Model of favoritism in outcry and electronic auctions[1]

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Abstract

Since the 2000s e-auctions have been actively used in public and private procurement in many countries. Although e-auction reduces participation costs of companies as compared with outcry auction, it may also encourage companies to bribe the electronic intermediary in order to intervene in e-auction process and block bids of their competitors. The purpose of our model is to examine how the auction format affects the favoritism and the efficiency of public procurement. Unlike the public procurer, the intermediary does not have the favored company and takes bribes from each company. Therefore, if the intermediary sets rather low bribe, that equalizes chances of getting the public contract for companies with different production costs. As a result, incentives for favoritism depend on the costs efficiency of the favored company. The model shows that if the favored company has high production costs, a corrupt intermediary encourages favoritism. On the contrary, if the favored company has low production costs, favoritism becomes less probable in e-auction, than in outcry auction. Hence, even if the intermediary is corrupt, e-auction may provide lower incentives to favoritism and increase social welfare.

Keywords: Favoritism, Public procurement, Auctions

1. Introduction

Public procurement constitutes 10-25% of GDP[4] and a significant share of domestic demand in most countries, and Russia is no exception[5]. These huge financial resources can be used to achieve various purposes: provision of goods and services, fostering innovation and small business development, etc. Corruption can hinder this, so it is one of the key problems in public procurement. E-auctions are usually treated as transparent public procedures, which can solve this problem (e.g. Lengwiler & Wolfstetter; 2006). However, current procurement practice does not always support these conclusions. The purpose of this article is to show how a corrupt

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[4] http://ec.europa.eu/trade/policy/accessing-markets/public-procurement/

[5] http://www.gks.ru/metod/torg.html

intermediary that may intervene in e-auction process affects favoritism in public procurement. By favoritism we mean repeated relationships between the pubic procurer and his favored company, which are connected with the restrictions of competition.

We consider Russian e-procurement reform as the starting point for this paper. In 2009-2010 the Russian government implemented the reform of public procurement, which was aimed at decreasing incentives for corruption, including favoritism. The reform presumed that e-auctions organized by specialized e-platforms would replace outcry auctions organized by public entities (mostly, by various public procurers). It was implicitly assumed that e-platforms operated for the sake of public interests, but this situation is not always true. As far as corruption is wide-spread in Russia[6] and employees working on the e-platform have incentives to take bribes, perhaps, some employees took bribes from companies in exchange for assistance in winning e-auctions. Moreover hackers may organize DDOS-attacks on the e-platform in order to prevent some companies from bidding. According to the anecdotal evidence, companies have made many complaints to the regulator about some actions that prevented them from bidding in e-auction. For instance, one company could not make bids in several auctions, because of some technical difficulties on e-platform, which meanwhile did not prevent the other company from making a bid and winning e-auction with a with slight decrease in price[7]. This situation may be caused either by real technical difficulties, or by corrupt behavior of the intermediary that is in the center of this paper.

We model outcry auction and e-auction and compare their results. We have found that the impact of a corrupt intermediary on favoritism depends on characteristics of the favored company. If it has high production costs, the corrupt intermediary decreases the optimal bribe and makes favoritism more probable. In contrast, if the favored company has low production costs, the corrupt intermediary increases the optimal bribe and makes favoritism less probable. Thus, corruption of the intermediary (hacker or e-platform) replaces the corruption of the public procurer.

This paper is close to two strands of economic research. Firstly, since we compare the results of two types of auctions (traditional auction and e-auction), the empirical and theoretical literature that analyzes the various procurement mechanisms is closely related to our work. In this literature auctions are usually treated as objective competitive mechanisms, while the negotiations, on the contrary, are an extreme case of the discretionary power of the auctioneer. Bulow & Klemperer (1996) and Laffont & Tirole (1991) are among the first researchers who started the theoretical discussion. Subsequent empirical work has shown that the choice between

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[6] http://www.transparency.org/cpi2013/results

[7] http://forum.gov-zakupki.ru/topic16447.html

auction and negotiation depends on such factors, as the complexity of the contract, the competence of the public procurer, the competition among bidders (Bajari et al., 2007, 2009; Estache et al., 2009; Chong et al., 2010) and the level of political competition (Chong et al., 2011; Moszoro & Spiller, 2012).

