$$

$$Scaled\ unit\ final\ price = \frac{unit\ final\ price}{unit\ retail\ price},$$

where *bundle rebate* is defined similarly to the usual variable *rebate* adopted in the empirical procurement literature for a single good/work/service, and normalization in the *scaled unit final price* is intended to take into account both the seasonal nature of sugar price variation and regional heterogeneity in retail market prices.

Table 2 presents descriptive statistics for our main variables of interest with the breakdown by SA and NSA auctions; for the latter, we also distinguish between auctions above and below the threshold for the reserve price value (below/above 15 M RUR). The average *bundle rebate* is higher in SA auctions (11.31%) than in NSA auctions (10.24%), and the difference is significant at 1%. Considering the *scaled unit final price*, we observe that it is lower for SA auctions (0.95) than for NSA auctions (0.965). Note that NSA auctions are larger in terms of reserve price and quantity of sugar in bundles. In SA auctions, we observe a higher number of applicants and qualified bidders than in NSA auctions, while there is no significant difference in the number of effective bidders.

Table 2: Average values for e-auction characteristics with breakdown by SA and NSA status and threshold

	Set-aside Reserve price <15M RUR	p-value (T-test)	Non Set-aside Reserve price <15M RUR	Non Set-aside Reserve price >15M RUR
Auction outcomes				
Bundle rebate	11.31 % (Obs. 3674)	0.0000	10.24 % (Obs. 10772)	4.42 % (Obs. 903)
Scaled unit final price	0.950 (Obs. 3954)	0.0001	0.965 (Obs. 11589)	1.068 (Obs. 1468)
Competition				
Number of applicants	3.78 (Obs. 3953)	0.0397	3.67 (Obs. 11589)	2.41 (Obs. 1147)
Number of qualified bidders	3.58 (Obs. 3953)	0.0129	3.45 (Obs. 11589)	1.89 (Obs. 1147)
Number of bidders	2.04 (Obs. 3953)	0.1105	2.01 (Obs. 11589)	1.20 (Obs. 1147)
Contract information				
Reserve price (M RUR)	1.27 (Obs. 3954)	0.0000	1.58 (Obs. 11589)	51.00 (Obs. 1126)
Quantity of sugar (ton)	8.45 (Obs. 3954)	0.0000	13.79 (Obs. 11590)	38.86 (Obs. 1468)

In the section that follows, we present our econometric model to investigate SA auction effects. To have comparable characteristics for SA and NSA auctions, we will estimate it excluding e-auctions with a bundle reserve price above the threshold of 15 M RUR.[14] However, below this threshold, the procurer still has discretion in choosing procurement procedures to implement. As explained above, according to Law 94FL, for auctions with a reserve price below 0.5 M RUR, each procurer can choose between a sealed-bid auction and e-auction; differently, for auctions with a reserve price above 0.5 M RUR, only e-auction is allowed. Therefore, to exclude this

[14] Above this threshold, according to Law 94FL, SA is not allowed.

source of potential endogeneity created by procurer choice, as our main sample, we consider only e-auctions with a reserve price of auction between 0.5 and 15 M RUR (9036 observations). All e-auctions with a reserve price below 15 M RUR (15543 observations) are left for the robustness check (see Section 6).

4 Empirical strategy

This section presents our empirical strategy to investigate SA auction effects in public procurement auctions. The first part of the section illustrates our econometric model and discusses related endogeneity issues. The second part describes the control function approach that we adopt to estimate our model.

4.1 Model specification and endogeneity problems

To capture the effect of SA auctions, in what follows, we focus on auction outcome y_{tp}, which refers alternatively to (i) *bundle rebate* and (ii) *scaled unit final price* for sugar (see Section 3 above for their definition). Our econometric model has the following form:

$$y_{tp} = \alpha SA_{tp} + \sum_{i=2}^{4} \beta_i Bidders_{tp}^i + \mathbf{X_{tp}}\gamma + \epsilon_{tp}, \tag{1}$$

where t stands for the auction ID, and p is the procurer ID. The variable SA_{tp} equals 1 if the auction is SA and 0 otherwise. The set of dummy variables $Bidders_{tp}^i$ is defined as

$$Bidders_{tp}^i = \begin{cases} I(\#Bidders_{tp} = 1) \text{ for } i = 1; \\ I(\#Bidders_{tp} = 2) \text{ for } i = 2; \\ I(\#Bidders_{tp} = 3) \text{ for } i = 3; \\ I(\#Bidders_{tp} \geq 4) \text{ for } i = 4, \end{cases} \tag{2}$$

where $\#Bidders_{tp}$ is the number of bidders, and $I(A)$ is the indicator function of the event A. This set of dummy variables allows for a nonlinear impact of the number of bidders on the auction outcome. Such nonlinearity enables us to take into account the decreasing marginal effect of an additional bidder [Klemperer, 2004], and it generalizes the standard linear case.[15] In our data, cases where $\#Bidders_{tp} > 4$ are quite rare[16], so we aggregate them into the same group together with $\#Bidders_{tp} = 4$. The row-vector X_{tp} is a vector of the following exogenous variables: i) contract information (specifically, ln(bundle reserve price), ln(sugar quantity), number of different items in lot, and delivery period); ii) information about timing (quarters) of contract

[15] The nonlinearity of the impact of the number of bidders on auction outcomes will also be especially important for the case of a heterogeneous effect of the number of bidders for different reserve price intervals, which we consider below.

[16] Auctions with $\#Bidders_{tp} > 4$ account for 4.5% of observations

signing and expected delivery; iii)the unit retail price normalized to the average (over Russian regions) unit retail price; and iv) name of the e-platform that runs the auction. The description of variables and their sources are presented in Table A1 of the Appendix.

Our main focus in (1) is on the estimate of the α coefficient. Its interpretation refers to the outcome variable considered. For the *bundle rebate*, the value α shows the average difference in the bundle rebate for SA and NSA auctions. For the *scaled unit final price* the value α shows the average difference in *unit final price* between SA and NSA auctions in percentage with respect to the *unit retail price*.

