Corrupt Reserve Prices

Sümeyra Atmaca, Elena Podkolzina and Koen Schoors

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Abstract

Procurement auctions are often plagued by favoritism and rent-seeking behavior. We develop a new methodology to red-flag potential favoritism in public procurement auctions with reserve prices, and apply it to Russian public purchases of gasoline between 2011 and 2013. Since the reserve price is set prior to the auction, it is independent of the identity of the winning seller in a fair and competitive auction. A procurer-seller pair is therefore red-flagged as potentially corrupt if it exhibits consistently higher reserve prices than the average reserve price of this procurer. Corrupt procurers limit auction entry so that their favored sellers face less competition in these auctions and are more likely to win them. Auctions with corrupt pairs also have higher final contract prices, implying considerable welfare losses. The inflationary effect of reserve price manipulation by corrupt procurer-seller pairs on final auction prices is mitigated by higher competition and fully offset by open bid e-auctions with sufficient competition.

1 Introduction

Procurement has been plagued by corruption in public and private sectors alike. It originates from a classical principal-agent problem that emerges when a principal delegates the authority to allocate funds to an agent in the presence of information asymmetries and private benefits. In this paper, we focus on a particular type of public procurement corruption where the public procurer has connections with a firm and seeks ways to favor this firm through the allocation of public contracts. Although this type of favoritism is in most cases illegal[1] and can therefore be labeled as a form of corruption, it is a wide-spread phenomenon in public procurement. We show that reserve price manipulation is one of the mechanisms for this type of corrupt favoritism in public procurement.

We specifically study competitive reverse auctions with reserve prices for the procurement of a homogeneous good by a public body. Although public bodies can buy these goods directly on the market, procurement regulations prescribe public bodies to buy them through competitive procedures. We study competitive reverse auctions, because they are expected to achieve the best results in terms of saving public money (Tadelis, 2012) and are therefore widely used by governments around the world. We study the purchase of a homogeneous good, as this allows us to use the good's local market price as the benchmark for public procurement contracts. We focus on competitive reverse auctions with reserve prices. The reserve price is the highest price the procurer is willing to pay for the demanded goods, services or works. The procurer sets his reserve price before he publicly announces the auction. We propose a methodology to detect whether corrupt procurer-seller pairs manipulate reserve prices to extract rents from the government in this specific, though broadly applicable, setting. The main result of this paper is a generic methodology to red-flag potential corruption in public procurement auctions with reserve prices.

[1] Even when favoritism is legal as a mechanism for supporting domestic firms or SMEs, it usually leads to inefficiencies (Marion, 2007; Nakabayashi, 2013)

In the empirical analysis we apply our approach to the detection of favoritism in the public procurement of gasoline in Russia, which is a close to perfect case of competitive reverse auctions with reserve prices for the public procurement of a homogeneous good. The corrupt manipulation of reserve prices is relevant and salient in the context of Russian public procurement. Public servants in Russia have to set reserve prices and make the level and the calculation public (Article 19.1 Federal Law No.94-FZ of 21/7/2005).[2] A few cases were taken to court where the participants accused officials of failing to comply with the rules, claiming that the rationale for the reserve price was either inadequate or missing. For instance, the case at the arbitration court of Altai Region on lacking justification of the reserve price for the supply of fuel oil[3], and the complaint at the arbitration court of Ural Region with regard to violation of Article 19.1 in the supply of medical products[4]. This anecdotal evidence ensures that the mechanism we study is relevant in the Russian context.

We start by estimating reserve prices as a function of the local market price, contract characteristics, procurer characteristics, time controls and the procurer-seller pairs' fixed effects. In the absence of corruption, the winning sellers' identity within a given procurer should be uncorrelated to the reserve price because the procurer sets the reserve price prior to the announcement of the auctions. If, on the contrary, a seller is found to enjoy systematically higher reserve prices in auctions won from a given procurer than other sellers in auctions won from the same procurer, we interpret it as a red flag for potentially corrupt contracting. Technically, a procurer-seller pair is labeled as potentially corrupt if its pair fixed effect in the reserve price estimation is significantly larger than the average procurer fixed effect. We will refer to this potentially corrupt behavior as reserve price overpricing. We find that 9.4% of the procurer-seller pairs (responsible for 15.3% of the auctions) exhibit reserve price overpricing. The re-

[2]For its calculation a variety of sources can be used such as price data, market research and price quotations by firms.

[3]Case number A76-17508/2011 http://sudact.ru/arbitral/doc/TqFV8GobXAVL/

[4]Case number A03-5924/2012 http://sudact.ru/arbitral/doc/tdi28O6ZsUmN/

sulting average mark-up per liter is 1.2 rubles or 4% of the average reserve price.

We evaluate the accuracy of the proposed identification of corrupt pairs by analyzing the impact of our corrupt pair indicator on auction competition, the odds of winning the auction and the final auction prices. The underlying hypothesis is that the suspicious procurer-seller pairs may transform the inflated reserve prices in higher final contract prices and thus rents for the favored seller, by restricting auction entry in a number of intricate ways. Procurers may for example include different restrictive clauses in the contract for auction (e.g. mandatory opening hours, specific methods of payments, ownership of a minimal number of gas stations, maximal distance to the customer etc.) to deter competing sellers from entering the auction. This artificially limits the competition in the auction and makes the favored seller much more likely to win such auctions, allowing him to sell the goods at higher final prices to the public body. We indeed observe that sellers face less competition in auctions organized by procurers with whom they form a corrupt pair and have a higher probability of winning these auctions, despite the fact that these auctions are characterized by higher reserve prices and should ceteris paribus invite more competitors.

Auctions won by corrupt pairs also exhibit higher final contract prices. When the mechanisms to restrict auction competition fail though, and the auction turns out to be competitive, electronic reverse open bid auctions[5] are much more effective than sealed bid auctions in combating the inflationary effect of reserve price overpricing on final contract prices. In many case corrupt pairs can, however, sort themselves into sealed bid auctions to avoid this salutary effect of these competitive e-auctions on final contract prices. In total, the reserve overpricing behavior leads to a waste of 161 million rubles in terms of overpricing in our small sample (three years, one product). If the final price mark-up were to be evenly split between the corrupt procurer and its favored

[5]In our specific context the electronic auctions are always electronic reverse open bid auctions. In the remainder of the paper, we will therefore simply refer to them as e-auctions.

seller, the private benefit to the procurer would amount to about 1% of the final contract price. We provide indirect evidence in line with the interpretation that private benefits or bribes are indeed exchanged. In previous studies along these lines, Compte et al. (2005) indicate that corruption inflates prices and the literature on e-auctions suggests that prices are either lower or not significantly different from sealed bid auctions (Athey et al., 2011; Lewis-Faupel et al., 2016). To the best of our knowledge the joint impact of corruption, competition and the auction procedure on final auction prices has heretofore remained unstudied.

Since our method requires different sellers repeatedly winning auctions from the same procurer, it is only appropriate for standardized goods that are either consumed on a regular basis by the procurer, like gasoline or stationery, or that are peculiar for the type of services provided by the procurer, like bandages or syringes for hospitals. The method also implies we can only identify corrupt links between the contracting parties if procurers differentiate the level of reserve prices across sellers. In case a corrupt procurer exhibits favoritism in all its public procurement auctions, we will only identify sellers who win auctions with the highest reserve price mark-ups as a corrupt pair with this corrupt procurer. If a procurer does not differentiate reserve prices across sellers at all, our method will by definition not identify any procurer-seller pair as corrupt. Our estimates of the number of procurer-seller pairs and transactions that are subject to corrupt favoritism are therefore lower bound estimates of the true level of corrupt favoritism.

Most of the papers investigating favoritism in public procurement, argue that it increases prices and the odds of winning for favored firms (Vagstad, 1995; Naegelen and Mougeot, 1998; Baltrunaite, 2019), and therefore leads to inefficiency (Burguet and Perry, 2007, 2009). Moreover, Laffont and Tirole (1991) explain that in order to prevent favoritism, the state should use non-manipulative monetary criteria to award the contract. The reserve price is often assumed to be such a strict monetary criterion that is hard to manipu-

late. We show, however, that implicit restrictions combined with high reserve prices set by the procurer still allow the favored seller to win the auction and be awarded the contract at a relatively high final price. Although the literature has studied different ways of how procurers exert discretionary power to manipulate the procurement process (Burguet and Che, 2004; Compte et al., 2005; Palguta and Pertold, 2017; Baltrunaite et al., 2018), we are the first to identify public procurement corruption through reserve price manipulation.

The literature usually studies reserve prices in the context of setting the optimal reserve price. In auctions with endogenous entry, the optimal reserve price equals the buyers' value of the traded goods (Milgrom, 2004). Klemperer (2004, p.138-9) claims that politicians and bureaucrats often make the mistake of skipping the proper calculation of the optimal reserve price, leading to significant welfare losses for the government in the resulting auctions. We extend this by arguing that reserve prices may be purposefully set at a sub-optimal level, with the intention to support a sophisticated form of corrupt favoritism. This study also fits in a larger literature on the potential mechanisms of corruption in public procurement. Milgrom (2004, p.212) states that if the price is the only award criterion in the auction, the procurer has incentives to outline detailed specifications of the goods to be procured to safeguard quality, even if this may somewhat restrict entry. But since detailed specifications and special contract clauses restrict auction entry, they could also be abused by corrupt public procurers desiring to restrict competition in auctions with a favored seller (Søreide, 2002; Boehm and Olaya, 2006; Ostrovnaya and Podkolzina, 2019). Other possibilities to influence auction entry are the design of the auction procedure (Laffont and Tirole, 1991), the choice of the procedure (Estache et al., 2009; Coviello et al., 2017; Palguta and Pertold, 2017) and manipulations within the chosen procedure (Compte et al., 2005; Burguet and Perry, 2007). In our sample, we find that entry restrictions, especially specifying the delivery method, are one of the main avenues to transform high reserve prices into higher odds of winning for the favored seller, and ultimately higher final prices.

With respect to the measurement of public procurement corruption, previous studies have studied tunneling during elections (Mironov and Zhuravskaya, 2016), compared physical public infrastructure with its procurement costs (Golden and Picci, 2005) and exploited the variation in contract prices (Di Tella and Schargrodsky, 2003) to find indications of public procurement corruption. This study complements the literature by providing a method to red-flag corruption at the level of the contracting procurer-seller pairs. Our approach is not based on an experiment or event, but applies a simple algorithm on publicly available procurement data, rendering it generally applicable.

The remainder of the paper is structured as follows. Section 2 describes the methodology to identify corrupt relations between public officials and firms, and section 3 discusses the data and institutional background. The methodology is implemented and evaluated in section 4. Sections 5 and 6 provide an assessment of the robustness of our results. Section 7 concludes.

2 Methodology

Our methodology aims at identifying corrupt links between a public procurer and its favored seller. As favoritism is a pair characteristic, the methodology focuses on variation at the procurer-seller level.