Since the beginning of the 2000s articles on e-auctions have been published. They address various issues arising in electronic public procedures, for instance, new forms of rent-seeking behavior (Kauffman & Wood, 2003) the redistribution of income between the seller and the buyer (Chang et al., 2006) and unequal access of different companies to e-procurement (Albano et al., 2008). Most studies state such features of e-auctions, as lower participation costs and the anonymity of companies. Conditions of Russian public procurement make more crucial another feature of e-auction – the participation of the intermediary in the procurement process, on which we focus in this paper.

Secondly, we rely on research on corruption. Søreide (2002), Boehm & Olaya (2006) show that public procurers have ample opportunities to restrict competition before an auction starts. Burguet & Che (2004), Compte et al. (2005) examine the relationship between corruption and competition of procurers and companies. A separate layer of papers is dedicated to the question of how intermediaries affect corruption between officials and their clients (Bayar, 2005; Drugov et al., 2014; Hasker & Okten, 2007). These articles assume that the client can give a bribe to official directly or through an intermediary. Using the intermediary is costly, but reduces the risk that the client will give a bribe to the honest official and suffer huge losses.

Our approach differs from previous papers in the following way. We assume that in e-auction the intermediary may take bribes, as well as the public procurer. However a corrupt deal between the public procurer and the favored company takes place without any participation of the intermediary. Collusion between the public procurer and the intermediary is beyond the scope of this paper. The idea of our study is to analyze how the corrupt behavior of the intermediary affects incentives to favoritism in public procurement.

This paper is organized as follows. Section 2 describes set-up of the theoretical model. Section 3 proposes a basic model of favoritism in public procurement. Section 4 considers preliminary results of the model and summarizes ideas for the future research.

2. Model set-up

The society asks the public procurer[8] to buy one indivisible product with the reserve price r[9]. The purpose of the society is to select the auction format (outcry auction or e-auction) that

[8] In what follows we will refer to the public procurer as “he”, to the intermediary as “she” and to a company as “it”.

maximizes social welfare. The format of both auctions is a reverse English auction, which we model as the "clock auction", following Ausubel (Ausubel, 2003; p. 137). Outcry auction is held by the public procurer; electronic auction (e-auction) is held on the electronic platform. The public procurer defines conditions and contract details for both auctions.

a. Companies' characteristics

The market consists of one company affiliated with the public procurer (the company 1; the favored company) and n other companies (newcomers). Each company has the following unrelated characteristics:

- production costs c, which may be high ($\bar{c}$) or low ($\underline{c}$), $r > \bar{c} > \underline{c}$, $c_i = \begin{cases} \bar{c}, & prob = \frac{1}{2} \\ \underline{c}, & prob = \frac{1}{2} \end{cases}$,
- k non-price characteristics, which constitute the vector $s_i = (s_{i1}, s_{i2}, ..., s_{ik})$, $i = 1, 2, ..., n+1$, $m = 1, 2..., k$, where m is the index of characteristic.

For instance, let us consider municipal gasoline market with four gasoline stations. Each gasoline station may have different opening hours (24 hours a day or less), size (small or medium enterprise or not) and location (in the town X or not). Then for each gasoline station we can present these non-price characteristics as a vector $s_i = (s_{i1}, s_{i3}, s_{i3})$, $i = 1, 2, 3, 4$, $m = 1, 2, 3$, where s_{i1} equals 1, if a gasoline station i is open 24 hours, and equals 0, otherwise; s_{i2} equals 1, if a gasoline station i is a small or medium enterprise, and equals 0, otherwise; s_{i3} equals 1, if a gasoline station i is located in the town X, and equals 0, otherwise.

All players know the distribution of production costs of companies; characteristics of a particular company are its private information. We assume that the favored company has executed several contracts for the public procurer; hence, the public procurer also has information about its characteristics.

b. Contract requirements and corruption

In the beginning of each period nature randomly selects one newcomer out of n newcomers that can deliver the product. In what follows we will refer to this newcomer as the company 2. To participate in the auction, a company must satisfy minimum requirements, which the public procurer sets: $s_{im} \geq s^*_m$, where s^*_m - the public procurer's requirements to the company's characteristic m, $i = 1, 2$, $m = 1, 2..., k$.

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[9] In the basic model we consider the reserve price as exogenous and higher than high production costs, which is the necessary condition for favoritism, if the favored company has high production costs. This assumption is plausible, because the society usually does not have complete information about the market and high reserve prices may be used to attract more companies to participate in procurement auctions.