We now discuss in detail two endogeneity issues arising in our empirical setting, which preclude us from adopting an OLS estimator for (1). The first endogeneity issue concerns the procurer's choice about which auctions to run in the SA format, i.e., SA_{tp}. The Russian Law 94FZ prescribes that each public procurer i) has to award 15% of the monetary value of his/her annual procurements to SBEs and, in this aim, ii) is free to choose which auctions to run in the SA format. To empirically address this procurer choice issue, we use a joint procurer-year fixed effect. This is effective in addressing such endogeneity, as each procurer implements tenders following a purchasing plan that, according to Russian procurement law, should be defined at the beginning of each year. Specifically, such a purchasing plan includes all the auctions the procurer is willing to run in the solar year, their objects and estimated reserve prices, the procedure chosen and the adoption of the SA/NSA format. Thus, once we have controlled in our model for a joint procurer-year fixed effect, we can consider each SA auction to be exogenously determined. Namely, we assume $\epsilon_{tp} = u_{year(t)\&p} + \varepsilon_{tp}$, where $year(t)$ refers to the year of auction date and $u_{year(t)\&p}$ the joint procurer-year fixed effect, so the variable SA_{tp} is uncorrelated with the idiosyncratic error ε_{tp}. Therefore, (1) can be rewritten as

$$y_{tp} = \alpha SA_{tp} + \sum_{i=2}^{4} \beta_i Bidders^i_{tp} + \mathbf{X_{tp}}\gamma + u_{year(t)\&p} + \varepsilon_{tp}. \quad (3)$$

Note that $u_{year(t)\&p}$ controls for procurer p's specific characteristics, which can vary over the years but is invariant within $year(t)$.[17]

The second endogeneity problem concerns the number of bidders entering each auction, i.e., $Bidders^i_{tp}$. In the empirical procurement literature, the *number of bidders* in auctions is usually considered as endogenous and affected by different elements [De Silva et al., 2008, 2009]. On the one hand, each firm's entry decision can depend on the procurer's reputation and behavior in the long run. For example, if procurer A permanently restricts competition in favor of a preferred incumbent firm, or relational contracts are at work, then competitors lose incentives to enter procurer's A forthcoming auctions. We refer to such behavior by a procurer as *procurer long-run behavior*, and it leads to $\mathbf{E}(u_{year(t)\&p}|\#Bidders_{tp}) \neq 0$, i.e., endogeneity of the number of bidders through an unobserved procurer-year fixed effect. On the other hand, each firm's participation

[17] This is relevant, as the procurer's decision on SA auctions is usually made once at the beginning of the year; that is, the procurer decides every year in January which auctions will be organized in the form of SA.

can also depend on the procurer's short-run behavior; i.e., in each auction, a procurer may impose some specific and nonstandard qualification requirements, and in such a manner, the procurer may disqualify some applicants from bidding. Such behavior by a procurer, i.e., *procurer short-run behavior*, implies $\mathbf{E}(\varepsilon_{tp}|\#Bidders_{tp}) \neq 0$. Note also that in equation (3), the dummy variables $Bidders^i_{tp}$ are functions of the variable $\#Bidders_{tp}$ (see (2)). Therefore, variables $Bidders^i_{tp}$ are also endogenous by the same arguments as those for the *number of bidders*. To overcome the endogeneity problem, we need to have an instrument for the *number of bidders* that would satisfy validity and relevance conditions. In what follows, we discuss such an instrument.

In the e-auctions we analyze, there might be difference between *number of bidders* and *number of applicants*. As explained in Section 2 above, e-auctions consist of application and bidding stages. At the former stage, any firm may submit an application that will be evaluated by a commission, which approves or refuses firms' admission to the bidding stage. Only admitted firms are allowed to bid in the descending open auction hosted on the electronic platform. In e-auctions, firms' application to enter the auction is very low cost: this enables us to use *number of applicants*, denoted by $\#Applicants_{tp}$, as a valid instrument for *number of bidders* [De Silva et al., 2008]. Namely, we assume that

$$Cov(\varepsilon_{sp}, \#Applicants_{tp}|u_{year(t)\&p}) = 0 \quad \forall s, t, \tag{4}$$

that is, the *number of applicants* does not correlate with the idiosyncratic error term ε_{tp} of equation (3) after controlling for a procurer-year fixed effect. This assumption implies that a firm's decision to apply for the auction does not correlate with the *procurer's short-run behavior*, i.e., ε_{tp}, given that the *procurer's long-run behavior*, i.e., $u_{year(t)\&p}$, is known to firms. In other words, given the low costs of application in an e-auction, information on the long-run procurer reputation/behavior would be enough to determine the firm's decision to apply in each specific auction. Noteworthy that for our empirical strategy, we allow for having $\mathbf{E}(u_{year(t)\&p}|\#Applicants_{tp}) \neq 0$, i.e., firms' decision to apply may be correlated with long-run procurer reputation/behavior. As we will show in estimation procedure, the assumption (4) is sufficient for *number of applicants* to be the valid instrument. The *number of applicants* is a relevant instrument for *number of bidders* as well. Indeed, for our sample, $Corr(\#Bidders_{tp}, \#Applicants_{tp}) = 0.62$.

Since we have three endogenous variables $Bidders^i_{tp}$ $(i = 2, 3, 4)$ in (3) and we introduce only one instrument $\#Applicants_{tp}$, the standard IV approach is not applicable. Differently, we can use the control function approach, as the variables $Bidders^i_{tp}$ $(i = 2, 3, 4)$ are functions of the variable $\#Bidders_{tp}$ (see e.g. [Wooldridge, 2015]).

4.2 Estimation procedure

We adopt a control function approach and proceed with an estimation procedure in two stages. In the first stage, we model *Number of bidders* as a linear function of *Number of applicants* with procurer-year fixed effects:

$$\#Bidders_{tp} = \kappa SA_{tp} + \lambda \#Applicants_{tp} + \mathbf{X_{tp}}\mu + \nu_{year(t)\&p} + e_{tp}. \qquad (5)$$

Since the number of procurers in the years covered by our dataset is large,[18] we estimate model (5) by exploiting within-transformation for each procurer-year group. Within-transformation implies, for each variable (dependent and controls), subtracting its average value by procurer-year group. This transformation enables to exclude the $\nu_{year(t)\&p}$ fixed effect and all other variables that do not vary within procurer-year group. The transformed model is then estimated by OLS. The idiosyncratic residuals are calculated as follows:

$$\hat{e}_{tp} = \#Bidders_{tp} - \hat{\kappa} SA_{tp} - \hat{\lambda}\#Applicants_{tp} - \mathbf{X_{tp}}\hat{\mu} - \hat{\nu}_{year(t)\&p}, \text{ where}$$

$$\hat{\nu}_{year(t)\&p} = \#\overline{Bidders}_{tp} - \hat{\kappa}\overline{SA}_{tp} - \hat{\lambda}\#\overline{Applicants}_{tp} - \overline{\mathbf{X}}_{\mathbf{tp}}\hat{\mu},$$

and variables with a bar sign on top are for the average value by procurer-year.

At the second stage, we substitute the idiosyncratic residuals into the main equation (3) as one of the regressors, so we obtain the following equation:

$$y_{tp} = \alpha SA_{tp} + \sum_{i=2}^{4} \beta_i Bidders^i_{tp} + \mathbf{X_{tp}}\gamma + \rho\hat{e}_{tp} + u_{year(t)\&p} + \tilde{\varepsilon}_{tp}. \qquad (6)$$

We estimate it through within-transformation by OLS with heteroscedasticity-robust corrections on variances of estimators. All in all, if model (3) is correctly specified and validity assumption (4) holds, then the estimate α from equation (6) is unbiased and consistent [Wooldridge, 2015].