2.1 Setup

We consider a government procurer that organizes an auction to buy standardized homogeneous goods, and potential sellers who compete for the contract. We implicitly assume that the said goods are traded in the market and that it has a stable demand from different consumers. The timing is as follows:

1. The procurer sets the reserve price and the contract conditions

2. The procurer publicly announces the public purchase (the time of an auction, the reserve price and contract conditions)

3. The sellers decide whether to apply for participation

4. The procurer decides which of the applying firms are allowed to participate

5. The auction is held and the winning seller is announced

In a competitive environment, the reserve price should depend on the market price (if available), the marginal costs of procurers and sellers (in as far they are known to the procurer) and on specific contract conditions. We define the reserve price per item of goods r_{ijt} for contract t allocated by procurer i to seller j as follows:

$$\mathrm{r_{ijt}} = \boldsymbol{X}_{\mathrm{ijt}}\boldsymbol{\beta} + \sum \gamma_{\mathrm{s}}\mathrm{year_t} + \mu_{\mathrm{ij}} + \epsilon_{\mathrm{ijt}} \tag{1}$$

where $\mathbf{X}_{ijt}$ denotes contract and procurer observed characteristics, $\sum year_t$ denotes year effects and μ_{ij} are the procurer-seller fixed effects. As the reserve price also reflects market and contract characteristics, we include monthly local market prices of the goods and the contract volume. The size of contracts reflects scale effects, and therefore we include the natural logarithm of volume in the regression. To capture possible breaks in the market structure or the regulations, we include year effects. Furthermore, each procurer has its own private costs. To account for these, we include dummy variables for the government level of the procurer (federal, regional, local). The procurer fixed effects μ_i are constructed as the average[6] of the corresponding procurer seller fixed effects $\hat{\mu}_{ij}$ obtained from equation 1:

$$\mu_{\mathrm{i}} = \frac{1}{\mathrm{k}} \sum_{\mathrm{j}=1}^{\mathrm{k}} \hat{\mu}_{\mathrm{ij}} \tag{2}$$

[6]The unweighted average is calculated to weigh each seller equally and avoid the procurer fixed effects to be skewed by sellers that obtained most of the contracts. The corruption indicator using the weighted average over sellers is strongly and significantly correlated to the indicator based on the unweighted average over sellers ($\rho = 0.7$).

2.2 Reserve price manipulation

We cannot interpret the procurer fixed effect μ_i as an indication of corruption, because it may also capture procurer inefficiency, rendering it difficult to disentangle both kinds of waste at the procurer level in the absence of numerous sellers (Bandiera et al., 2009). Therefore our method relies on reserve price differences between multiple sellers within the same procurer. In the absence of corruption, the winning sellers' identity should be uncorrelated to the reserve prices set by a given procurer. Uncorrupted procurers should not be found to have set different reserve prices for different winning sellers in a systematic way, since not only the identity of the winner of the auction, but also the identities of the participating sellers are unknown at the moment the procurer sets the reserve price, i.e. μ_{ij} should not be significantly different from μ_i for honest procurer-seller pairs. If, however, μ_{ij} turns out to be statistically significant and larger than μ_i, it raises the suspicion that the winner was known before the implementation of the auction, and that the excessive reserve prices therefore reveal a potentially corrupt procurer-seller pair. To test whether μ_{ij} is significantly larger than μ_i, a t-test is performed with variance of μ_i and degrees of freedom calculated using the estimate $\hat{\sigma}_{ij}$ from equation 1 (Satterthwaite, 1946):[7]

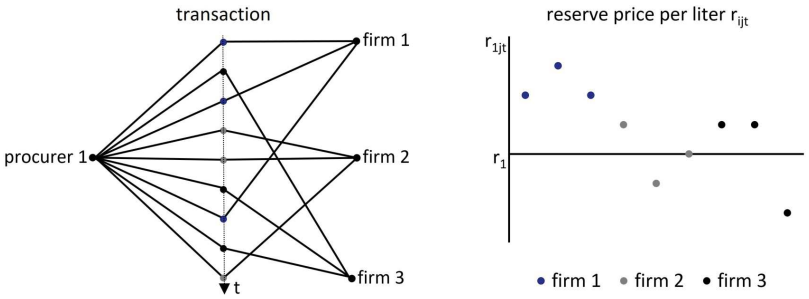
$$\sigma_{\mathrm{i}}^2 = \frac{\sum(\hat{\mu}_{\mathrm{ij}} - \overline{\mu}_{\mathrm{i}})^2}{\mathrm{n_i}} \tag{3}$$

$$\mathrm{df} = \frac{(\frac{\hat{\sigma}_{\mathrm{ij}}^2}{\mathrm{n_{ij}}} + \frac{\sigma_{\mathrm{i}}^2}{\mathrm{n_i}})^2}{\frac{(\hat{\sigma}_{\mathrm{ij}}^2/\mathrm{n_{ij}})^2}{(\mathrm{n_{ij}}-1)} + \frac{(\sigma_{\mathrm{i}}^2/\mathrm{n_i})^2}{(\mathrm{n_i}-1)}} \tag{4}$$

[7] The test assumes that μ_{ij} and μ_i are approximately normally distributed. The central limit theorem further renders the test robust to deviations from this assumption.

Thus, the method analyzes whether contractual terms, in particular reserve prices, may be influenced by procurers to favor certain firms.[8] A positive $\mu_{ij} - \mu_i$ identifies systematic overpricing at the procurer-seller level, which could indicate corrupt behavior. We illustrate the proposed methodology in figure 1.

Figure 1: Illustration of the methodology



Notes: On the left, we show a hypothetical network of transactions between procurer 1 and her selling firms j. The procurer allocates contracts to sellers through auctions, resulting in transactions $1jt$ between procurer 1 and a winning seller j. The vertical axis in the middle shows the order of the transactions over time (top to bottom).
On the right, the same transactions are ordered by winning firm j and the dots represent the reserve prices of each transaction. We observe how much the reserve prices of each transaction, grouped by winning seller j, deviate from the average reserve price of this procurer 1, calculated as $\mu_1 = \frac{1}{3}\sum_{j=1}^{3} \hat{\mu}_{1j}$). Procurer-seller pairs are labeled corrupt if $\mu_{1j} > \mu_1$, which is the case for firm 1 in the example in the figure ($\mu_{11} > \mu_1$).

Corruption definition. A procurer and seller constitute a corrupt pair if the reserve price set by the procurer in contracts won by the seller is systematically higher than the average reserve price set by the same procurer: $\mu_{ij} - \mu_i > 0$.[9]

Since our method relies on reserve price differences between multiple sellers

[8] Frontier analysis is not used as it assumes that inefficiency can only deviate in one direction.

[9] In this paper, we develop a red flag but for the sake of convenience we will sometimes mention corruption instead of potential corruption.

within the same procurer, it is not able to identify corrupt relations of procurers that have transactions with mainly, or only one seller. Another related issue arises when procurers allocate all contracts with all sellers through favoritism. In this case, there is no set of honest pairs to which the corrupt pairs can be compared. Nonetheless, the degree of corruption may differ across pairs within the same procurer, and our approach therefore still allows us to distinguish the highly corrupt pairs from the less corrupt ones in this specific case. Because of the aforementioned issues, some corrupt pairs would not be detected by our method and our estimates of reserve price-related favoritism are therefore to be considered as lower bound estimates.

The proposed method is especially adequate in an environment where there are several buyers purchasing homogeneous goods on a regular basis and they have contracts with different sellers of these goods. Examples of such markets include all basic commodities, like paper, stationery, sugar, basic drugs, medical equipment, gasoline and so forth.

2.3 Testable implications

The gist of our argument is that corrupt procurer-seller pairs may agree on a reserve price in excess of the local market price, to facilitate a higher final price for the favored corrupt seller. The rent extracted in this way from the government can then be shared in the form of a private benefit for the official to sustain the corrupt relationship. But higher reserve prices should also attract more bidders to the auction and hence deliver lower final prices, rendering this corrupt strategy infeasible, unless corrupt procurer-seller pairs can limit competition in the auction so effectively that the planned seller is indeed much more likely to win. Our mechanism therefore entails the following deviations from the theoretical predictions in the case of a competitive auction:

1. Although higher reserve prices provide sellers with higher production costs

of the product with incentives to participate in the auction and should therefore increase auction competition, transactions that involve a corrupt procurer-seller pair should exhibit **lower competition** despite their elevated reserve prices.

2. Sellers that constitute a corrupt pair with a procurer should be **more likely to win auctions of this procurer**, although the higher reserve price should attract more competitors and therefore reduce the likelihood of success of every individual seller, all else equal.

3. Although the reserve price should in theory not affect the final price in first-price auctions (Menezes and Monteiro, 2005; Krishna, 2009), auctions won by a corrupt procurer-seller pair should not only be characterised by abnormally high reserve prices, but also exhibit **higher final contract prices** to facilitate the payment of the private benefit to the procurer that is needed to maintain this corrupt favoritism relationship.

In the absence of a mechanism to establish sufficiently high final contract prices through limiting competition and fostering the corrupt favorite's likelihood of winning, rationally corrupt procurer-seller pairs would never adopt the proposed overpricing strategy, because higher reserve prices by themselves cannot guarantee the corrupt pair a corruption rent. If the empirical analysis on the other hand validates the proposed mechanism of higher reserve prices, lower competition, high odds of winning and higher final prices, we may state that our methodology to detect manipulated reserve prices, is a reliable indicator of corruption. In this case we will have found a simple metric to detect potentially corrupt pairs that only relies on the analysis of reserve prices that are part of the tendering procedure and often public information.

Since our analysis exploits the variation within procurers, we are able to separate **competence** from corruption considerations. If a procurer sets systematically high reserve prices due to a general lack of information or to incompetence, our methodology would not identify it as corrupt, because the high

reserve price would still be unrelated to the identity of its winning sellers. Our approach only reveals whether a procurer endows favored winning sellers with high reserve prices relative to other winning sellers of the same homogeneous product to the same procurer.

We also seek to distinguish corrupt pairs from **relational contracts**. If relational contracts were allowed by the regulator, then the procurer would not use a tendering procedure to find the seller in the first place. If such relational contracts are prohibited, as is the case in most countries for government contracts, the procurer may feel tempted to manipulate the level of competition to maintain the relation. In the context of this paper, the advantages of a long-term relationship are to be found largely in the reduction of search costs and information asymmetries, for example, about product quality or reliability of delivery. In this case the procurer will want to limit competition, while minimizing the risk of detection and breaking as few rules as possible. The most straightforward way to achieve this goal is to lower the reserve price rather than increasing it. The lower reserve price will at the same time reduce competition, increase the probability of maintaining the relation and lead to lower final prices. Relational contracts can support the lower final prices that may come with lower reserve prices, because their value hinges on the reduction of transaction costs and therefore does not require extra rents to finance a private benefit for the procurer. Since lower than average reserve prices for a procurer-seller pair are not labeled as corrupt by the proposed methodology, it is ensured that we did not wrongly identify this type of relational contracts as cases of corruption.

3 Institutional background and data

3.1 Public procurement in Russia

The proposed method is potentially relevant for any procurement auction where the procurer has sufficient discretion to set the reserve price but it is probably

more applicable to the public than to the private procurement sphere. First, public officials run auctions with public money and are only partially responsible for the results, exacerbating the classical principal-agent problem and leaving ample room for attempts to redirect some of this public money to their private pockets. Second, the regulation of public procurement creates additional barriers to firms and lowers competition, relative to private procurement auctions.

We employ the Russian public procurement sphere as the testing ground for our methodology, because the country scores relatively high in any corruption indicator available, suggesting that its general institutional environment is relatively conducive to corrupt behavior. The Russian procurement system is regulated by the same law in all regions. We base our estimations on the period 2011-2013 when the Federal Law No. 94 (the Law) was in effect.[10] All public contracts offered by federal, regional and municipal authorities are subject to the law. In 2011, a single website for procurement announcements became obligatory for all levels of government.[11] Before 2011, this website was only used by federal authorities while regional and municipal purchases were advertised on regional websites. Since 2011, announcement requirements no longer differ across different levels of the government. Because since 2011 all official procurement information is equally available to all potential sellers in the market, announcement differences cannot longer influence sellers' entry decisions in a substantial way. The Federal Law No. 94 was replaced by the Federal Law No. 44 in 2014.

Under the said law procurers can choose among several public procurement procedures: single seller (for all contract values below 100,000 rubles and in a limited number of special cases); sealed bid auctions (for contracts below 500,000 rubles and in so far the total volume of these contracts does not exceed 500,000 rubles per quarter and per type of good); open bid auctions (public outcry before 2011, e-auctions thereafter); tenders with scoring rules (only for

[10] Roudik, P. (2011, March). Government Procurement Law and Policy: Russia. Retrieved November 25, 2016, from http://www.loc.gov/law/help/govt-procurement-law/russia.php.