Let us assume that one non-price characteristic of the favored company always equals 1 and is distributed for the newcomers in the following way:

$$\exists l: \ s_{1l} = 1, \ l \in [1;k], s_{il} = \begin{cases} 0, & prob = \frac{1}{2} \\ 1, & prob = \frac{1}{2} \end{cases}, \ i = 2,3,...,n+1.$$

Then the favored company can secretly offer the public procurer a bribe B[10] in exchange for setting contract requirements $s^*_l = 1$ and restricting participation of newcomers in the auction. This deal is secret, so no one knows about it, but the public procurer and his favored company. We will refer to this type of corruption as favoritism, which may occur in both auction formats. For the sake of simplicity we consider only the case when the public procurer can include only one non-price characteristic in the contract requirements and has the following choice: to set restrictive requirements to the characteristic l ($s^*_l = 1$) or not ($s^*_l = 0$).

Unlike favoritism, corruption of the intermediary may occur only in e-auction. With probability φ, $\varphi \in [0;1]$ intermediary (hacker or dishonest employee of e-platform) offers each company to give her a bribe b in exchange for blocking its competitor's bids. Companies simultaneously and independently make decisions to bribe the intermediary or not. If one company agrees to bribe the intermediary, and the other does not, the intermediary blocks bid of the latter company and the former company wins the auction. If two companies agree to bribe the intermediary, she randomly takes a bribe from one company and blocks the other one. If both companies refuse to bribe the intermediary, she blocks nobody and holds honest e-auction.

c. Auction process

If two companies participate in the auction, the auctioneer (the public procurer or e-platform) holds a reverse English auction with the announced reserve price r. If only one company participates in the auction, it wins the auction at the reserve price. If two companies do not participate in the auction, all players receive zero.

d. Payoffs

Expected utility of the public procurer equals the sum of the contract utility that he gets and bribe:

$$EU_{proc} = \alpha \cdot Ev(s^*_l) + p_1(c_i)B, \ i = 1,2$$

where $Ev(s^*_l)$ is the expected contract utility when the public procurers chooses contract requirements s^*; $v(s)$, $v(s) > 0$ is the contract utility with requirements s for the society;

[10] We model such type of the bribe, as a kickback, which the company pays after and only if it concludes the contract with the public procurer. The problems connected with contractual problems of making corrupt deals (e.g. see Lambsdorff, 2002) are beyond the scope of this paper.

α, $\alpha \in [0;1]$ is the share of the contract utility that the public procurer gets; p_1 is the probability that the favored company wins auction.

The expected profit of each company equals the difference between the expected revenue in auction and the sum of bribes that it pays to the public procurer and the intermediary:

$$E\pi_1 = E(P_{WIN} - c_1 - B - b);\ E\pi_2 = E(P_{WIN} - c_2 - b),$$

where P_{WIN} is the contract price that equals the bid of the winning company.

The expected payoff of the intermediary equals the expected bribe $ER = Eb$ if the intermediary is corrupt, and equals zero, if the intermediary is honest.

Social welfare equals the sum of all players' payoffs and a share of the contract utility that the society gets minus the expected contract price EP_{WIN}:

$$\begin{aligned} &EW = EU_{PR} + \sum\nolimits_{i=1}^{2} E\pi_i + ER + (1-\alpha)\cdot v(s_{WIN}) - EG,\ i = 1,2 \\ &EW = v(s_{WIN}) - c_{WIN} \end{aligned},$$

where c_{WIN} is production costs of the winning company; s_{WIN} is the non-price characteristic of the winning company.

e. <u>Timing</u>

	Table 1	
Step	**Outcry auction**	**E-auction**
1	The favored company may offer a bribe to the public procurer in exchange for setting restrictive requirements.	
2	If the favored company has offered a bribe to the public procurer, he chooses to accept a bribe or reject it and then chooses to set requirements or not.	
3	Companies register for participation in the auction.	
4	Bidding: • First-price English auction, if two companies participate in the auction; • A company gets the contract at the reserve price, if the other company does not participate in the auction.	If two companies have registered for participation in the e-auction and the intermediary is corrupt, she may demand a bribe in exchange for blocking a bid of the other company.
5	The procurer buys a product and receives a bribe if he has made a corrupt deal with the favored company.	If the intermediary has demanded a bribe, each company decides if it agrees to give a bribe or not.
6		Bidding: • First-price English auction, if two companies participate in the auction and the intermediary is not corrupt; • A company gets the contract at the reserve price, if the other company does not participate in the auction or is blocked by the intermediary.
7		The procurer buys a product and receives a bribe if he has made a corrupt deal with the favored company. The intermediary receives a bribe if she has made a corrupt deal with any company.