5 Estimation results

With the aim of assessing the effects of SA as compared to NSA in e-auctions, in this section, we describe our empirical results in three steps. In the first one, we illustrate the SA auctions' average effect on our outcome variables (i.e., *Bundle rebate* and *Scaled unit final price*), assuming such SA auction effects to be homogeneous over different reserve price values. Then, we present SA auction effects as related to different intervals of auctions' reserve price values. Finally, we discuss the SA auction effects along with both reserve price value and number of bidders in each auction.

In considering the average effect of SA auctions, we apply the empirical strategy described in Section 4 to the sample of e-auctions with a reserve price value between 0.5 and 15 M RUR. Our results from the model estimation are presented in Table 3. We can observe that in SA auctions, on average, *Bundle rebate* is 1.32 % higher—leading to lower awarding bundle prices—than in NSA auctions (Table 3, Column 1). Moreover, in SA auctions, on average, *Scaled unit final price*

[18] There are more than 2100 procurer-year groups for the main sample.

is 1.9 % lower than in NSA auctions (Table 3, Column 5). Both of these effects are significant at the 1 % level. These results show that, under the assumption of homogeneity of SA auction effects over reserve price value, SA auctions, on average, determine more efficient outcomes, in terms of final prices, than NSA auctions.

In the literature on empirical public procurement, an auction's reserve price is usually adopted as a proxy for awarded contract size, and it is used to control for scale and related effects [Porter and Zona, 1993, Hong and Shum, 2002, Jofre-Bonet and Pesendorfer, 2003, Krasnokutskaya and Seim, 2011, Bajari et al., 2014, Coviello et al., 2018].

In our setting, reserve price is *per se* a determinant of non-SBE participation in auctions: accordingly, the restriction by SA auctions could produce different effects for different reserve price values. Following [Athey et al., 2013], we split our sample of auctions into three intervals by reserve price value[19]:

1. 0.5 - 2 M RUR ($\approx$ 17 - 67 K USD);
2. 2 - 5 M RUR ($\approx$ 67 - 167 K USD);
3. 5 - 15 M RUR ($\approx$ 167 - 500 K USD).

In Tables A2-A4 of the Appendix, we present, for each reserve price interval, the descriptive statistics for the dependent and main independent variables. Then, we replicate our empirical strategy separately for each interval defined above.

Our empirical results are summarized in Table 3 (Columns 2-4 and 6-8). Columns 2 and 6 show that there is no significant difference in *Bundle rebate* and *Scaled unit final price* between SA and NSA auctions for small-value auctions; i.e., when the bundle's reserve price falls within $0.5 - 2$ M RUR. For medium-value auctions, i.e., when the bundle's reserve price is within $2 - 5$ M RUR, SA significantly affects auction outcomes (Columns 3 and 7): in SA auctions, *Bundle rebate* is 1.66% higher, and *Scaled unit final price* is 2.7% lower, than in NSA auctions. Differently, for large-value auctions, i.e., when the bundle's reserve price is within $5 - 15$ M RUR, SA auctions are significantly less efficient than NSA auctions (Columns 4 and 8). Specifically, in SA auctions, *Bundle rebate* is 6% lower, and *Scaled unit final price* is 9.3% higher, than in NSA auctions.[20] We explain this nonlinearity in the SA auctions' effect on auction outcomes with the nonlinearity in the bidders' total average costs: for auctions of small size, where fixed costs take a large portion, small firms are more efficient because their fixed costs are lower compared to large firms. Differently, for auctions of large size, where total variable costs dominates fixed costs, economy of scales make large firms more efficient compared to small ones. This argument is supported by Table A5 of Appendix, showing that probability of small firm to win in NSA auctions decreases with reserve price interval.

[19]Note that, in the robustness check in Section 6, we run the estimations of our model with manipulations on these thresholds.

[20]While the coefficient of *Scaled unit final price* for large-value auctions is statistically significant only at the 10% level (Table 3 Column 8), its magnitude is large.

By running a back-of-envelope assessment of the gains and losses for medium- and large-valued auctions, we obtain the following evidence: implementing SA auctions in the interval 2-5 M RUR gives savings of 48.8 K RUR (1.6 K USD) per contract (i.e., bundle) and of 22.5 K RUR (0.75 K USD) in terms of procured sugar; differently, implementing SA auctions in the interval 5-15 M RUR leads to losses of 447.7 K RUR (14.9 K USD) per contract and of 58.9 K RUR (1.9 K USD) in terms of procured sugar.[21]

[21]The amounts of savings and losses were calculated in the following ways. Savings per contract: 0.0166 (Table 3 Column 3) times Average reserve price in interval 2-5 M RUR (Table A3); Losses per contract: 0.0610 (Table 3 Column 4) times Average reserve price in interval 5-15 M RUR (Table A4); Savings only for sugar: 0.027 times Average regional price per kilo times Average quantity of sugar(kilo); and Losses only for sugar: 0.093 times Average regional price per kilo times Total quantity of sugar(kilo). In all the calculations, the first multiplier is the coefficient of SA auctions of Table 3 in the corresponding intervals: 2-5 M RUR (Columns 3 and 7) and 5-15 M RUR (Columns 4 and 8).

Table 3: Results of estimation for the main sample and for sub-samples with breakdown by reserve price

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Bundle rebate				Scaled unit final price			
Reserve price (M RUR)[(a)]	0.5-15	0.5-2	2-5	5-15	0.5-15	0.5-2	2-5	5-15
SA auction	1.32***	-0.15	1.66***	-6.10***	-0.019***	-0.0045	-0.027***	0.093*
	(0.32)	(0.50)	(0.32)	(1.93)	(0.0052)	(0.0071)	(0.0077)	(0.052)
# Bidders = 2	12.5***	12.2***	16.7***	-0.47	-0.083***	-0.084***	-0.089***	0.036
	(0.38)	(0.45)	(0.99)	(2.12)	(0.0066)	(0.0080)	(0.013)	(0.035)
# Bidders = 3	16.1***	16.3***	22.2***	-5.15	-0.10***	-0.14***	-0.10***	0.16**
	(0.52)	(0.69)	(1.12)	(7.32)	(0.0089)	(0.011)	(0.017)	(0.076)
# Bidders $\geqslant$ 4	19.4***	17.6***	24.6***	14.1	-0.16***	-0.19***	-0.15***	-0.043
	(0.75)	(1.00)	(1.59)	(8.77)	(0.012)	(0.015)	(0.020)	(0.13)
Log quantity	-1.14***	-0.73*	-0.87	-0.21	-0.038***	-0.034***	-0.015	-0.047***
	(0.30)	(0.38)	(0.67)	(1.03)	(0.0071)	(0.0056)	(0.018)	(0.016)
Log reserve price	0.92**	1.24*	4.38***	-3.72	0.023***	0.033***	-0.032	0.48**
	(0.39)	(0.65)	(1.05)	(7.35)	(0.0082)	(0.011)	(0.028)	(0.19)
Normalized price	6.48	21.6***	-13.1	-92.5**	-0.81***	-0.93***	-0.24	-0.81**
	(5.27)	(6.53)	(8.26)	(37.4)	(0.089)	(0.11)	(0.16)	(0.39)
Delivery period	0.0011	-0.0020	0.00082	-0.020***	0.00014***	-0.000037	0.00021***	0.00027***
	(0.0013)	(0.0016)	(0.0020)	(0.0052)	(0.000025)	(0.000025)	(0.000072)	(0.000087)
Stage 1 residual	-0.014	-0.63*	0.12	6.45*	0.0055	0.029***	-0.017***	-0.15***
	(0.24)	(0.35)	(0.45)	(3.64)	(0.0038)	(0.0056)	(0.0053)	(0.034)
Observations	7,083	4,130	1,800	951	7,647	4,438	1,966	1,012
R-squared	0.449	0.484	0.686	0.774	0.191	0.219	0.220	0.745
# of procurer-year FE	666	442	144	45	729	485	156	50
Singleton groups[(b)]	1316	990	450	78	1389	1024	482	114