[11] http://www.zakupki.gov.ru

a limited number of goods). E-auctions were fostered by the government as one of the most transparent procedures with the lowest scope for corruption. The Federal Antitrust Service (FAS) highly recommended procurers to use auction procedures and even created a list of products that can only be bought through an auction procedure.[12] Gasoline is one of the products on this list.

In both types of competitive procedures accessible to gasoline procurers (sealed bid and e-auctions) the procurers have to set the reserve price and the contract conditions before the auction is announced. Federal Law No. 94-FZ of 21/7/2005 obliges procurers to make reserve prices public. In April 2011, the government issued an amendment of the law stating that procurers have to justify the level of these reserve prices (Article 19.1 Federal Law No.79-FZ of 21/4/2011). They could use several sources like price quotations from firms, market analysis and recommendations of regional authorities. The main change was the obligation to disclose this information about the source to the public.[13]

The main difference between these procedures is the way how they are organized – simultaneous bids for sealed bid auctions versus sequential bids for e-auctions. If there is only one bidder in an e-auction, the procurer can conclude a contract with the single bidder at the reserve price. This rule provides an easy mechanism through which high reserve prices in combination with restricted competition may lead to high corruption rents in the case of e-auctions.

3.2 Gasoline market

We use gasoline as the standardized and homogeneous good of our choice. Gasoline is procured by public institutions to fuel the vehicles used by employees for their work, for example, vehicles used by hospitals and the police. Although there are different types of gasoline (different octane rates) and contracts can

[12] Provided that the contract value exceeds 100,000 rubles.

[13] We retrieved the sources used to determine reserve prices in the appendix. Most of the reserve prices are based on price quotations from firms.

contain multiple types, gasoline is a relatively homogeneous good and it is hard to manipulate its quality. To rule out this possibility as much as possible, we only consider public contracts for gasoline that should be supplied through gas stations according to the contractual details. This allows us to steer clear from the possibility of substantial quality differences across sellers in their public procurement deliveries. Since we only consider contracts where gasoline is delivered to the private and the public market on the same infrastructure of gas stations, sellers cannot sell public clients gasoline of inferior quality without risking to loose their private clients to their higher quality local peers. This minimizes incentives and possibilities for quality manipulation, leaving only the allocation, the price of the contract and cheating with delivered quantities as possible avenues of corruption.

One additional peculiarity of this market is that potential sellers should be present on the private market before being able to enter the public procurement market. We have no cases where gas stations supply exclusively to the public market, even not in the case of subcontracting intermediaries. The private market is quite transparent and it is fairly easy to collect and compare prices of several sellers at a any given moment. Several firms even update their prices regularly on their websites. The gasoline market is also monitored systematically by the Federal Statistics Service (Rosstat). Rosstat collects, calculates and publishes monthly average prices of all types of gasoline by region.

To illustrate the market we study, consider the typical case of Kostroma State University (red dot on the map, see figure 2) that orders gasoline for the cars owned by the university a few times a year. During winter, the university purchased 9,000 liters of gasoline through sealed bid auctions. The reserve price was fixed at 360,000 rubles. This reserve price was established on the basis of price quotations from several firms. The conditions set in the procurement announcement included the quantity in liters (3,000 liters AI-92, 4,000 liters AI-95 and 2,000 liters diesel), the requirement to have several gas stations situated in

the town Kostroma, 24-hours availability and payment by cards issued by the seller. Under the contract conditions the workers of the university would fuel their cars at the stations of the winning seller for a period of three months (contract duration). Figure 2 shows that several companies owned more than one gas station in Kostroma: Lukoil, KTK (Kostromskaya Toplivnaya Kompanya), TNK and Gazprom. All of these were potential participants in the auction. If the university would not have added the requirement to own several gas stations, more sellers could have participated in the auction. We observe, for example, Shell owned only one gas station in Kostroma. If, however, it would not have been obligatory to own a network of stations, Shell could have established an agreement with TNK to use its gas stations and in this way could have entered the auction and offered fuel through several stations.

Figure 2: Gas stations in Kostroma

3.3 Data

Our data is scraped from the official website containing information on Russian public procurement.[14] Our sample focuses on the procurement of gasoline through stations, because gasoline is a standardized commodity and the regional market price is provided on a monthly basis by Rosstat.[15] Gasoline cannot only be purchased through sealed bid auctions and e-auctions but also through single-source contracting.[16] We restrict our sample to sealed bid and e-auctions, because we are interested in detecting corruption in potentially competitive procedures. Contracts allocated through sealed bid or e-auctions are in principle awarded to firms with the lowest bid. In e-auctions with only one applicant, procurers can and often do conclude contracts at the reserve price, suggesting a simple way in which reserve price manipulation may affect outcomes.[17] Our data covers the name and address of the procuring public authority, the subject of the procurement, the volume, the reserve price, the procedure and the time and place of the procurement. Auction outcomes such as the identities of the bidders, the bids, the identity of the winner and the contract price are also reported.[18]

The dataset comprises the period 2011-2013 as data in unique structured format for all regions is available only since 2011 and further major amendments of law took place in 2014. The initial sample consists of 171,984 auctions for 83 regions. Procurement is outsourced to centralized agencies in 28.3% of the cases, leaving us with 123,325 observations of independent procurements. We exclude all procurements by centralized agencies including situations when these centralized agencies procured for themselves, because as an intermediary they

[14] Thanks to Sergey Trunov and Anya Balsevich for data collection from https://zakupki.gov.ru/.

[15] https://eng.gks.ru/

[16] Single-source contracting is non-competitive and the contract price ought to be below 100,000 rubles. Also it can be implemented by natural monopolies, for the procurement of military or cultural goods, works or services and in case of emergency (Federal Law No.94 Art.55).

[17] 78.7% of the e-auctions has only one applicant.

[18] See table A.13 in the annex for an overview of the used variables.

have more connections with different buyers and sellers than the independent procurers in the sample. We drop auctions without seller identity, volume and reserve price per liter,[19] leading to a final sample of 81,813 observations.[20]

Table 1: Summary statistics

	N	mean	p50	sd	min	max
1 bidder	81,813	0.5	0	0.5	0	1
Applicants	81,813	1.8	2	0.8	0	12
Bidders	81,813	1.6	2	0.7	0	12
Delivery	81,813	0.6	1	0.5	0	1
E-auction	81,813	0.3	0	0.5	0	1
Exclusion	81,813	0.1	0	0.3	0	1
Federal	81,813	0.6	1	0.5	0	1
Lnvolume	81,813	9	9	1.2	4.6	15.8
Market price	81,813	27.9	27.8	2.4	18.3	41.3
Mixed	81,813	0	0	0.1	0	1
Municipal	81,813	0.2	0	0.4	0	1
Notbidding	81,813	0	0	0.2	0	1
p	73,296	0	0	0.1	-0.3	0.5
r	81,813	29.4	29.3	2.8	23.2	36.5
Regional	81,813	0.2	0	0.4	0	1
Voluntary e-auction	81,813	0.1	0	0.3	0	1
Win	97,131	0.8	0.1	0.4	0	1

Notes: 1 bidder is a dummy variable equal to 1 if the number of bidders is 1, *applicants* is the number of applicants, *bidders* is the number of bidders, *delivery* is a dummy variable equal to 1 if the delivery method is specified, *e-auction* is a dummy variable equal to 1 if electronic open bid auction and 0 if sealed bid auction, *exclusion* is a dummy variable equal to 1 if the procurer excluded at least 1 applicant from the auction, *federal* is a dummy variable equal to 1 if the procurer is on federal level, *lnvolume* is the natural logarithm of the contract volume, *market price* is the weighted average of monthly market prices of different gasoline types, *mixed* is a dummy variable equal to 1 if the procurement contains other items, *municipal* is a dummy variable equal to 1 if the procurer is on the municipal level, *notbidding* is a dummy variable equal to 1 if an applicant allowed to bid refrains from bidding, p is the winning bid per liter of gasoline minus the market price divided by the latter, r is the reserve price per liter of gasoline, *regional* is a dummy variable equal to 1 if the procurer is on the regional level, *voluntary e-auction* is a dummy variable equal to 1 if e-auction is not mandatory but voluntary, and *win* is a dummy variable equal to 1 if the bidder is the winner of the auction. The sample is restricted to the estimation sample of the reserve price per liter (model 1).

[19] The reserve price variable is corrected for outliers.

[20] Table A.10 in the annex shows the construction of the sample and table A.11 contains the summary statistics for the initial and reduced sample. Competition seems slightly higher in the latter but in general the statistics are comparable across the samples.

Table 1 shows how over 70% of the auctions in the final sample are conducted through sealed bid auctions and only 28.3% through e-auctions.[21] Federal authorities represent 56% of the auctions, while 44% of the auctions are organized by lower level government authorities. The average contract value is 510,177.5 rubles which amounts to approximately 12,448.3 euros.[22] Since procurers only need to post the total contract value, the reserve price per liter is not directly available for the majority of cases. We calculate the reserve price per liter by dividing the contract value by the contract volume. We arrive at an average reserve price per liter of 29.4 rubles or about 0.72 euros over the sampling period. The auctions in our sample have a median of only 2 bidding firms, with a standard deviation of 0.7. Besides procurement data, we use monthly market prices of gasoline per Russian region (see figure 3). The average local market price in our sample period is 27.9 rubles or 0.68 euros, which is below the average reserve price of 0.72 euros that acts as a price ceiling for the final contract prices.

4 Empirical evidence

4.1 Reserve price overpricing and favoritism

We begin this section with the estimation of reserve prices per liter of gasoline for decentralized purchases which are not outsourced to other institutions using equation (1) outlined in the methodology section. For contracts that contain multiple types of gasoline we construct the market price as the a weighted average of the monthly regional market prices[23] with the volume of each type relative to the total contract volume as weights. Results are presented in table 2.[24] As expected, the monthly regional average market price per liter turns out

[21] This pattern is largely maintained at the regional level with the noteworthy exception of Tatarstan where gasoline is procured mainly through e-auctions.

[22] Calculated at the average exchange rate over the considered period, 1 RUB = 0.0244 EUR.

[23] Quality differences will be reflected by the market price of each type of gasoline.

[24] Model estimated using the Stata command by Nichols (2008).

Figure 3: Market price of gasoline

Notes: Average regional gasoline prices in the period 2011-2013 (Rosstat). The darker, the higher market prices. The regions are grouped into 4 classes: [24.7;26.9],]26.9;27.4],]27.4;28] and]28;42.7]. No data available for white colored regions.

to be a significant determinant of the contract-specific reserve price per liter. The contract volume has a positive and significant effect on prices. Procurement at the municipal level exhibits higher prices per liter than procurement at the regional or federal level and mixed purchases[25] also have on average a higher reserve price per liter.

To test for manipulation of reserve prices, we analyze the fixed effects for each pair of procurer and seller μ_{ij}. For notational convenience, *overpricing*=1 if $\mu_{ij} - \mu_i$ is significantly larger than zero at the 5% significance level.[26] Table 3 summarizes the results. 1,028 out of 10,932 procurer-seller pairs are identified as overpricing (potentially corrupt) pairs, representing 15.3% of the auctions.[27]

[25] We focus on purchases of gasoline without any related products, but in a small number of cases related products were mentioned in the description of the purchase and were not reported as supplied goods in the contract stage. We marked these cases as mixed.

[26] *Overpricing* at the 1 and 10% significance level is provided in table A.9 part of the appendix. The correlation between testing at the 5% significance level and the 1% (10%) is 0.6 (0.8) and statistically significant.