First of all, we consider the basic model. In this version of the model, we show that even if e-auctions do not reduce the participation costs and provide opportunities for corruption of the intermediary, in some cases they reduce incentives to favoritism and increase social welfare in comparison with the outcry auctions.

3. Basic model of favoritism

Q: What's worse than one monopolist?
A: Two monopolists.
(Bad Economist Joke)

In this case we focus only on one difference between outcry auction and e-auction: whether there is a corrupt intermediary (probability ϕ) or not. If $\phi = 0$, there is no corrupt intermediary and the results of auctions are equal. So in order to compare two auctions, we need to solve only the game in e-auction. We will find a subgame perfect Nash equilibrium using backward induction. *In the Step 6* (see Table 1) the auctioneer holds a reverse English auction, where two companies make bids, if they both satisfy the procurer's restrictions and the intermediary do not block anybody, and one company makes a bid, if it is the only company, which satisfies the procurer's restrictions, or the intermediary blocks a bid of the other company.

Proposition 1.1

If the company 1 gives a bribe to the public procurer, it wins the auction with two participants, only if it has low production costs, the company 2 has high production costs and the difference between high and low production costs exceeds the size of the bribe to the public procurer. This happens with probability no greater than ¼.

Proof. As we have assumed that production costs of companies are independent, their bids in first-price English auction equal to the bids in the second-price sealed-bid auction (Ausubel, 2003; p. 138). The auction proceeds as follows. The auctioneer gradually reduces the price from the reserve price to zero. When the price becomes equal to the production costs of the company 2 (or the sum of production costs and bribe of the company 1), this company refuses to continue the auction. The other company wins the auction at this price. Thus, if the company 1 gives a bribe to the public procurer and two companies participate in the auction, they get the following profits:

$$\pi_1 = \begin{cases} c_2 - c_1 - B \; if \; c_1 + B < c_2 \\ 0 \;\; if \; c_1 + B \geq c_2 \end{cases} ; \; \pi_2 = \begin{cases} c_1 - c_2 + B \; if \; c_2 < c_1 + B \\ 0 \;\; if \; c_2 \geq c_1 + B \end{cases} .$$

The company 1 wins the auction if $c_1 + B < c_2$, that happens only in this case:

$$\begin{cases} c_1 = \underline{c} \\ c_2 = \overline{c} \\ \overline{c} - \underline{c} > B \end{cases}.$$

As the production costs of companies are independent of each other and each company may have high and low production costs with probability ½, the first two equations of the system are simultaneously true with probability ¼. Imposing inequality $\overline{c} - \underline{c} > B$ we get that the probability the company 1 wins the auction is less or equal to ¼.

Proposition 1.2

If the company 1 does not give a bribe to the public procurer, a company with low production costs wins the auction with probability ¾, a company with high production costs wins the auction with probability ¼.

Proof. Let us first consider the behavior of the company with low production costs. If a company has low production costs, it always wins the auction, if the other company has high production costs, and in half of the cases, if the other company has low production cost. The probability the company with low production costs wins the auction is:

$$Prob(\underline{c}\ wins) = \frac{1}{2} \cdot 1 + \frac{1}{2} \cdot \frac{1}{2} = \frac{3}{4}.$$

Analogically, if a company has high production costs, it always looses the auction, if the other company has low production costs, and wins the auction in half of the cases, if the other company has high production cost. The probability the company with high production costs wins the auction is:

$$Prob(\overline{c}\ wins) = \frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}.$$

In the Step 5 companies decide whether to give a bribe to the intermediary. For the sake of plausibility let us assume that a company gives a bribe to the intermediary only when this strategy increases its payoff compared with the strategy not to give a bribe. Also assume that the intermediary has limited possibilities to set the size of the bribe. Then the following proposition is true:

Proposition 2

Let the size of the bribe to the intermediary be less than the difference between the reserve price and the high production costs, $b < r - \overline{c}$*. Then in equilibrium both companies agree to give a bribe to the intermediary and this equilibrium is unique.*

Proof. We should find Nash equilibrium in pure strategies in the corruption game between companies 1 and 2. If both companies agree to give a bribe $b < r - \bar{c}$ to the intermediary, the intermediary blocks each of them with probability ½. The unblocked company wins the auction at the reserve price and gives a bribe. Then the expected profits of companies equal:

$$E\pi_i = \frac{r - c_i - b}{2}, \ i = 1, 2.$$

If one company gives a bribe to the intermediary, and the other one refuses to give a bribe, the intermediary blocks the latter company and the former company wins the auction at the reserve price. The expected profits of companies equal:

$$\begin{cases} E\pi_1 = r - c_1 - b \\ E\pi_2 = 0 \end{cases}$$ if the company 1 agrees to give a bribe and the company 2 refuses,

$$\begin{cases} E\pi_1 = 0 \\ E\pi_2 = r - c_2 - b \end{cases}$$ if the company 1 refuses to give a bribe and the company 2 agrees.

If bribe to the intermediary is less than the difference between the reserve price and high production costs, the intermediary does not collect the entire corruption revenue of companies with high and low production costs. Hence, the auction with the corrupt intermediary is more beneficial for them then honest e-auction. Detailed proof of Proposition 2 is given in Appendix 1.

In the Step 4 the intermediary sets the size of a bribe given into account the expected behavior of companies. According to the Proposition 2, both companies agree to bribe the intermediary if $b < r - \bar{c}$. Then in order to maximize her payoff the intermediary sets the bribe equal to:

$b^* = r - \bar{c} + o, \ o \to 0$, where o is infinitely small positive number.

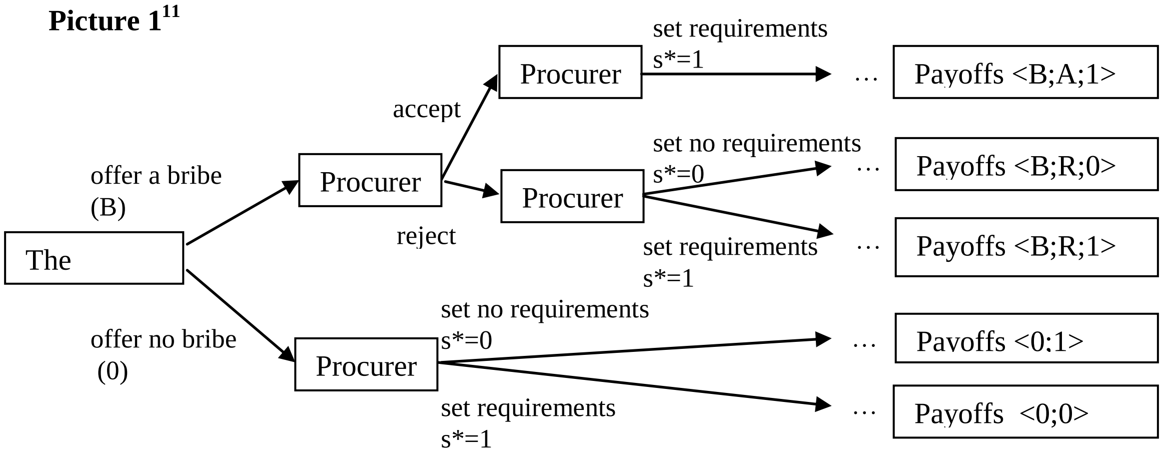
In the Step 3 companies register for participation in the auction. Each company registers if its expected profit is non-zero and it satisfies the requirements of the public procurer:

$$\begin{cases} E\pi_i \geq 0 \\ s_{il} \geq s^*_l \end{cases}, \ i = 1, 2.$$

Earlier, we have made the assumption that $s_{1l} = 1 \Rightarrow s_{1l} \geq s^*_l$, so the company 1 always satisfies the requirements of the public procurer, and companies do not carry out any non-zero participation costs, therefore their expected profits are greater than zero or equal to it, $E\pi_i \geq 0, \ i = 1, 2$. Then the company 1 always registers for participation in the auction; the company 2 registers for participation in the auction if it satisfies the requirements of the public procurer $s_{2l} \geq s^*_l$.