*** p<0.01, ** p<0.05, * p<0.10

Note: the table reports estimates (robust standard errors in parentheses) from linear model (1). The dependent variables are *Bundle rebate* (columns 1-4) and *Scale unit final price* (columns 5-8). Columns 1 and 5, Columns 2 and 6, Columns 3 and 7, Columns 4 and 8, report results for the sample referring - respectively - to intervals of reserve price between 0.5-15 M RUR ; 0.5-2 M RUR; 2-5 M RUR; and 5-15 M RUR. Explanatory variable *SA auction* equals 1 if auction is set-aside and 0 otherwise. The variable *Stage 1 residual* refers to the residuals from the first stage regression as equations (5) and (6) describe. Other control variables are: number of bidders (set of dummy variables as (2) describes), logarithm of the quantity of sugar in a contract, logarithm of the bundle reserve price, normalized unit retail price, delivery period, number of different products in contract, quarter of contract signing, quarter of contract delivery, e-platforms for procurement.

(a) Reserve price indicates an interval of contracts reserve price specified in millions of RUR, e.g. 0.5-15 means interval between 0.5 and 15 M RUR.

(b) Row *Singleton groups* shows the number of procurer-year groups with only one auction in it. These observations were automatically excluded from regressions by the within transformation.

Finally, we allow for the SA auction effect to vary over both reserve price and number of bidders in the auctions. Indeed, by construction, SA auctions affects SBE participation decision [Szerman, 2012, Athey et al., 2013, Nakabayashi, 2013]; moreover, SA auctions can also impact SBE behavior (i.e., aggressiveness) in bidding. Table 4 presents the distribution of auctions in our sample across SA and NSA status, reserve price intervals and number of bidders.

Table 4: Breakdown of SA and NSA auctions by number of bidders and reserve price intervals

	Reserve price intervals (M RUR)					
	0.5 - 2		2 - 5		5 - 15	
	NSA	SA	NSA	SA	NSA	SA
# Bidders = 1	1695	416	748	163	260	120
# Bidders = 2	1201	356	397	152	432	3
# Bidders = 3	921	183	411	205	82	115
# Bidders $\geqslant$ 4	520	170	316	56	109	5

With the aim of taking into account the possible heterogeneity of the SA auction effect over the number of bidders, we extend the basic model (3) to a more flexible form:

$$y_{tp} = \sum_{i=1}^{4} \alpha_i SA_{tp} Bidders^i_{tp} + \sum_{i=2}^{4} \beta_i Bidders^i_{tp} + \mathbf{X_{tp}}\gamma + u_{year(t)\&p} + \varepsilon_{tp}, \tag{7}$$

Here, the coefficient α_i measures the average difference in outcome variable between SA and NSA auctions, given that the *number of bidders* equals i (or the *number of bidders* ≥ 4 for $i = 4$). That is, for a fixed number of bidders in the auctions, the coefficient α_i can be interpreted as recording the difference in aggressiveness of bidding in SA, as compared to NSA, auctions. We estimate the model (7) by using the control function approach for each interval of reserve price value, as explained in Section 4 above on empirical strategy.

The results of the estimation are presented in Table 5. Columns 1 and 4 show the results for small-valued auctions (0.5-2 M RUR). We observe that the SA effect varies depending on the number of bidders. If an auction is unsuccessful (i.e., only one bidder) or it is highly competitive (there are at least four bidders in the auction), then the SA auctions leads to a negative effect, i.e., a lower *Bundle rebate* and a higher *Scaled unit final price* for SA compared to NSA auctions. In this interval of reserve price value, if the number of bidders in the auction equals to two or three, then the SA auction yields higher efficiency as compared to NSA auctions. In particular, the SA auction effect is at the maximum for a number of bidders equal to two: *Bundle rebate* is 7.52 % higher and *Scaled unit final price* is 8.2 % lower for SA auctions compared to NSA ones.

Columns 2 and 5 (Table 5) show our findings for medium-valued auctions (2-5 M RUR): in this interval, for any level of competition, the SA auction effect is either positive or neutral, i.e., for SA auctions, the outcomes are either better or insignificantly different from those of NSA auctions. This means that, for a medium-valued auction, SA weakly dominates NSA auctions in terms of auction outcomes.

Columns 3 and 6 (Table 5) show the results for large-valued auctions (5-15 M RUR): we observe that SA auctions are weakly dominated by NSA ones in terms of outcomes. For this interval of the reserve price value, in SA auctions, the *Bundle rebate* is lower and *Scaled unit final price* is higher compared to NSA auctions. Despite the statistical insignificance of SA coefficients for *Scaled unit final price*, their magnitude is high. In this setting, and for any level of competition, SA auctions lead to more economic losses for the procurer as compared to NSA auctions.