[27] For 51,330 out of the initial 81,813 auctions we can tell whether the procurer-seller pair is corrupt. The remaining auctions mainly involve procurers who concluded contracts with

Table 2: Reserve price per liter

	(1) r
Market price	0.898***
	(0.00433)
Lnvolume	0.0613***
	(0.00774)
Federal	0.248
	(0.214)
Municipal	0.169***
	(0.0530)
Mixed	0.772***
	(0.110)
Constant	4.304***
	(0.205)
Year FE	Yes
Procurer-seller FE	Yes
Observations	81,813

Notes: The dependent variable r is the reserve price per liter of gasoline. *Market price* is the weighted average of monthly market prices of different gasoline types, *lnvolume* is the natural logarithm of contract volume, *federal* is a dummy equal to 1 if the procurer is on the federal level and *municipal* if on the municipal level. *Mixed* is a dummy variable equal to 1 if the procurement can contain other items. Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

The corresponding average size of the corrupt reserve price mark-up is 1.2 rubles per liter which should be related to the average price of 30.5 rubles for the overpriced subset of auctions, leading to a 4% mark-up per liter of gasoline (see figure 4).[28] If we multiply the mark-up on procurer-seller level with the pro-

only one seller. The summary statistics for the *overpricing* sample are part of table A.11 in the annex. Furthermore, we provide the histogram of the number of interactions between potentially corrupt procurers and suppliers and the number of auctions per corrupt procurer (figure A.9).

[28]The identification of corrupt pairs is not driven by seller characteristics since we never label all relations of a given seller as corrupt or not corrupt. Our method only captures systemic behavior at the procurer-seller level.

cured quantity by pair, we obtain an average mark-up of 157 thousand rubles. Summing the mark-ups over all corrupt pairs yields a total of 161 million rubles waste in reserve prices. Figure 5 reveals large regional variation in both the average reserve price mark-up of corrupt pairs and the share of corrupt pairs in total regional pairs. The figure also reveals a positive association between these two variables. Regions with a higher share of corrupt pairs, that is, also exhibit higher average reserve price mark-ups.[29]

Table 3: Summary corruption indicator

	N	overpricing	%
procurement by procurers			
pairs	10,932	1,028	9.4
procurers	5,542	840	15.2
sellers	2,200	437	19.9
auctions	51,330	7,855	15.3
procurement by centralized agencies			
pairs	3,644	212	5.8
procurers	2,267	198	8.7
sellers	919	133	14.5
auctions	14,521	1,514	10.4

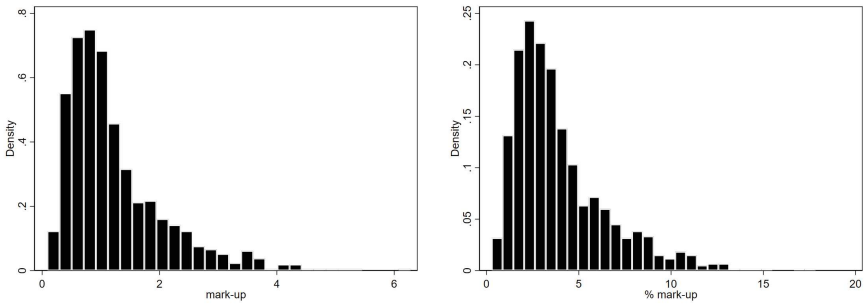
Note: Overpricing indicates whether reserve prices at the procurer-seller level are significantly higher than prices on procurer level.

Comparing the number of corrupt procurers and sellers to the number of corrupt pairs, we can deduct that agents have on average more than one corrupt relation. Overpricing sellers participate in significantly more auctions, confirming the repetitive character of corrupt transactions between two parties in the absence of formal enforcement mechanisms. Moreover the number of unique procurers engaged in corrupt pairs exceeds the number of unique sellers engaged in corrupt pairs, implying that there must be a competition for corrupt sellers among the more ubiquitous corrupt procurers. As a sanity check, we run our method for detecting corrupt pairs on the sample of outsourced public procurements managed by centralized procurement agencies, which we do not further consider in this paper. The results in table 3 show that the share of

[29] Not all regions are included in the figure because not all regions have corrupt pairs.

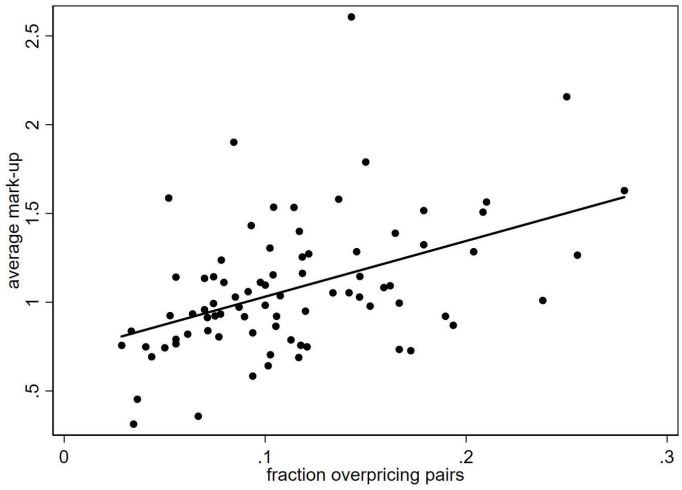
corrupt pairs and corrupt transactions is substantially lower in the sample of centralized procurements than in our sample of decentralized procurements, in line with the earlier findings of Bandiera et al. (2009).[30]

Figure 4: Histogram of mark-up



Note: Sample restricted to unique corrupt pairs.

Figure 5: Regional variation



Note: Sample restricted to unique corrupt pairs.

One could argue that reserve prices are manipulated by only the seller rather

[30] We consider pairs between procurers and sellers, treat agencies as intermediaries and exclude their purchases for themselves from the dataset.

than the procurer-seller pair. Next to fact that it is hard to imagine how this kind of one-sided corruption could work, we also calculate the fraction of corrupt relations per seller and find that all corrupt sellers exhibit at least some non-corrupt relations too, which is in line with our interpretation of corruption as a pair characteristic, rather than a seller characteristic.

4.2 Validity and accuracy of our test to identify reserve price overpricing

Given the given the non-trivial structure of our data, we want to make sure the results of our approach are not driven by randomness, but really capture a stable pattern of reserve price manipulation. Remind that reserve price overpricing is identified through our two-step procedure:

1. Estimate $r_{ijt} = \boldsymbol{X}_{ijt}\boldsymbol{\beta} + \sum \gamma_s year_t + \mu_{ij} + \epsilon_{ijt}$ (model 1)
2. Test if $\mu_{ij} - \mu_i > 0$

Validity First we verify that the share of pairs labeled as corrupt by our method is not driven by randomness. To this purpose we generate the reserve price per liter r_{ijt} under the assumption of no corruption and repeat the two-step procedure:

1. Calculate the linear prediction from model 1
2. Replace μ_{ij} by μ_i (imposing no corruption at the procurer-seller level)
3. Employ the variance of error terms of model 1 to randomly draw errors
4. Generate r_{ijt} (left-hand side) using the elements obtained in step 1, 2 and 3 (right-hand side)
5. Reapply the two-step procedure to identify reserve price overpricing

Given that r_{ijt} is generated in the explicit absence of corruption and tests are performed at the 5% significance level, the two step procedure should identify

approximately 5% of the pairs as corrupt. Accordingly, the null hypothesis of no corruption is rejected in 6.3% of the procurer-seller pairs. We can compare this to the results of the actual analysis (see Section 4.1) where the null hypothesis of no corruption is rejected in 9.4% of the procurer-seller pairs, which is significantly larger than the approximately 5% we could expect by randomness. Our test therefore seems to be valid.

Accuracy Similarly, we want to verify to what extent our test is accurate in labeling the right pairs as corrupt. We test the accuracy or our method to identify reserve price manipulation by drawing the reserve price per liter r_{ijt} from a distribution which assumes corruption.

1. Calculate the linear prediction from model 1
2. Replace μ_{ij} by $\hat{\mu}_{ij}$ (imposing corruption on procurer-seller level)
3. Employ the variance of error terms of model 1 to randomly draw errors
4. Generate r_{ijt} (left-hand side) using the elements obtained in step 1, 2 and 3 (right-hand side)
5. Reapply the two-step procedure to identify reserve price overpricing

Given that r_{ijt} is generated in the presence of corruption and tests are performed at the 5% significance level, this two step procedure should retrieve most of the corrupt pairs. We find that 75% of the procurer-seller pairs labeled as potentially corrupt (see Section 4.1) are again identified as being corrupt, testifying of the accuracy of the method.

These simulations ensure us that the pairs we label as corrupt are not just driven by randomness but capture a true pattern of reserve price manipulation.

4.3 Restricted competition

Corrupt procurers can foster the odds of winning of their favored seller by restricting auction competition. The number of participants can be reduced, for example, by imposing requirements for participation such as a number of gas stations in the district or by shortening the application period. Atmaca (2020) shows that potentially corrupt officials shorten the time firms get to apply for participation in auctions to limit competition and to allocate the contract to favored firms. Regardless of what precise mechanisms are used to restrict participants from entering the auction, we can analyze whether the presence of corrupt pairs in the auction affects competition by estimating the following model:

$$\begin{aligned} \text{competition}_{ijt} = \alpha_1 \text{overpricing}_{ij} + \alpha_2 \text{lnvolume}_{ijt} + \alpha_3 \text{r}_{ijt} \\ + \mathbf{X}_{ijt}\boldsymbol{\beta} + \epsilon_{ijt} \end{aligned} \tag{5}$$

Our first measure of competition *applicants* is the number of applying firms. This variable measures to what extent firms choose not to participate in certain auctions (either through self-selection or because of unobserved pressure by the corrupt pair). Our second measure of competition *exclusion* is a dummy variable equal to 1 if the procurer excluded at least one applicant from the auction. This measures the discretionary exclusion of certain bidders from the auction by public officials. Indeed, officials can exclude bidders from the auction by resorting to the argument that they are not fully complying with some technical details, clauses or conditions of the contract. The third measure *notbidding* is a dummy variable equal to 1 if at least one non-excluded applicant decides not to bid in e-auctions after all. Since the threat of explicit exclusion by the procurer is credible, it is to be expected that some sellers may refrain from participating in e-auctions for which they have come to the understanding their presence is undesired by a corrupt pair. Our fourth measure of competition *bidders* is the number of sellers that in effect place a bid in the auction. Our fifth and final

measure of competition is a dummy equal to 1 if only one bidder remains in the auction.[31] The general interpretation is straightforward: auctions with fewer bidders and especially auctions with only one bidder are less competitive. We expect that procedures with only one bidder will be especially prevalent among corrupt pairs in e-auctions because in this case the law allows procurers to award contracts at the reserve price instead of the winning bid price, which provides an excellent opportunity to transform the inflated reserve price into higher final contract prices.

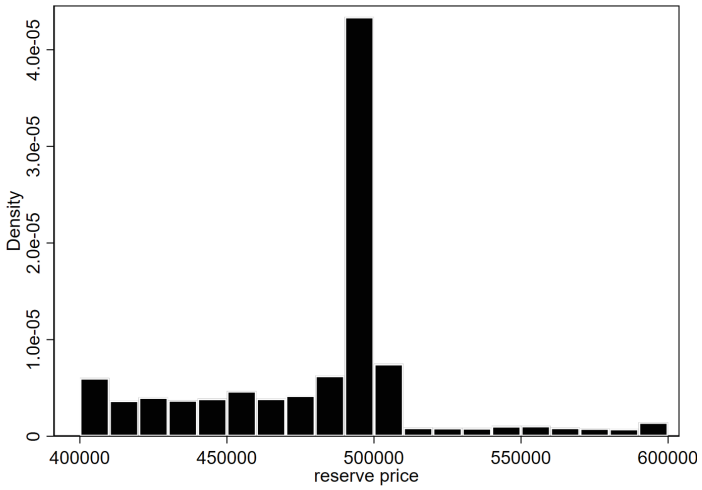
The main independent variable is our pairwise measure of overpricing. If auctions with overpricing corrupt pairs exhibit less competition, we regard this as evidence of our corruption mechanism. The reserve price per liter is included, because it will affect firms' willingness to participate in the auction. We further include the natural logarithm of the contract volume as it will determine firms' ability to deliver. $\mathbf{X}$ contains additional control variables: the auction procedure (sealed bid or e-auction), voluntary e-auctions, year and region fixed effects. The variable *e-auction* is a dummy variable equal to 1 if e-auction and 0 if sealed bid auction. To identify a causal effect of the auction procedure, we rely on the aforementioned procurement rules regarding the mandatory use of e-auctions. First, we distinguish between mandatory and voluntary e-auctions. Then, we compare mandatory e-auctions with sealed bid auctions by controlling for voluntary e-auctions.