In the step 2 the public procurer sets the level of requirements s^*_l. If the favored company has offered a bribe to the procurer, he chooses to accept it or not and then sets the level of requirements. If the favored company has not offered a bribe to the procurer, he sets the level of requirements. Picture 1 illustrates the part of the game tree with the corruption game between the public procurer and the company 1.

Picture 1[11]



A – accept a bribe; R – reject a bribe.

Previously we have assumed that the procurer and his favored company do not lie to each other, therefore, if the procurer accepts a bribe, he always sets restrictive requirements $s^*_l = 1$. In other cases (when the procurer rejects the bribe or the favored company does not offer it) the procurer is free to choose the level of requirements s^*_l only on the basis of the contract utility that he gets.

Proposition 3.1

If the company 1 does not offer a bribe to the public procurer, he sets restrictive requirements when the utility of contract with restrictive requirements is higher than the utility of contract without requirements: $v(1) > v(0)$.

Proof. We should compare the expected utility of the public procurer from a different set of strategies in cases where the favored company (the company 1) has high and low production costs. First of all, let us consider the situation when the company 1 has high production costs. If

[11] In the Picture 1 we delete the index l to make formulas simpler and clearer, so the public procurer chooses between $s^* = 1$ (when he sets $s^*_l = 1$) and $s^* = 0$ (when he sets $s^*_l = 0$).

the company 1 does not offer a bribe, the expected utility of the public procurer in case of setting restrictive requirements equals:

$$EU_{PR}(s_l = 1) = \alpha \cdot v(1) .$$

The expected utility of the public procurer in case of setting no requirements equals:

$$EU_{PR}(s_l = 0) = \alpha \cdot (\frac{5}{8} + \frac{\varphi}{8}) \cdot v(1) + \alpha \cdot (\frac{3}{8} - \frac{\varphi}{8}) \cdot v(0) .$$

Comparing the expected utility of the public procurer, we find that if the company 1 has high production costs and does not offer a bribe to the public procurer, the public procurer sets restrictive requirements if the utility of the contract with these requirements is higher than the utility of the contract without requirements: $v(1) > v(0)$. Analogically we compare the expected utility of the public procurer if the company 1 has low production cost. The rest proof of Proposition 3.1 is given in Appendix 2.

Now let us consider the case where the company 1 offers a bribe to the public procurer. Let us assume that the corrupt deal is not connected with any substantial transaction costs. Then both the public procurer and his favored company are indifferent between the situations when the favored company does not offer a bribe to the public procurer and when it offers a bribe, but the public procurer rejects it. In order to find the conditions under which the public procurer sets restrictive requirements, we need to find the size of the bribe.

Proposition 3.2

Let us assume that the minimum size of the bribe that the public procurer accepts equals the difference between the expected utility of the public procurer when he does not set requirements and the expected utility of the public procurer when he sets them. Then:

1. Optimal size of the bribe to the public procurer positively depends on the share of the contract utility that the public procurer gets and the difference between the utilities of two types of contracts: with and without restrictions.

2. If the company 1 offers a bribe to the public procurer, the public procurer sets restrictive requirements when the utility of contract with restrictive requirements is lower than the utility of contract without requirements: $v(1) < v(0)$.

Proof. As before, at first we consider the case when the company 1 has high production costs. If the company 1 offers a bribe to the public procurer, the procurer's expected utility from taking a bribe is equal to:

$$EU_{PR}(B > 0; s^*_l = 1) = \alpha \cdot v(1) + \frac{1}{2} \cdot B .$$

If the public procurer rejects the bribe and still sets requirements, his expected utility is:

$EU_{PR}(B=0; s^*_l=1)=\alpha\cdot v(1)$.

If the public procurer rejects the bribe and sets no requirements, his expected utility is:

$$EU_{PR}(B=0; s^*_l=0)=\alpha\cdot(\frac{5}{8}+\frac{\varphi}{8})\cdot v(1)+\alpha\cdot(\frac{3}{8}-\frac{\varphi}{8})\cdot v(0).$$

The company 1 maximizes its expected profit and chooses the minimum possible bribe that the public procurer accepts, that happens when $EU_{PR}(B>0; s^*_l=1)=EU_{PR}(B=0; s^*_l=0)$. The optimal bribe positively depends on the share of the contract utility that the public procurer gets and the difference between the utilities of two types of contracts and equals:

$$B^*=\alpha\cdot\left(\frac{3}{4}-\frac{\varphi}{4}\right)\cdot\left(v(0)-v(1)\right).$$

Then the public procurer accepts a bribe if the company 1 offers non-zero bribe, $v(1)<v(0)$. Analogically we compare the expected utility of the public procurer if the company 1 has high production cost. Detailed proof of Assumption 3.2 is given in Appendix 2.