Table 5: Set-Aside effect for different levels of competition with breakdown by the reserve price

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Bundle rebate			Scaled unit final price		
Reserve price	0.5-2	2-5	5-15	0.5-2	2-5	5-15
SA & # bidders = 1	-2.74***	-0.58	-8.09**	0.031***	-0.054**	0.089
	(0.74)	(0.84)	(3.17)	(0.011)	(0.023)	(0.068)
SA & # bidders = 2	7.52***	1.18		-0.082***	-0.043*	
	(1.22)	(1.33)		(0.018)	(0.026)	
SA & # bidders = 3	3.38***	2.10***	-5.13**	-0.024*	-0.018***	0.095
	(1.07)	(0.38)	(2.39)	(0.014)	(0.0059)	(0.061)
SA & # bidders ⩾ 4	-3.68***	3.62***		0.0049	0.0062	
	(0.56)	(1.27)		(0.012)	(0.024)	
# Bidders = 2	11.1***	16.0***	-0.90	-0.071***	-0.095***	0.035
	(0.44)	(1.08)	(2.10)	(0.0078)	(0.015)	(0.034)
# Bidders = 3	15.1***	21.3***	-6.06	-0.13***	-0.11***	0.16*
	(0.66)	(1.19)	(7.40)	(0.011)	(0.020)	(0.086)
# Bidders ⩾ 4	17.7***	23.1***	12.7	-0.18***	-0.17***	-0.047
	(0.96)	(1.97)	(8.96)	(0.015)	(0.028)	(0.15)
Log quantity	-1.02***	-0.71	-0.67	-0.032***	-0.014	-0.048**
	(0.37)	(0.65)	(1.39)	(0.0056)	(0.018)	(0.023)
Log reserve price	1.01	4.77***	-3.96	0.033***	-0.026	0.48**
	(0.65)	(1.03)	(7.50)	(0.011)	(0.030)	(0.19)
Normalized price	22.9***	-16.4*	-88.9**	-0.93***	-0.26	-0.80**
	(6.48)	(8.35)	(38.0)	(0.11)	(0.16)	(0.40)
Delivery period	-0.0016	0.0017	-0.019***	-0.000035	0.00022***	0.00027***
	(0.0016)	(0.0020)	(0.0056)	(0.000025)	(0.000078)	(0.000100)
Stage 1 residual	-0.37	0.34	6.64*	0.027***	-0.014**	-0.15***
	(0.34)	(0.49)	(3.74)	(0.0057)	(0.0062)	(0.034)
Observations	4,130	1,800	951	4,438	1,966	1,012
R-squared	0.516	0.689	0.775	0.233	0.224	0.745
# of procurer-year FE	442	144	45	485	156	50
Singleton groups	990	450	78	1024	482	114

*** p<0.01, ** p<0.05, * p<0.10

Note: see note in Table 3 for description of control variables that are used in this table.

Table 6: Set-Aside effect for only SBEs as winners

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES		Bundle rebate			Scaled unit final price	
Reserve price	0.5-2	2-5	5-15	0.5-2	2-5	5-15
SA & # bidders = 1	-2.66***	-0.98	-20.9***	0.017	-0.061**	0.41***
	(0.78)	(0.86)	(2.30)	(0.011)	(0.024)	(0.043)
SA & # bidders = 2	8.37***	1.08		-0.092***	-0.048*	
	(1.36)	(1.31)		(0.020)	(0.026)	
SA & # bidders = 3	4.01***	1.93***	-13.5***	-0.035**	-0.018***	0.29***
	(1.06)	(0.38)	(2.99)	(0.014)	(0.0061)	(0.050)
SA & # bidders $\geqslant$ 4	-3.13***	4.70***		-0.00076	0.0016	
	(0.56)	(1.27)		(0.012)	(0.024)	
# Bidders = 2	10.9***	15.7***	-0.78	-0.088***	-0.10***	0.11***
	(0.47)	(1.19)	(1.32)	(0.0073)	(0.016)	(0.021)
# Bidders = 3	14.5***	21.0***	-9.15	-0.14***	-0.12***	0.44***
	(0.69)	(1.24)	(5.81)	(0.011)	(0.022)	(0.079)
# Bidders $\geqslant$ 4	16.6***	22.3***	20.7**	-0.19***	-0.18***	0.13
	(1.03)	(2.04)	(9.48)	(0.016)	(0.030)	(0.11)
Log quantity	-1.43***	-0.45	1.51	-0.025***	-0.018	-0.030*
	(0.35)	(0.66)	(1.55)	(0.0054)	(0.020)	(0.017)
Log reserve price	1.70***	4.70***	-70.5***	0.016	-0.028	1.79***
	(0.63)	(1.07)	(13.0)	(0.011)	(0.032)	(0.19)
Normalized price	22.6***	-23.4***	-9.57	-1.03***	-0.18	-0.64
	(6.80)	(8.68)	(39.1)	(0.12)	(0.17)	(0.50)
Delivery period	-0.0027	0.0011	-0.0016	5.5e-07	0.00022***	0.00014*
	(0.0017)	(0.0021)	(0.0052)	(0.000026)	(0.000079)	(0.000081)
Stage 1 residual	-0.17	0.50	0.17	0.028***	-0.0098	-0.10***
	(0.38)	(0.51)	(2.83)	(0.0061)	(0.0065)	(0.036)
Observations	3,727	1,727	776	4,011	1,884	786
R-squared	0.524	0.710	0.841	0.258	0.246	0.604
# of procurer-year FE	348	120	36	384	130	41
Singleton groups	888	341	61	917	355	97

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Note: see note in Table 3 for description of control variables that are used in this table.