Another challenge to the identification of causal effects of the auction procedures is that procurers tend to sort just below the threshold of 500,000 rubles to avoid mandatory e-auctions, as clearly indicated by the distribution of the reserve price in figure 6.[32] In line with Barreca et al. (2016), we deal with this by dropping auctions just below and above the thresholds to account for the

[31] We use a Poisson regression for the estimation of the number of applicants and bidders.
[32] The McCrary (2008) density test rejects the null hypothesis of no discontinuity at the threshold.

manipulation of reserve prices.[33]

Figure 6: Sorting



Note: Sample restricted to the estimation sample of table 2.

The results in tables 4 and 5 shed light on the mechanisms to limit competition in auctions of corrupt pairs. In table 4, the overall effect of corruption on the number of potential competitors in column 1 is negative and statistically significant at the 1% significance level implying auctions of corrupt pairs attract fewer bidders wanting to participate in auctions. E-auctions are characterized by lower entry than sealed bid auctions which is in contrast with the theoretical prediction but in line with the interpretation that a substantial share of the procurers are inclined to exploit the rule that the contract can be concluded at the reserve price if there is only one seller in the auction. Higher reserve prices per liter and higher contract size attract more sellers. In column 2, the corrupt pair dummy is interacted with the auction procedure. The previous result that procurers tend to limit the number of applicants especially for e-auctions is even stronger for e-auctions with corrupt pairs. Similarly in column

[33]More specifically, we drop auctions with reserve price $\in$ [490,000;510,000] rubles.

3 we interact the corruption indicator with a dummy indicating whether the procurer specified the required delivery method. Requiring a specific delivery method can function as an entry barrier, as not every firm will be able to comply with the requirement. This is exactly the mechanism discussed earlier in our example of Kostroma State University (see Section 3.2). Although the direct effect of *delivery* is small and statistically insignificant, we find that requiring a specific delivery method lowers the number of applicants significantly for corrupt pairs. In sum, corrupt pairs limit entry by imposing requirements on the delivery method.

In columns 4-6 we consider exclusion of sellers by procurers and we obtain significant effects of overpricing procurer-seller pairs, suggesting that the reduction of competition does also occur by actively denying applying bidders access to the auction on some technical ground. In column 6, the direct effect of *delivery* is significant and positive, implying that procurers in general use their discretionary power to exclude sellers on the grounds of delivery requirements. For corrupt pairs this effect is reversed, since sellers have in the case of delivery requirements already understood in the first phase of the process they will have no chance of winning and have self-selected out of the auction by not even applying (see column 3). The reserve price per liter has a negative effect on the fraction of allowed applicants and the volume has a positive effect.

In the last column, we estimate the impact of corruption on the decision not to place a bid in e-auctions, despite being authorized to do so. The coefficient of our corrupt pair variable is insignificant and negative.

Table 5 presents the results for the number of sellers that actually place a bid in the auction. We observe that our corrupt pair dummy reduces the number of bidding companies and increases the likelihood that only one bidder finally shows up at the auction, which allows both parties to conclude the contract at the inflated reserve price. When we interact the auction procedures with the corrupt pair dummy, we observe again that corrupt pairs limit competition

Table 4: Mechanisms

	(1) applicants	(2) applicants	(3) applicants	(4) exclusion	(5) exclusion	(6) exclusion	(7) notbidding
Overpricing	-0.0246***	-0.0148***	0.00299	0.130***	0.152***	0.234***	-0.0967
	(0.00521)	(0.00532)	(0.00836)	(0.0488)	(0.0531)	(0.0717)	(0.0768)
E-auction	-0.370***	-0.366***	-0.369***	-1.450***	-1.427***	-1.465***	
	(0.00760)	(0.00781)	(0.00768)	(0.0734)	(0.0767)	(0.0739)	
Overpricing*E-auction		-0.0299**			-0.138		
		(0.0123)			(0.131)		
Delivery			-0.00433			0.119***	
			(0.00424)			(0.0396)	
Overpricing*Delivery			-0.0508***			-0.183*	
			(0.0103)			(0.0955)	
r	0.00300***	0.00299***	0.00307***	-0.0270***	-0.0270***	-0.0276***	-0.0242
	(0.00107)	(0.00107)	(0.00107)	(0.00948)	(0.00948)	(0.00951)	(0.0158)
Lnvolume	0.0454***	0.0457***	0.0452***	0.132***	0.133***	0.135***	0.147***
	(0.00229)	(0.00229)	(0.00229)	(0.0208)	(0.0208)	(0.0208)	(0.0377)
Voluntary e-auction	-0.0137	-0.0130	-0.0143	-0.378***	-0.375***	-0.374***	-0.0513
	(0.00922)	(0.00923)	(0.00923)	(0.111)	(0.111)	(0.111)	(0.0970)
Constant	-0.251***	-0.255***	-0.246***	-3.830***	-3.843***	-3.914***	-3.466***
	(0.0552)	(0.0552)	(0.0552)	(0.708)	(0.708)	(0.709)	(0.820)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	47,521	47,521	47,521	47,521	47,521	47,521	15,579

Notes: The first dependent variable is the number of applicants, *exclusion* is a dummy variable equal to 1 if the procurer excluded at least one applicant from the auction and *notbidding* is a dummy variable equal to 1 if a not excluded applicant decides not to bid. *Overpricing* is a dummy variable equal to 1 if reserve prices on procurer-seller level are significantly higher than prices on procurer level, *e-auction* is a dummy variable equal to 1 if e-auction and 0 if sealed bid auction, r is the reserve price per liter of gasoline, *lnvolume* is the natural logarithm of the contract volume, *voluntary e-auction* is a dummy variable equal to 1 if e-auction is not mandatory but voluntary, *delivery* is a dummy variable equal to 1 if the delivery method is specified. Sealed bid auctions with reserve price $\in$ [490,000;510,000] RUB are dropped because of manipulation of the reserve price. The sample in column 7 is restricted to e-auctions. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

more in e-auctions than in sealed bid auctions. In sum, our results are in line with a mechanism by which the reduction of the number of bidding firms does occur through both explicit exclusion of certain bidders by corrupt procurers and credibly threatening unwanted bidders with this perspective, causing them to self-select out of the bidding process despite the attractive high reserve price. The effects of the control variables on the number of bidders are in line with the effects on the number of applicants.

Table 5: Competition

	(1) bidders	(2) bidders	(3) 1 bidder	(4) 1 bidder
Overpricing	-0.0360***	-0.0266***	0.188***	0.0702*
	(0.00488)	(0.00586)	(0.0301)	(0.0377)
E-auction	-0.417***	-0.413***	2.413***	2.363***
	(0.00712)	(0.00734)	(0.0429)	(0.0438)
Overpricing*E-auction		-0.0296***		0.349***
		(0.0101)		(0.0645)
r	0.00550***	0.00549***	-0.0377***	-0.0375***
	(0.000973)	(0.000973)	(0.00591)	(0.00592)
Lnvolume	0.0363***	0.0365***	-0.164***	-0.167***
	(0.00223)	(0.00224)	(0.0131)	(0.0131)
Voluntary e-auction	0.0104	0.0110	-0.116**	-0.122**
	(0.00824)	(0.00824)	(0.0482)	(0.0482)
Constant	-0.292***	-0.295***	3.156***	3.201***
	(0.0526)	(0.0526)	(0.335)	(0.334)
year FE	Yes	Yes	Yes	Yes
region FE	Yes	Yes	Yes	Yes
Observations	47,521	47,521	47,521	47,521

Notes: The dependent variable in the first two columns is the number of bidders and in the last two columns a dummy variable equal to 1 if the number of bidders is 1. *Overpricing* is a dummy variable equal to 1 if reserve prices at the procurer-seller level are significantly higher than prices at the procurer level, *e-auction* is a dummy variable equal to 1 if e-auction and 0 if sealed bid auction, r is the reserve price per liter, *lnvolume* is the natural logarithm of the contract volume and *voluntary e-auction* is a dummy variable if e-auction is not mandatory but voluntary. Auctions with reserve price $\in$ [490,000;510,000] RUB are dropped because of manipulation of the reserve price. Robust standard errors in parentheses.

*** p<01, ** p<05, * p<0.1

4.4 Increased probability of winning

Our procedure detects systemic deviations in reserve prices on procurer-seller level and shows that these are inversely related to competition but to nail down the identification of corrupt pairs, we also need to confirm that winning bids indeed accrue to corrupt pairs. After all, corrupt reserve prices are set in consultation with bidders to allocate contracts to those bidders in exchange for private benefits in kind or in cash (bribes). To finance these corrupt private benefits for procurers, the bidders need to be more likely to win the procedure and the final price has to provide enough rent to finance this private benefit. Here we analyze the former part of this assertion. The latter part is analyzed in the next section. In table 6 we estimate the probability of winning auctions given corrupt relations *overpricing* using a logistic regression with procurer i, bidder b at time t:

$$\text{winning auction}_{\text{ibt}} = \alpha_1 \text{overpricing}_{\text{ibt}} + \alpha_2 \text{bidders}_{\text{ibt}} + \mathbf{X}_{\text{ibt}}\boldsymbol{\beta} + \epsilon_{\text{ibt}} \quad (6)$$

The results in table 6 show that bidding firms are much more likely to win if they form a corrupt pair with the procurer. The odds of winning in column 1 are 18.3% higher for overpricing pairs than for pairs that do not manipulate reserve prices. The marginal effect, evaluated at the means of covariates, is 2 percentage points. These results are in line with the results by Baltrunaite (2019) who showed that corporate donors with favored connections had higher chances of getting public contracts. We also find that the probability of obtaining the contract is lower in e-auctions and when competition increases. The effect of corruptly overpricing does not vary with the auction procedure (columns 2, 4 and 6). In columns 3-6, region fixed effects are replaced by procurer fixed effects. Even within the subsample of sellers that have at least one corrupt relation (see columns 5 and 6), sellers are much more likely to win the auction if they form a corrupt pair with the procurer.

Table 6: Probability of winning public contracts

	(1) win	(2) win	(3) win	(4) win	(5) win	(6) win
Overpricing	0.168***	0.155***	0.232***	0.240***	0.367***	0.368***
	(0.0338)	(0.0409)	(0.0463)	(0.0552)	(0.0550)	(0.0659)
E-auction	-0.198***	-0.204***	-0.0319	-0.0281	-0.0578	-0.0572
	(0.0331)	(0.0345)	(0.0574)	(0.0591)	(0.0680)	(0.0711)
Overpricing*E-auction		0.0398		-0.0245		-0.00323
		(0.0720)		(0.0904)		(0.100)
Bidders	-1.347***	-1.347***	-1.406***	-1.406***	-1.627***	-1.627***
	(0.0168)	(0.0168)	(0.0216)	(0.0216)	(0.0277)	(0.0277)
Voluntary e-auction	-0.0643	-0.0646	0.0129	0.0126	-0.0305	-0.0306
	(0.0437)	(0.0438)	(0.0612)	(0.0612)	(0.0708)	(0.0708)
Constant	4.269***	4.273***				
	(0.255)	(0.256)				
region FE	Yes	Yes	No	No	No	No
year FE	Yes	Yes	Yes	Yes	Yes	Yes
procurer FE	No	No	Yes	Yes	Yes	Yes
Observations	64,283	64,283	48,771	48,771	34,230	34,230
Procurers			3,052	3,052	2,413	2,413

Notes: The dependent variable *win* is a dummy variable equal to 1 if the bidder is the winner of the auction. *Overpricing* is a dummy variable equal to 1 if reserve prices at the procurer-seller level are significantly higher than prices at the procurer level, *bidders* is the number of bidders, *voluntary e-auction* is a dummy variable equal to 1 if e-auction is not mandatory but voluntary. Auctions with reserve price $\in$ [490,000;510,000] RUB are dropped because of manipulation of the reserve price. The sample in the last two columns is restricted to sellers who have at least one corrupt relation. Standard errors in parentheses.