In the step 1 the company 1 chooses to offer a bribe to the public procurer or not.

Proposition 4

Assume that the rent that the company 1 gets from offering a bribe to the public procurer exceeds the bribe, and utility of the contract without restrictive requirements is greater than utility of the contract with the restrictive requirements. Then the set of strategies <offer a bribe; accept a bribe> is the only Nash equilibrium in pure strategies in the corrupt game between the public procurer and the favored company.

Proof. We should calculate expected profits of the company 1 if it chooses strategies "offer a bribe" and "offer no bribe", and then find Nash equilibrium in pure strategies in this corruption game. As before, let us at first find the solution in case when the company 1 has high production costs. As follows from the Proposition 3.1, if the company 1 does not offer a bribe to the public procurer and the public procurer receives greater utility from the contract without restrictive requirements, the strategy "set no requirements" strictly dominates the strategy "set requirements". The public procurer never sets requirements, and the expected payoff of the company 1 equals $o\to 0$ with probability ½, if there is a corrupt intermediary, and equals zero, otherwise:

$$E\pi_1(\bar{c}; s^*_l=1)=\frac{\varphi}{2}\cdot o.$$

As follows from the Proposition 3.2, if the company 1 offers a non-zero bribe to the public procurer, and the public procurer receives greater utility from the contract without restrictive requirements, the public procurer always accepts a bribe and sets requirements. Then the expected payoff of the company 1 is:

$$E\pi_1(\bar{c}; B>0; s^*_l=1)=\frac{1}{2}(r-\bar{c}-B),$$

$$E\pi_1(\bar{c}; B>0; s^*_l=1)=\frac{1}{2}\left[r-\bar{c}-\alpha\cdot\left(\frac{3}{4}-\frac{\varphi}{4}\right)\cdot\left(v(0)-v(1)\right)\right].$$

Hence, the set of strategies <offer a bribe; accept a bribe> is the only Nash equilibrium in pure strategies if:

$$\begin{cases} v(1)<v(0) \\ r-\bar{c}>\alpha\cdot\left(\frac{3}{4}-\frac{\varphi}{4}\right)\cdot\left(v(0)-v(1)\right)+\frac{\varphi}{2}\cdot o \end{cases}$$

Proof of Assumption 4 for the case when the company 1 has low production costs is similar to this (see Appendix 2).

Lemma 1

The corruption of the intermediary has different impact on favoritism depending on the production costs of the favored company:

1. If the favored company has high production costs, a corrupt intermediary increases probability that it wins e-auction in comparison with outcry auction. As a result, the bribe to the public procurer declines and favoritism becomes more probable.

2. If the favored company has low production costs, a corrupt intermediary decreases probability that it wins e-auction in comparison with outcry auction. As a result, the bribe to the public procurer increases, and favoritism becomes less probable.

Proof. Lemma 1 is the direct consequence of Propositions 3.1, 3.2 and 4.

Table 1 presents results of the game.

Table 1 Results of auctions without participation costs

	Production costs of the favored company		
	High costs, $c_1=\bar{c}$	**Low costs**, $c_1=\underline{c}$	
		$B>\bar{c}-\underline{c}$	$B\le\bar{c}-\underline{c}$
Optimal bribe	$B^*=\alpha\cdot\frac{(3-\varphi)}{4}\cdot\left(v(0)-v(1)\right)$	$B^*=\alpha\cdot\frac{(1+\varphi)}{4}\cdot\left(v(0)-v(1)\right)$	$B^*=\alpha\cdot\frac{(1+\varphi)}{6}\cdot\left(v(0)-v(1)\right)$
Conditions of favoritism	$\begin{cases} v(1)<v(0) \\ \frac{r-\bar{c}-\varphi\cdot o}{3-\varphi}>\alpha\cdot\frac{\left(v(0)-v(1)\right)}{4} \end{cases}$	$\begin{cases} v(1)<v(0) \\ \frac{r-\bar{c}-\varphi\cdot o}{1+\varphi}>\alpha\cdot\frac{\left(v(0)-v(1)\right)}{4} \end{cases}$	$\begin{cases} v(1)<v(0) \\ \frac{2r-\bar{c}-\underline{c}-\varphi\cdot o}{(1+\varphi)}>\alpha\cdot\frac{\left(v(0)-v(1)\right)}{2} \end{cases}$