Table 7: Set-Aside effect with perturbation of reserve price intervals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Bundle rebate				Scaled unit final price			
Reserve price[(a)]	0-2	0.5-1.5	1.5-4.5	4.5-15	0-2	0.5-1.5	1.5-4.5	4.5-15
SA & # bidders = 1	-0.73**	-1.94**	1.19	-17.6***	-0.013*	0.038***	-0.035	0.16**
	(0.32)	(0.78)	(1.00)	(4.06)	(0.0077)	(0.012)	(0.021)	(0.066)
SA & # bidders = 2	1.40***	5.76***	4.54**	-3.05	-0.022***	-0.039**	-0.0092	0.11*
	(0.48)	(1.31)	(1.81)	(3.74)	(0.0064)	(0.019)	(0.031)	(0.064)
SA & # bidders = 3	2.96***	2.13	2.15***	-3.90	-0.011	-0.0062	-0.021***	0.055
	(0.59)	(1.40)	(0.40)	(3.34)	(0.0079)	(0.017)	(0.0072)	(0.038)
SA & # bidders ⩾ 4	-1.23**	-3.07***	1.56		-0.0032	0.017	0.041	
	(0.53)	(0.65)	(1.50)		(0.0086)	(0.014)	(0.029)	
Observations	8,911	3,408	2,265	1,192	9,662	3,683	2,453	1,253
R-squared	0.483	0.521	0.598	0.778	0.219	0.236	0.241	0.728
Reserve price		0.5-1.75	1.75-4.75	4.75-15		0.5-1.75	1.75-4.75	4.75-15
SA & # bidders = 1		-2.64***	-0.45	-16.2***		0.036***	-0.026	0.14**
		(0.80)	(0.97)	(2.87)		(0.012)	(0.024)	(0.059)
SA & # bidders = 2		8.47***	0.25	-1.42		-0.096***	0.021	0.11*
		(1.17)	(1.83)	(3.83)		(0.018)	(0.035)	(0.062)
SA & # bidders = 3		3.73***	2.34***	-3.14		-0.026*	-0.018**	0.044
		(1.08)	(0.39)	(2.81)		(0.014)	(0.0078)	(0.035)
SA & # bidders ⩾ 4		-3.74***	3.64***			0.010	0.018	
		(0.55)	(1.24)			(0.012)	(0.029)	
Observations		3,793	2,074	995		4,086	2,245	1,056
R-squared		0.521	0.601	0.841		0.278	0.240	0.740
Reserve price[(b)]		0.5-2	2-5	5-15		0.5-2	2-5	5-15
SA & # bidders = 1		-2.74***	-0.58	-8.09**		0.031***	-0.054**	0.089
		(0.74)	(0.84)	(3.17)		(0.011)	(0.023)	(0.068)
SA & # bidders = 2		7.52***	1.18			-0.082***	-0.043*	
		(1.22)	(1.33)			(0.018)	(0.026)	
SA & # bidders = 3		3.38***	2.10***	-5.13**		-0.024*	-0.018***	0.095
		(1.07)	(0.38)	(2.39)		(0.014)	(0.0059)	(0.061)
SA & # bidders ⩾ 4		-3.68***	3.62***			0.0049	0.0062	
		(0.56)	(1.27)			(0.012)	(0.024)	
Observations		4,130	1,800	951		4,438	1,966	1,012
R-squared		0.516	0.689	0.775		0.233	0.224	0.745
Reserve price		0.5-2.25	2.25-5.25	5.25-15		0.5-2.25	2.25-5.25	5.25-15
SA & # bidders = 1		-2.51***	-1.02	-7.35*		0.022*	-0.067**	0.12
		(0.73)	(0.79)	(4.44)		(0.012)	(0.026)	(0.078)
SA & # bidders = 2		5.41***	3.43**			-0.053***	-0.055*	
		(1.30)	(1.36)			(0.019)	(0.028)	
SA & # bidders = 3		3.74***	3.30***	-4.61		-0.028**	-0.021***	0.041
		(1.07)	(0.39)	(3.85)		(0.014)	(0.0061)	(0.043)
SA & # bidders ⩾ 4		-3.38***	5.71***			-0.00055	-0.024	
		(0.59)	(1.62)			(0.012)	(0.024)	
Observations		4,348	1,634	904		4,715	1,745	963
R-squared		0.498	0.757	0.686		0.240	0.297	0.739

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Note: see note in Table 3 for description of control variables that are used in this table.
(a) Reserve price indicates an interval of contracts reserve price specified in millions of RUR, e.g. 0-2 means interval between 0 and 2 M RUR.
(b) The third block shows the results from Table 5 for convenient comparison.

6 Robustness checks

In this section, we check the robustness of our results by estimating them on samples that are different from those adopted in the previous sections. First, from the NSA auction sample, we exclude those auctions where medium or large firms win: in this way, we end up highlighting the SA auction effect by comparing SA and NSA auctions in which only small firms were winners, and thus, we reduce asymmetry among bidders. Table 6 presents the results of the estimation of model (7)—the most flexible model specification. The results in Table 6 are similar to those in Table 5. Namely, for small-valued auctions, SA auctions can be both better and worse than NSA auctions depending on the number of bidders; for medium-valued auctions, SA auctions weakly dominate NSA auctions; and for large-valued auctions, SA auctions are dominated by NSA ones. The last two results show even more prominent effects compared to those presented in Table 5.

Second, we re-estimate model (7) by considering all the e-auctions with a reserve price below 2 M RUR, rather than the interval 0.5-2 M RUR. The results are presented in Table 7 (Columns 1 and 5). The results for *Bundle rebate* are similar to the results of Table 5 (Column 1), i.e., the SA auction effect depends on number of bidders. The results for *Scaled unit final price* shows that SA auctions are either more efficient or similar to NSA ones. Both these results do not contradict our main finding that for small-valued auctions, SA might be efficient, and highlight that its efficiency depends on number of bidders.

Third, we manipulate the intervals of the reserve price values to define the group of small-, medium- and large-value auctions. We vary these intervals around the main threshold pair 2 and 5 M RUR in both directions. Namely, we consider three other threshold pairs: 1.5 and 4.5 M RUR, 1.75 and 4.75 M RUR, and 2.25 and 5.25 M RUR. For these new intervals, we estimate model (7). For compactness, Table 7 presents estimates only for interacted variables $SA_{tp}Bidders^{i}_{tp}$, $(i = \overline{1,4})$ for each of the threshold pairs in the block.[22] Comparing the results for each column (Columns 2-4 and 6-8) over blocks of threshold pairs, we can observe some variation in terms of significance of coefficients. However, there are no controversial findings. Namely, there are no blocks that include significant coefficients for the same variable, but with different signs. Therefore, this evidence implies that even if the definition of intervals for medium- and large-valued auctions around main threshold pair 2 and 5 M RUR is changed, the efficiency of SA in medium-valued auctions and inefficiency of SA in large-valued auctions remain largely confirmed.

[22]We also include the basic threshold pair 2 and 5 M RUR from Table 5 for convenience of comparison.

7 Conclusion

In this paper, we have investigated the effects of affirmative action in the form of set-aside (SA) auctions for small business enterprises (SBEs) in Russia—a governmental policy aiming to support the entry of SBEs in public procurement tenders. We exploit a large and original database consisting of the population of procurement contracts for granulated sugar in Russia in the period 2011-2013.

In an empirical auction setting in which suppliers' entry costs are minimized (through an electronic auction format) and the quality of the procured item is not an issue (i.e., granulated sugar, a largely homogeneous good), we estimate the efficiency of SA auctions as compared to NSA ones, focusing on both reserve price value intervals and competitiveness (number of bidders). The homogeneity of the good enables us to use price per unit of good as an efficiency measure on top of the standard procurement performance measure, price rebate. The richness of the data enables us to overcome two endogeneity issues that are directly related to the research question: procurers' choice of contracts to be awarded through SA auctions and firms' entry decision.

Our empirical results show that there exists an optimal interval for reserve price value of a medium size (i.e., 2-5 M RUR), where SA auctions are more efficient compared to non-set-aside (NSA) auctions. Moreover, inside this interval and for any level of competition, under the SA format, firms appear not to bid less aggressively than under the NSA one. We also highlight that there exists a nonoptimal interval for the reserve price of a large size (i.e., 5-15 M RUR), where SA auctions are less efficient compared to NSA ones for any level of competition. Finally, we found that for auctions with a small reserve price value (i.e., 0.5-2 M RUR), the efficiency of SA auctions compared to NSA ones largely depends on number of bidders. By running a back-of-envelope assessment of the gains and losses for medium- and large-valued auctions, we obtain evidence that implementing SA auctions in the interval 2-5 M RUR gives a savings of 48.8 K RUR (1.6 K USD) per contract (i.e., bundle) and of 22.5 K RUR (0.75 K USD) in terms of procured sugar, while implementing SA auctions in the interval 5-15 M RUR leads to losses of 447.7 K RUR (14.9 K USD) per contract and of 58.9 K RUR (1.9 K USD) in terms of procured sugar.