*** p<01, ** p<05, * p<0.1

4.5 Higher final contract prices

After having shown that our overpricing procurer-seller pairs face less auction competition despite the higher reserve price and are more likely to win auctions, we finally need to show that their auctions also lead to higher final prices. Without the rent provided by higher final prices, corrupt winning bidders would not be able to finance the private benefits promised to the procurer. Without higher final prices, that is, a crucial step in the corruption mechanism would be missing. We can expect that the transmission of inflated reserve prices to higher contract prices also depends on competition and on the auction procedure. First, corrupt pairs may not be able or not want to completely control competition in all cases. In auctions of corrupt pairs with relatively high competition, we can therefore expect that final prices may be relatively lower. Still this behavior may make sense because allowing some competition some of the time reduces the odds of being caught, which has to be traded off against the lower final prices. Second, the auction procedure itself may also affect non-corrupt agents' incentives to participate. For the allocation of urban land in China for example, Cai et al. (2013) find that the auction procedure is exploited by auctioneers for corrupt deals, leading to lower competition. Therefore the specification below regresses the relative difference between the contract price and the monthly regional market price per liter of gasoline p on the same independent variables as before, accounting for the interaction effects between corrupt procurer-seller pairs, auction competition and auction procedure:

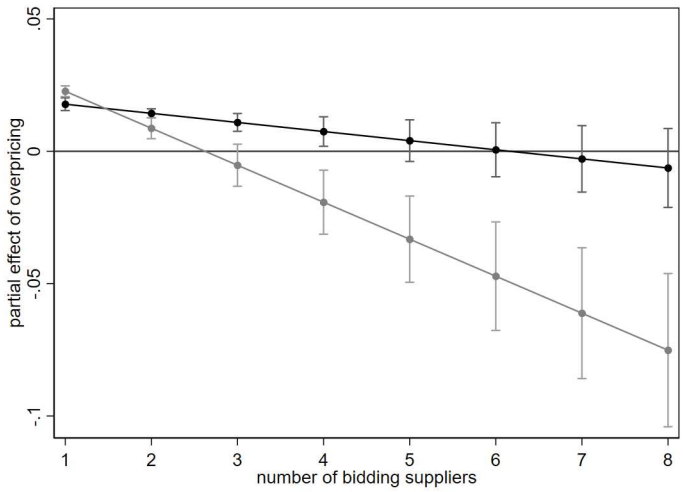
$$\begin{aligned} \mathrm{p_{ijt}} = {} & \alpha_1 \mathrm{overpricing_{ij}} + \alpha_2 \mathrm{r_{ijt}} + \alpha_3 \mathrm{lnvolume_{ijt}} + \alpha_4 \mathrm{bidders} \\ & + \alpha_5 \mathrm{overpricing_{ij}} * \mathrm{e\,auction_{ijt}} + \alpha_6 \mathrm{overpricing_{ij}} * \mathrm{bidders_{ijt}} \\ & + \alpha_7 \mathrm{overpricing_{ij}} * \mathrm{e\,auction_{ijt}} * \mathrm{bidders_{ijt}} + \mathrm{X_{ijt}}\boldsymbol{\beta} + \epsilon_{\mathrm{ijt}} \end{aligned} \tag{7}$$

Table 7 reveals that *overpricing* has the expected sign: corrupt pairs indeed also enjoy the higher final prices they need to finance corruption fees. The regression results without interaction terms are provided in column 1. The price increases by 1.72 percentage points. Both the reserve price per liter and the

contract volume significantly and positively affect prices. As expected, final contract prices are also significantly affected by competition[34] and by the auction procedure. While competition is related to relatively lower final contract prices, e-auctions unexpectedly do not exhibit by themselves lower final prices. The negative and statistically significant coefficient of the interaction between competition and the auction procedure however reveals that e-auctions become effective in reducing final prices once there is sufficient competition (column 2). The coefficient of the interaction between corrupt pairs and competition (*overpricing*bidders*) is negative and significant, indicating that corruption is less effective in inflating final prices in the presence of several bidders. The interaction term *overpricing*auction* has a significant and positive coefficient while the effect of *overpricing*auction*bidders* is significant and negative. The adverse effect of corruption on higher final prices is therefore larger for e-auctions than for sealed bid auctions in the case of one bidder but this relation is reversed once competition increases. Figure 7 visualizes the partial effect of corrupt pairs on final contract prices for sealed bid and e-auctions, conditional on the number of bidders in the auction. We may conclude that competition is an effective tool to combat corruption and especially so in open bid e-auctions. This finding partially results from the procurement rule that permits procurers in e-auctions with only one bidder to conclude the contract at the reserve price, which implies a large downward marginal effect on the final price from securing at least three real competitors in the e-auction.

[34]The number of observations by auction procedure and number of bidders is shown in table A.12 part of the appendix.

Figure 7: Partial effect of overpricing on contract prices



Notes: Black (gray) line shows partial effect and the 95% confidence interval of corruption in sealed bid auctions (e-auctions) based on table 7.

5 Further robustness of the corrupt pairs

5.1 Simulations

To make sure our results are not driven by random variation in the setting of reserve prices, we conduct a set of straightforward simulations. We start from the sample of pairs for which we could tell whether there is overpricing. We then randomly label pairs of procurers and sellers as corruptly overpricing. The fraction of randomly defined corrupt pairs is restricted to the fraction of pairs labeled as corrupt in our empirical results (9.4 %). We then use these randomly generated corruption variables to estimate the effect of being a corrupt pair on the number of bidders, the probability of one bidding firm, the probability of winning and final contract prices. We iterate this procedure 5,000 times.

The regression coefficients of these 5,000 simulated random sets of corrupt pairs are plotted in figure 8, with the effect on the number of bidders in the

Table 7: Contract price

	(1) p	(2) p
Overpricing	0.0172***	0.0212***
	(0.000642)	(0.00227)
E-auction	0.000603	0.0481***
	(0.000810)	(0.00144)
Bidders	-0.0212***	-0.0122***
	(0.000358)	(0.000365)
Overpricing*E-auction		0.0154***
		(0.00354)
Overpricing*Bidders		-0.00344***
		(0.00121)
Bidders*E-auction		-0.0341***
		(0.000957)
Overpricing*E-auction*Bidders		-0.0105***
		(0.00248)
r	0.0158***	0.0158***
	(0.000153)	(0.000151)
Lnvolume	0.000883***	0.000964***
	(0.000252)	(0.000246)
Voluntary e-auction	0.00299***	0.00111
	(0.000877)	(0.000836)
Constant	-0.519***	-0.533***
	(0.00708)	(0.00695)
region FE	Yes	Yes
year FE	Yes	Yes
Observations	46,717	46,717

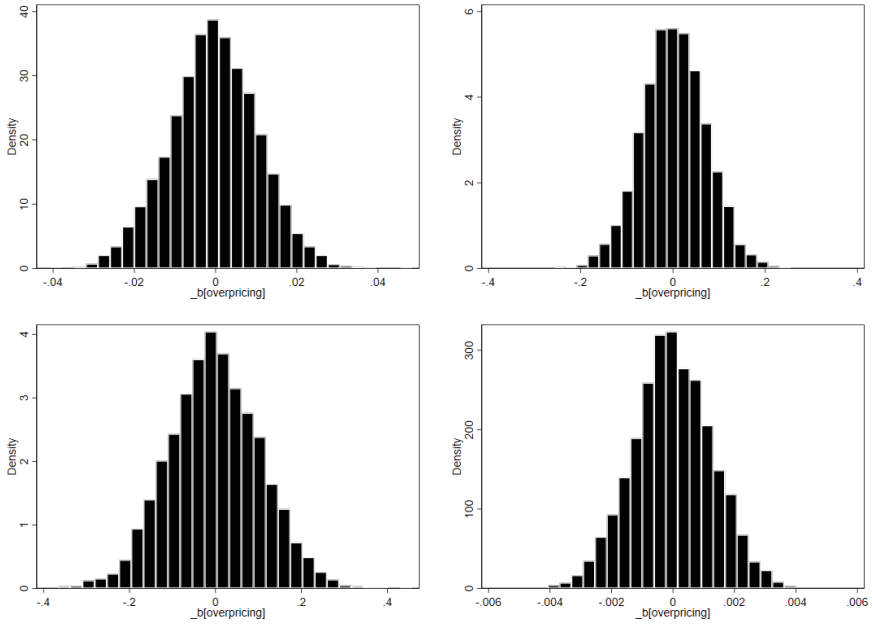
Notes: The dependent variable p is the winning bid per liter minus the market price divided by the latter. *Overpricing* is a dummy variable equal to 1 if reserve prices at the procurer-seller level are significantly higher than prices at the procurer level, *e-auction* is a dummy variable equal to 1 if e-auction and 0 if sealed bid auction, *bidders* is the number of bidders, r is the reserve price per liter of gasoline, *lnvolume* is the natural logarithm of the contract volume, *voluntary e-auction* is a dummy variable equal to 1 if e-auction is not mandatory but voluntary. Auctions with reserve price $\in$ [490,000;510,000] RUB are dropped because of manipulation of the reserve price. Robust standard errors in parentheses.

*** p<01, ** p<05, * p<0.1

upper left panel, on the probability of one bidding firm in the upper right panel,

on the probability of winning in the lower left panel and on final contract prices in the lower right panel. The coefficients of the simulations are not skewed to the left (right) of zero in the estimation of the number of bidders (probability of one bidding firm, probability of winning, final contract price). Since the effects of the randomly defined corruption indicators is on average zero we rest assured that our approach of detecting reserve price overpricing is not driven by randomness.

Figure 8: Simulations



Notes: Random labeling of pairs of procurers and sellers used in the estimation of the number of bidders (upper left panel), the probability of one bidding firm (upper right panel), the probability of winning controlling for procurer fixed effects (lower left panel) and contract prices (lower right panel). Coefficients of 5,000 simulations are plotted.

5.2 Evidence from a corruption perception index

In this part we correlate our corruption indicator with existing indicators that capture similar forms of corruption as a back of the envelope sanity check of our approach. We make use of the Georating survey from the Public Opinion Foundation, commonly referred to as FOM.[35] The survey from 2008 (but not later surveys unfortunately) includes questions on corruption that are particularly relevant for our research. As corruption is relatively persistent we expect that the 2008 responses still largely reflect the variation in corruption in our sampling period. The first relevant survey question (q39) related to the fight against corruption by regional governments provides the following response options: 1) the regional government is willing and able to deal effectively with corruption, 2) the regional government wants, but cannot effectively fight corruption, 3) the regional government may, but does not want to fight corruption effectively and 4) the regional government does not want and cannot effectively fight corruption. Higher values reflect a lower willingness of the regional authorities to fight corruption. The next question (q42) is 'Have you personally experienced in the last year or two that any civil servant requested or expected an informal payments in return for their service?' which can be replied on a four point scale ranging from 1) certainly and 4) definitely not or 5) difficult to answer. Lastly, the question 'Have you ever given a bribe to an official?' (q46) with the same set of possible answers as the previous question is considered. For each corruption indicator, we take the mean per region to construct a regional corruption index. Then, we calculate the regional amount of overpriced auctions and overpricing procurer-seller pairs to correlate with the subjective corruption indices. The correlations have the correct sign but only the last question on the willingness to bribe officials significantly correlates with our overpricing indicator (table 8).[36] The fact that our approach detects more corrupt pairs in regions where individuals are more likely to bribe officials provides some comfort about the general validity of our approach.

[35] https://fom.ru/

[36] Using the fraction of overpriced transactions and overpricing pairs gives similar results.

Table 8: Correlation with corruption indices

	q39	q42	q46
Overpriced transactions			
ρ	0.1780	-0.0503	-0.1815
p-value	0.1464	0.6882	0.1385
N	68	66	68
Overpricing pairs			
ρ	0.1878	-0.0233	-0.2042
p-value	0.1250	0.8526	0.0949
N	68	66	68

Notes: The variables are at regional level. The corruption indicators are correlated to the number of overpriced transactions in the first panel and the number of overpricing pairs in the second panel. *Q39*, *q42* and *q46* are from the Georating survey and measure respectively the fight against corruption, civil servants requesting informal payments and the willingness to bribe. The lower the values of *q42* and *q46*, the higher corruption. The correlation coefficient, p-value and number of observations is provided for each variable.

6 Robustness of the empirical estimations

6.1 Control variables

Procurers who agree with firms to manipulate reserve prices may simultaneously select a procedure to determine the allocation of the contracts. For this reason, we additionally control for the auction procedure in the estimation of the reserve price per liter. The correlation between the resulting corruption indicator and our baseline is 0.97 and significant. The inclusion of the auction procedure therefore hardly affects the identification of overpriced reserve prices. The choice of the auction procedure varies with the procurer instead of the combination of procurer and seller. More than 80% of the procurers made use exclusively of either sealed bid or e-auctions. The rest of the procurers implemented both procedures.

Then, we control for the time until first delivery. The risk premium will increase with the time between the publication of the auction and the day of

first delivery. By applying text analysis, we can deduct the day of first delivery and calculate the duration for 67,285 auctions after correcting for outliers and obvious errors. By including duration as a control variable, we keep a fifth of the procurer-seller pairs. Our methodology is robust for including the duration of contracts. The resulting corruption indicator is highly correlated to our initial index. The correlation is 0.75 and statistically significant.

6.2 Fully interacted model

The competition, probability of winning and price regressions only include interactions between the overpricing indicator and the auction procedure. It follows that our baseline estimates only provide the average effects of the control variables but we cannot exclude these effects may also vary with the procedure. Therefore we test whether our results are robust to interacting all covariates with the auction procedure. The impact of the overpricing indicator remains robust in the fully interacted models (tables A.14-A.17 in appendix A2). Furthermore, the net effect of the control variables and the interaction terms are in line with the baseline estimates.

6.3 Sample period

As mentioned in the previous section, the government amended Federal Law No.94-FZ of 21/7/2005 on 21/4/2011 by obliging procurers to disclose information on the calculation of reserve prices. The change in law might influence procurers' behavior in setting the level of these prices, which could lead to a structural break in prices. To account for this, we drop auctions that were announced before 21/4/2011 and repeat our analysis. *Overpricing* in the restricted sample is highly correlated to our baseline *overpricing* variable. The correlation is 0.89 and statistically significant.

7 Conclusion

We propose a generic method to identify corruption in auctions with reserve prices and apply it to Russian public procurement auction of gasoline in the period 2011-2013. We identify corrupt procurer-seller pairs by exploiting the variation in reserve prices. More specifically, we estimate reserve prices as a function of the local market price, contract, procurer characteristics, time controls and procurer-seller fixed effects. A procurer-seller pair is labeled as potentially corrupt if its pair fixed effect is significantly larger than the average procurer fixed effect. Since the reserve price is set before the public procurement auction, it should never be dependent on the winning seller within the same procurer but still we observe it is the case in 9.4% of procurer seller pairs, representing not less than 15.3% of the transactions.

Despite overpricing, favored sellers face less competition in auctions organized by procurers with whom they form a corrupt pair and have a higher probability of winning these auctions, suggesting that potential competitors are successfully discouraged from applying to high reserve price auctions by corrupt pairs. Finally, auctions won by corrupt pairs also exhibit higher final contract prices, indicating there is a substantial welfare cost from this type of reserve price inflation. The good news is that the negative effect of reserve price manipulation on final prices is mitigated by higher competition and can even be fully offset by e-auctions with sufficient competitors.

All this evidence is in line with a mechanism whereby corrupt procurers succeed in allocating public procurement orders to favored sellers at inflated prices, creating a private benefit for themselves at the expense of the government's budget. We believe therefore it would be useful to integrate our straightforward approach in anti-corruption efforts as a low cost and automated effort to find some good first indications of which pairs deserve further inspection. Although corrupt agents could hide malpractice by taking this measure into account and

switching to other forms of corruption, the reserve price still determines to what extent money can be tunneled from the public to the private sphere. Corrupt agents could prevent the detection of reserve price manipulation by also assigning contracts with inflated reserve prices to random sellers, yet this strategy is costly. Even if they successfully circumvent exposure, the measure can still be applied on prior purchases and provide insights into reserve price manipulation.

The method examines repeated interactions between procurers and sellers. Since our method relies on reserve price differences between multiple sellers within the same procurer, it is not able to identify corrupt relations of procurers that have transactions with mainly or only one seller or only transact with favored sellers. In these cases our method will underestimate the degree of favoritism. Our estimates of reserve price-related favoritism are therefore to be considered as lower bound estimates of the true level of favoritism.

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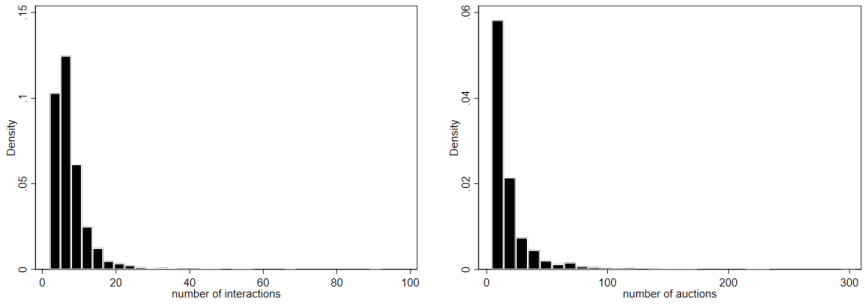
Appendix

Table A.9: Significance level

Significance level	N	Overpricing	%
1	10,932	402	3.7
5	10,932	1,028	9.4
10	10,932	1,659	15.2

Figure A.9: Histogram of the number of interactions and auctions



Note: The figure on the left shows the number of interactions between potentially corrupt procurers and suppliers and the number of auctions per corrupt procurer is graphed on the right.

Table A.10: Sample

	N
Initial sample	171,984
- Outsourcing	48,659
- Missing seller identity	18,441
- Missing volume	14,232
- Missing reserve price per liter	8,838
Reduced sample	81,813

Table A.11: Summary statistics by sample

	No outsourcing			Reserve price			Overpricing		
	N	mean	sd	N	mean	sd	N	mean	sd
1 bidder	123,325	0.4	0.5	81,813	0.5	0.5	51,330	0.5	0.5
Applicants	123,325	1.5	1	81,813	1.8	0.8	51,330	1.7	0.8
Bidders	123,325	1.4	0.9	81,813	1.6	0.7	51,330	1.6	0.7
Delivery	123,325	0.6	0.5	81,813	0.6	0.5	51,330	0.6	0.5
E-auction	123,325	0.3	0.5	81,813	0.3	0.5	51,330	0.3	0.5
Exclusion	123,325	0.1	0.3	81,813	0.1	0.3	51,330	0.1	0.3
Federal	123,325	0.6	0.5	81,813	0.6	0.5	51,330	0.6	0.5
Lnvolume	106,294	9	1.5	81,813	9	1.2	51,330	8.9	1.2
Market price	109,169	27.9	2.8	81,813	27.9	2.4	51,330	27.9	2.3
Mixed	123,324	0	0.1	81,813	0	0.1	51,330	0	0.1
Municipal	123,325	0.2	0.4	81,813	0.2	0.4	51,330	0.2	0.4
Notbidding	123,325	0	0.2	81,813	0	0.2	51,330	0	0.2
p	81,146	1	0.1	80,216	1	0.1	50,416	1	0.1
r	95,392	29.2	2.8	81,813	29.4	2.8	51,330	29.3	2.8
Voluntary e-auction	123,325	0.1	0.3	81,813	0.1	0.3	51,330	0.1	0.4
Win	124,159	0.8	0.4	97,131	0.8	0.4	69,470	0.8	0.4

Notes: The first sample is without outsourced procurement. The second sample – used for the estimation of the reserve price per liter – is without missing seller identity, volume and reserve price per liter. The third sample contains the observations without missing values for *overpricing*.

Table A.12: Number of bidding suppliers by auction procedure

		number of bidding suppliers							
	N	1	2	3	4	5	6	7	8
sealed bid auction	30,975	10,763	16,812	2,853	444	78	20	4	1
e-auction	15,742	12,450	2,706	493	81	10	1	0	1

Note: The number of observations by auction procedure and number of bidding suppliers is based on the estimation sample of table 7.

Table A.13: Variable description

Variable	Description
1 bidder	Dummy variable equal to 1 if the number of bidders is 1
Applicants	Number of applicants
Bidders	Number of bidders
Delivery	Dummy variable equal to 1 if the delivery method is specified
E-auction	Dummy variable equal to 1 if electronic open bid auction and 0 if sealed bid auction
Exclusion	Dummy variable equal to 1 if the procurer excluded at least one applicant from the auction
Federal	Dummy variable equal to 1 if the procurer is on federal level
Lnvolume	Natural logarithm of the contract volume
Market price	Weighted average of monthly market prices of different gasoline types
Mixed	Dummy variable equal to 1 if procurement can contain other items like engine oils or greases
Municipal	Dummy variable equal to 1 if the procurer is on municipal level
Notbidding	Dummy variable if a not excluded applicant decides not to bid
Overpricing	Dummy variable equal to 1 if reserve prices on procurer-seller level are significantly higher than prices on procurer level
p	Winning bid per liter of gasoline minus the market price divided by the latter
r	Reserve price per liter of gasoline
Regional	Dummy variable equal to 1 if the procurer is on regional level
Voluntary e-auction	Dummy variable equal to 1 if e-auction is not mandatory but voluntary
Win	Dummy variable equal to 1 if bidder is the winner of the auction

Fully interacted model

Table A.14: Self-selection and exclusion, fully interacted model

	(1) applicants	(2) applicants	(3) exclusion	(4) exclusion
Overpricing	-0.0194***	-0.0119	0.150***	0.207***
	(0.00531)	(0.00752)	(0.0536)	(0.0793)
E-auction	-0.416***	-0.375***	-8.851***	-8.711***
	(0.143)	(0.142)	(1.716)	(1.722)
Overpricing*E-auction	-0.0175	0.0297	-0.182	-0.0220
	(0.0127)	(0.0224)	(0.137)	(0.195)
Delivery		0.00461		0.136***
		(0.00442)		(0.0425)
Delivery*E-auction		-0.0520***		-0.217*
		(0.0119)		(0.123)
Overpricing*Delivery		-0.0138		-0.0939
		(0.0102)		(0.105)
Overpricing*E-acution*Delivery		-0.0870***		-0.341
		(0.0263)		(0.272)
r	0.00447***	0.00445***	-0.0388***	-0.0399***
	(0.00104)	(0.00105)	(0.0103)	(0.0104)
Lnvolume	0.0352***	0.0353***	0.0933***	0.0976***
	(0.00237)	(0.00238)	(0.0216)	(0.0217)
Voluntary e-auction	0.0384***	0.0394***	0.159	0.167
	(0.0137)	(0.0137)	(0.163)	(0.162)
r*E-auction	-0.00479	-0.00485*	0.0638**	0.0644**
	(0.00295)	(0.00293)	(0.0275)	(0.0275)
Lnvolume*E-auction	0.0355***	0.0357***	0.243***	0.240***
	(0.00612)	(0.00611)	(0.0621)	(0.0622)
Constant	-0.278***	-0.281***	-2.790***	-2.883***
	(0.0570)	(0.0570)	(0.729)	(0.731)
Year FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Observations	47,521	47,521	46,038	46,038