These findings highlight direct policy implications for procurers' design of efficient SA auctions in the market for granulated sugar. First, since the procurer has discretion to decide the SA format for each auction, our results suggest that procurer should jointly consider adopting SA format along with the auction's reserve price value. In our study, for auctions of medium-size, the SA format provides efficient results as compared to NSA one. Second, in the case of small-size auctions, a crucial role in determining the efficiency of an SA auction is played by the number of bidders: accordingly, in designing SA auctions with a low reserve price, the procurer should also assess the potential level of competition, for example, referring to his/her past experience with similar auctions.

Furthermore, with the aim of providing policy implications for sectors other than the granulated sugar sector, one should start from the consideration that the interval of reserve prices, where SA format leads to efficient awarding prices can be affected/determined by features of the goods/services to be procured and of the related market regulation. In this light, our investigation suggests that procurers or regulator run a preliminary study before implementing such an affirmative action. In particular, this study should help in designing efficient SA auctions by highlighting elements such as market concentration, number of local SBEs, effective and potential competition, and barriers to entry, as well as goods/services characteristics and related regulations before implementing SA auctions. Finally, as competition also plays a relevant role in efficient SA auctions, procurement regulators should consider training policies aiming to incentivize SBE participation in procurement and, specifically, in combination with preferential policies such as SA auctions [De Silva et al., 2017].

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8 Appendix

A further general criterion adopted in the definition of SMEs in Russia refers to their capital share: an SME cannot have more than 25% of its capital owned by the state and/or not more than 49% of its capital owned by foreign organizations or by non-SMEs. According to this criterion, in 2013, 88% of all SMEs in the RF were microcompanies, 11,3% were small firms and 0,66% were medium firms. [23]

Given SMEs' relevance in the RF's economy, state policies to foster SMEs' activities have been implemented since the passing of federal law N.209-FZ dated 06.07.2007 "On the development of small and medium enterprises in the Russian Federation", representing the first legal regulation in the RF on SME support: it contains the definition of SMEs, a reference framework about their activities and a number of regulations governing the provision of financial and organizational support to SMEs. The state program to support SMEs through funding was operative from then until 2015, expanding until that year in financial amount and number of regions participating. In 2015, the volume of financing programs to support SMEs (regional subsidies) accounted for 18.5 bln rubles, and the program involved 85 regions of the RF.

Then, in 2016—following a change in the 2015 regulations on regional subsidies distribution—funding through programs supporting SMEs was reduced to 12,2 bln rubles, and a new strategy[24] for SME development for the period 2015-2030 has been developed with the aim of fostering innovation and improving economic and social development, ensuring a stable high level of employment. This new strategy aims to achieve a 2,5 times increase in SME turnover by 2030 (from RUR 41.8 bln in 2014 up to RUR 104.7 bln), doubling the share of SMEs in the country's GDP from 20% to 40% and almost doubling the share of manufactured goods in the total SME turnover from 11.8% to 20%. Accordingly, this would determine an increase in employees in SMEs, from 18 mln people in 2014 to 25 mln in 2030, corresponding to a change from 25% to 30% of total employment.

[23] Source: Federal State Statistic Service (2014) Small and medium enterprises in Russia 2014: statistical digest, FSSS, Moscow, available at: http://smb.gov.ru/statistics/official data (accessed 17 August 2016).

[24] In his address to the Federal Assembly 2016, the President of the Russian Federation and the Chairman of the Russian Government repeatedly emphasized the necessity and urgency to support SMEs. See: http://kremlin.ru/events/president/news/50864 (accessed 17 August 2016).

Table A1: Variables description

Variable	Description	Type	Source
	Contract information		
Bundle rebate	Rebate on the whole procurement bundle in %. Calculated as: 100*(reserve price - winner price)/reserve price.	Quantitative	zakupki.gov.ru
Scaled unit final price	The ratio of the contract price per kilo of sugar to the regional retail price per kilo of sugar at the week of contract sign.	Quantitative	zakupki.gov.ru
Set-aside auction	Dummy variable if auction was set-aside, i.e. only small firms can participate in this auction. Micro firms and individual entrepreneurs can participate in set-aside auctions as well.	Factor (1-yes, 0-no)	zakupki.gov.ru
Log quantity	Logarithm of the quantity of sugar in a contract in kilo.	Quantitative	zakupki.gov.ru
Log reserve price	Logarithm of the reserve procurement price in RUR.	Quantitative	zakupki.gov.ru
Normalized price	Ratio of the regional retail price per kilo of sugar to the average over Russian regions retail price per kilo of sugar at the week of contract sign.	Quantitative	fedstat.ru
Number of products	Number of different procured goods in contract.	Quantitative	zakupki.gov.ru
Number of applicants	Number of firms applied their documents to participate in auction.	Quantitative	zakupki.gov.ru
Number of qualified bidders	Share of not admitted applicants to bid % Calculated as 100*(number of applicants - number of admitted applicants to bid)/number of applicants.	Quantitative	zakupki.gov.ru
Number of bidders	Number of auction bidders (might be different from number of applicants).	Quantitative	zakupki.gov.ru
Successful auction	Dummy variable if number of bidders is more than one (applicable only for E-auctions).	Quantitative	zakupki.gov.ru
Delivery period	Time from the date of contract signing to the date of products delivery, days.	Quantitative	zakupki.gov.ru
	Timing		
Sign quarter	Set of dummy variables indicating the quarter of contract signed date.	Factor (1-yes, 0-no)	zakupki.gov.ru
Delivery quarter	Set of dummy variables indicating the quarter of product delivery date.	Factor (1-yes, 0-no)	zakupki.gov.ru
Sign year	Set of dummy variables indicating the year of contract signed date (2011-2013).	Factor (1-yes, 0-no)	zakupki.gov.ru
	Supplier information		
Small firm	Dummy variable if supplier is a small firm. Also micro firms and individual entrepreneurs were considered as small firms. The number of employees during the previous year not exceeds 100 persons.	Factor (1-yes, 0-no)	spark-interfax.ru
Medium firm	Dummy variable if supplier is a Medium firm. The number of employees in Middle size firms during the previous year is 101-250.	Factor (1-yes, 0-no)	spark-interfax.ru

Large firm	Number of employees during the previous year is over 250 persons.	Factor (1-yes, 0-no)	spark-interfax.ru
Unknown firm size	Suppliers whose size is unknown.	Factor (1-yes, 0-no)	spark-interfax.ru
	Procurer information		
Platform: ATP	Dummy variable if electronic platform for auction is organized by "Agency for Public Procurement, Investment Activity and Interregional Relations of the Tatarstan Republic" State Unitary Enterprise (www.zakazrf.ru).	Factor (1-yes, 0-no)	zakupki.gov.ru
Platform: UETP	Dummy variable if electronic platform for auction is organized by "United electronic trading platform" JSC (www.roseltorg.ru).	Factor (1-yes, 0-no)	zakupki.gov.ru
Platform: MICEX	Dummy variable if electronic platform for auction is organized by "MICEX-Information Technologies" CJSC - ETP of MICEX (www.223.etp-ets.ru).	Factor (1-yes, 0-no)	zakupki.gov.ru
Platform: RTS	Dummy variable if electronic platform for auction is organized by "RTS Index Agency" LLC (www.rts-tender.ru) - RTS-Tender.	Factor (1-yes, 0-no)	zakupki.gov.ru
Platform: SBER	Dummy variable if electronic platform for auction is organized by Sberbank - Automated System of Trading Electronic Trading Platform (ETP) (www.sberbank-ast.ru)	Factor (1-yes, 0-no)	zakupki.gov.ru

Table A2: Average values for e-auction characteristics with reserve price in 0.5 – 2 M RUR

	Set-aside Reserve price <15M RUR	p-value (T-test)	Non Set-aside Reserve price <15M RUR
Auction outcomes			
Bundle rebate	12.30 % (Obs. 1010)	0.0000	9.75 % (Obs. 4119)
Scaled unit final price	0.951 (Obs. 1129)	0.0075	0.969 (Obs. 4342)
Competition			
Number of applicants	4.30 (Obs. 1129)	0.0001	3.89 (Obs. 4342)
Number of qualified bidders	4.05 (Obs. 1129)	0.0002	3.67 (Obs. 4342)
Number of bidders	2.07 (Obs. 1129)	0.6343	2.05 (Obs. 4342)
Contract information			
Reserve price (M RUR)	1.01M (Obs. 1129)	0.3485	1M (Obs. 4342)
Quantity of sugar (ton)	8.09 (Obs. 1129)	0.0000	14.22 (Obs. 4342)

Table A3: Average values for e-auction characteristics with reserve price in 2 – 5 M RUR

	Set-aside Reserve price <15M RUR	p-value (T-test)	Non Set-aside Reserve price <15M RUR
Auction outcomes			
Bundle rebate	13.26 % (Obs. 544)	0.0000	10.72 % (Obs. 1706)
Scaled unit final price	0.933 (Obs. 576)	0.0002	0.976 (Obs. 1872)
Competition			
Number of applicants	4.94 (Obs. 576)	0.0000	4.28 (Obs. 1872)
Number of qualified bidders	4.55 (Obs. 576)	0.0000	3.80 (Obs. 1872)
Number of bidders	2.22 (Obs. 576)	0.4210	2.17 (Obs. 1872)
Contract information			
Reserve price (M RUR)	2.94M (Obs. 576)	0.1808	2.99M (Obs. 1872)
Quantity of sugar (ton)	24.63 (Obs. 576)	0.0025	29.96 (Obs. 1872)

Table A4: Average values for e-auction characteristics with reserve price in 5 – 15 M RUR

	Set-aside Reserve price < 15M RUR	p-value (T-test)	Non Set-aside Reserve price < 15M RUR
Auction outcomes			
Bundle rebate	7.75 % (Obs. 238)	0.0000	14.92 % (Obs. 792)
Scaled unit final price	0.967 (Obs. 243)	0.0464	0.934 (Obs. 884)
Competition			
Number of applicants	3.25 (Obs. 243)	0.0006	4.04 (Obs. 884)
Number of qualified bidders	3.07 (Obs. 243)	0.0017	3.76 (Obs. 884)
Number of bidders	1.86 (Obs. 243)	0.4317	1.92 (Obs. 884)
Contract information			
Reserve price (M RUR)	7.34M (Obs. 243)	0.0000	8.35M (Obs. 884)
Quantity of sugar (ton)	18.67 (Obs. 243)	0.0000	28.41 (Obs. 884)

Table A5: Probability of small firm to win as a function of reserve price interval for NSA auctions

	(1)	(2)	(3)	(4)
VARIABLES	Contr.Func.	OLS	Contr.Func.	OLS
Reserve price in (0.5, 2] M RUR			-0.0021	-0.0021
			(0.0076)	(0.0077)
Reserve price in (2, 5] M RUR	-0.032**	-0.033**	-0.030**	-0.030**
	(0.013)	(0.013)	(0.014)	(0.014)
Reserve price in (5, 15] M RUR	-0.085***	-0.085***	-0.077***	-0.077***
	(0.024)	(0.024)	(0.023)	(0.023)
# Bidders = 2	0.00041	-0.0019	-0.0011	-0.0010
	(0.0081)	(0.0073)	(0.0059)	(0.0053)
# Bidders = 3	0.010	0.0055	-0.0025	-0.0024
	(0.0089)	(0.0075)	(0.0076)	(0.0060)
# Bidders $\geq$ 4	-0.0018	-0.0096	-0.026**	-0.026***
	(0.012)	(0.0079)	(0.011)	(0.0074)
Log quantity	0.0023	0.0027	-0.0021	-0.0021
	(0.0075)	(0.0074)	(0.0051)	(0.0051)
Normalized price	0.16	0.17	0.35***	0.35***
	(0.10)	(0.10)	(0.080)	(0.080)
Delivery period	-0.00012***	-0.00012***	-0.000088***	-0.000088***
	(0.000028)	(0.000027)	(0.000025)	(0.000025)
Stage 1 residual	-0.0033		0.000091	
	(0.0042)		(0.0037)	
Observations	5,604	5,604	8,918	8,918
R-squared	0.042	0.042	0.024	0.024
# of procurer-year FE	476	476	1,125	1,125
Singleton groups	1126	1126	2186	2186
Reserve price interval (M RUR)	0.5-15	0.5-15	0-15	0-15

*** p<0.01, ** p<0.05, * p<0.10

Notes: the table presents results of model (3) for the sample of NSA auctions (i.e. $SA_{tp} = 0$), where dependent variable is dummy variable equal to one if the winner if small firm and zero otherwise. The set of additional control variables not presented in the table are: number of different products in contract, quarter of contract signing, quarter of contract delivery, e-platforms for procurement. Columns 1 and 2 (columns 3 and 4) show result for auctions with reserve price in interval $(0.5 - 15]$ M RUR ($(0 - 15]$ M RUR, respectively). In columns 1 and 3 estimation procedure is control function approach (i.e. formulas (5) and (6) are used), while in columns 2 and 4 OLS is implemented. All the columns show the clear pattern that probability of small firm to win decreases with respect to reserve price.