Notes: The first dependent variable is the number of applicants, *exclusion* is a dummy variable equal to 1 if the procurer excluded at least one applicant from the auction and *notbidding* is a dummy variable if a not excluded applicant decides not to bid. *Overpricing* is a dummy variable equal to 1 if reserve prices on procurer-seller level are significantly higher than prices on procurer level, *e-auction* is a dummy variable equal to 1 if e-auction and 0 if sealed bid auction, r is the reserve price per liter of gasoline, *lnvolume* is the natural logarithm of the contract volume, *voluntary e-auction* is a dummy variable equal to 1 if e-auction is not mandatory but voluntary and *delivery* is a dummy variable equal to 1 if the delivery method is specified. Sealed bid auctions with reserve price $\in$ [490,000;510,000] RUB are dropped because of manipulation of the reserve price. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table A.15: Competition, fully interacted model

	(1) Bidders	(2) 1 bidder
Overpricing	-0.0299***	0.0864**
	(0.00590)	(0.0385)
E-auction	-0.283**	-0.941
	(0.121)	(0.700)
r	0.00680***	-0.0458***
	(0.00111)	(0.00720)
Lnvolume	0.0311***	-0.159***
	(0.00255)	(0.0154)
Voluntary e-auction	0.0288**	-0.103
	(0.0117)	(0.0696)
Overpricing*E-auction	-0.0210**	0.309***
	(0.0104)	(0.0677)
Lnvolume*E-auction	0.0191***	-0.0367
	(0.00539)	(0.0315)
r*E-auction	-0.00345	0.0173
	(0.00227)	(0.0134)
Constant	-0.373***	4.628***
	(0.0602)	(0.386)
Year FE	Yes	Yes
Region FE	Yes	Yes
Observations	47,521	47,519

Notes: The dependent variable in column 1 is the number of bidders and in column 2 a dummy variable equal to 1 if the number of bidders is 1. *Overpricing* is a dummy variable equal to 1 if reserve prices at procurer-seller level are significantly higher than prices at procurer-level, *e-auction* is a dummy variable equal to 1 if e-auction and 0 if sealed bid auction, r is the reserve price per liter, *lnvolume* is the natural logarithm of the contract volume and *voluntary e-auction* is a dummy variable if e-auction is not mandatory but voluntary. Sealed bid auctions with reserve price $\in$ [490,000;510,000] RUB are dropped because of manipulation of the reserve price. Robust standard errors in parentheses.

*** p<01, ** p<05, * p<0.1

Table A.16: Probability of winning, fully interacted model

	(1) win	(2) win	(3) win
Overpricing	0.174***	0.252***	0.381***
	(0.0401)	(0.0544)	(0.0648)
E-auction	1.133**	1.246***	1.506***
	(0.532)	(0.309)	(0.368)
Bidders	-1.083***	-1.143***	-1.302***
	(0.0191)	(0.0246)	(0.0320)
Voluntary e-auction	-0.129**	-0.0512	-0.115
	(0.0506)	(0.0657)	(0.0763)
Overpricing*E-auction	0.00497	-0.0934	-0.0438
	(0.0777)	(0.0942)	(0.104)
Bidders*E-auction	-0.965***	-0.882***	-0.999***
	(0.0420)	(0.0490)	(0.0611)
Constant	3.930***		
	(0.339)		
Region FE	Yes	No	No
Year FE	Yes	Yes	Yes
Procurer FE	No	Yes	Yes
Observations	64,225	48,771	34,230
Procurers		3,052	2,413

Notes: The dependent variable *win* is a dummy variable equal to 1 if the bidder is the winner of the auction. *Overpricing* is a dummy variable equal to 1 if reserve prices at procurer-seller level are significantly higher than prices at procurer level, *bidders* is the number of bidders, *voluntary e-auction* is a dummy variable equal to 1 if e-auction is not mandatory but voluntary. Sealed bid auctions with reserve price $\in$ [490,000;510,000] RUB are dropped because of manipulation of the reserve price. The sample in the last column is restricted to sellers who have at least one corrupt relation. Standard errors in parentheses.

*** p<01, ** p<05, * p<0.1

Table A.17: Contract price, fully interacted model

	(1)	(2)
	p	p
Overpricing	0.0166***	0.0223***
	(0.000808)	(0.00225)
E-auction	-0.0758***	-0.0769***
	(0.0147)	(0.0147)
Bidders	-0.0117***	-0.0114***
	(0.000360)	(0.000371)
Overpricing*E-auction	-0.000434	0.0111***
	(0.00124)	(0.00353)
Overpricing*Bidders		-0.00324***
		(0.00120)
Overpricing*E-auction*Bidders		-0.0108***
		(0.00251)
r	0.0145***	0.0145***
	(0.000186)	(0.000186)
Lnvolume	0.000769***	0.000782***
	(0.000292)	(0.000292)
Voluntary e-auction	0.00274**	0.00285**
	(0.00114)	(0.00114)
Bidders*E-auction	-0.0388***	-0.0370***
	(0.000933)	(0.000992)
r*E-auction	0.00379***	0.00376***
	(0.000315)	(0.000315)
Lnvolume*E-auction	0.000559	0.000574
	(0.000553)	(0.000552)
Constant	-0.489***	-0.490***
	(0.00901)	(0.00901)
Region FE	Yes	Yes
Year FE	Yes	Yes
Observations	46,717	46,717

Notes: The dependent variable p is the winning bid per liter of gasoline minus the market price divided by the latter. *Overpricing* is a dummy variable equal to 1 if reserve prices at procurer-seller level are significantly higher than prices at procurer level, *e-auction* is a dummy variable equal to 1 if e-auction and 0 if sealed bid auction, *bidders* is the number of bidders, r is the reserve price per liter of gasoline, *lnvolume* is the natural logarithm of the contract volume, *voluntary e-auction* is a dummy variable equal to 1 if e-auction is not mandatory but voluntary. Sealed bid auctions with reserve price $\in$ [490,000;510,000] RUB are dropped because of manipulation of the reserve price. Robust standard errors in parentheses.

*** p<01, ** p<05, * p<0.1

Determination of reserve prices

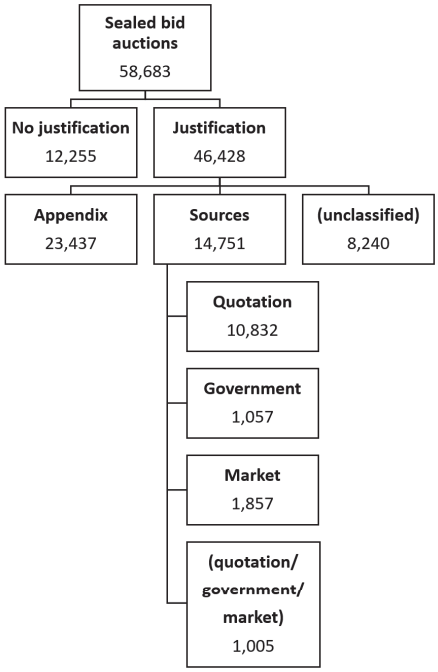
Since the amendment of 21/4/2011 procurers have to explain the level of reserve prices of both sealed bid and e-auctions in tender documentation. From October 2011 onward, they also have to report the calculation for sealed bid auctions in the tender notice. The on-line notices contain an additional field 'justification of reserve price' where procurers can explain how they established the reserve price and/or refer to the appendix. In October 2011, the field is not always filled out but since November 2011 it is. To analyze the determination of reserve prices, the sample is restricted to sealed bid auctions for which the procurers justified reserve prices in the tender notice. Given this information, we will distinguish between three main groups: *quotation*, *government* and *market*. The information does not have a standardized format but is instead a piece of text which we have to clean before we apply text analysis. Reserve prices based on price quotations from firms are detected by the words (in Russian): *запрос*, *котиров*, *предложен* and *оферты*. Public institutions such as the Rosstat, Federal Anti-Monopoly Service, Federal Tax Service, Ministry of Economic Development and also regional departments are captured by: *федеральной службы государственной статистики*, *gks*, *уфас*, *уфнс россии*, *минэкономики*, *министерства экономики*, *письму министерства экономики*, *письмо министерства экономики*, *департамента экономического развития*, *бюллетень рекомендуемых*, *бюллетень предельных цен*, *дцт*, *департаментом цен и тарифов*, *департаменте цен и тарифов* and *департамента цен и тарифов*. Finally, prices from the Internet, petrol stations and register of contracts are related to market research by the official. For the subclass Internet we have to exclude state websites and search: *интернет*, *www.*, *http* and *сайт*. For petrol stations – *станциях*, *станциям*, *азк* and *азс* – we have to make sure that these do no coincide with quotations. The last subclass register of contracts refers to prior procurements: *реестр* and *контрактов*. Through binary variables we can state which sources are used for the price level.

Besides identifying sources for setting reserve prices, we can also distinguish

auctions that refer to tender documentation for the calculation. *документ*, *приложени* or *файл* are indicative words.

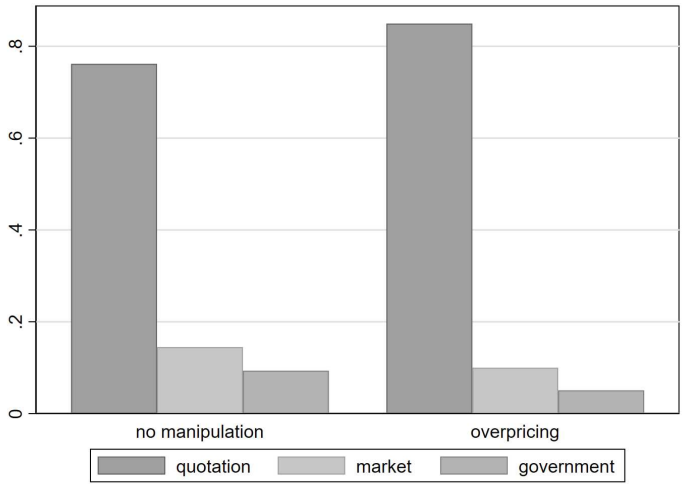
Departing from the information provided in tender notices of sealed bid auctions, we first identify the distinct sources used for the determination of reserve prices and subsequently group these sources. Given our estimation sample, the prices are justified for 46,428 sealed bid auctions and 12,255 auctions do not have a rationale as most took place before the reform (figure A.10). In 50.5% of the cases procurers refer to the tender documents and do not explain the price level in the on-line notices. We are able to identify the source in 31.8% of the cases and the rest remains unclassified. The sources are divided in three main groups: *quotation*, *government* and *market*. In general, authorities request price quotations. Officials may also rely on statistics provided by state institutions such as the Rosstat, Federal Anti-Monopoly Service and Ministry of Economy. Besides obtaining information on prices from the government and firms, officials may conduct market research by monitoring prices at filling stations, accessing information on the Internet or register of prior contracts. According to our classification, 10,832 reserve prices out of 14,751 are based on quotations only. *Government* and *market* account for respectively 7.2 and 12.6%. Finally, procurers may use several sources simultaneously (6.8%). If we investigate the sources used for the calculation of reserve prices by *overpricing*, we observe in figure A.11 that overpricing pairs rely significantly more on price quotations than procurer-seller pairs that do not manipulate prices.

Figure A.10: Justification of reserve prices



Notes: Tender notices of which the sources are identified may also include documents regarding the calculation of reserve prices. *Quotation*, *government* and *market* are disjoint sets.

Figure A.11: Determination of reserve prices by link type



Notes: Tender notices of which the sources are identified may also include documents regarding the determination of the reserve price. *Quotation*, *government* and *market* are disjoint sets.