Probability the company 1 wins the auction	$Prob_1 = \frac{1}{2} \cdot Prob_1(B;1) +$ $+ \frac{5+\varphi}{8} \cdot Prob_1(0;1) +$ $+ \frac{1+\varphi}{4} \cdot [Prob_1(B;0) + Prob_1(0;0)]$	$Prob_1 = \frac{1}{2} \cdot Prob_1(B;1) +$ $+ \frac{7-\varphi}{8} \cdot Prob_1(0;1) +$ $+ \frac{3-\varphi}{2} \cdot [Prob_1(B;0) + Prob_1(0;0)]$	$Prob_1 = \frac{3}{4} \cdot Prob_1(B;1) +$ $+ \frac{7-\varphi}{8} \cdot Prob_1(0;1) +$ $+ \frac{3-\varphi}{2} \cdot [Prob_1(B;0) + Prob_1(0;0)]$

Note. $Prob_1(A;Z)$ is the probability that the company 1 wins the auction when the company 1 and the public procurer chooses different strategies; the company 1 chooses between “offer a bribe” (B) and “offer no bribe” (0), while the public procurer chooses between “set requirements” (1) and “set no requirements” (0).

4. Discussion

In the basic model we consider one difference between outcry auction and e-auction – whether there is a corrupt intermediary or not. The model shows that the corrupt intermediary stimulates favoritism if the favored company has high production costs and decreases incentives to it if the favored company has low production costs. When the favored company has high production costs, the corrupt intermediary increases the probability that the favored company wins e- auction as compared with outcry auction. Hence, as far as the favored company always executes the contract with restrictive requirements, the winning company is more probable to execute this type of contract. Then the expected contract utility decreases if the procurer does not to set requirements. Hence, as we have assumed that the optimal bribe equals the difference between the expected contract utility when the procurer does not to set requirements and the contract utility when the procurer sets requirements, this difference becomes smaller. The favored company could give him lower bribe for setting restrictive requirements in comparison with outcry auction. The expected rent of corruption for the favored company is more likely to exceed the bribe to the public procurer and favoritism becomes more probable.

On the contrary, if the company 1 has low production costs, the corrupt intermediary decreases its probability to win e-auction. That increases optimal bribe to the public procurer and makes favoritism less probable in e-auction compared with outcry auction.

In the future research we are going to add the following assumptions to the basic model. Firstly, we will add to the function of the procurer’s utility the fine for purchasing the product at high price. The higher the price is, the greater fine the procurer should pay and the lower utility he gets ceteris paribus. This assumption will allow us to extend the range of the analyzed situations. The basic model describes only the cases when favoritism arises only if the contract, which the favored company offers, is worse for the procurer and the society than the contract without restrictions. The model with the fine will cover the situations where the contract, which the favored company offers, is better for the procurer and the society than the contract without restrictions. Secondly, we are going to add the participation costs in the outcry auction. Then we will examine how two differences between the outcry auction and e-auction affect favoritism.

References

- Albano, G. L., Dini, F., Zampino, R., & Fana, M. (2008). The Determinants of Suppliers' Performance in E-procurement: Evidence from the Italian Government's E-procurement Platform. *FEEM Working Paper No. 49.2008.*
- Ausubel, L. M. (2003). Auction Theory for the New Economy. Ch. 6 in *New Economy Handbook*, 126-162.
- Bajari. P, Houghton S., Tadelis S. (2007) Bidding for Incomplete Contracts: An Empirical Analysis of Adaptation Costs. *NBER Working Paper No. 1251*.
- Bajari, P., McMillan, R., & Tadelis, S. (2009). Auctions versus Negotiations in Procurement: an Empirical Analysis. *Journal of Law, Economics, and Organization, 25(2),* 372-399.
- Bayar, G. (2005). The Role of Intermediaries in Corruption. *Public Choice, 122(3-4),* 277-298.
- Boehm, F., & Olaya, J. (2006). Corruption in Public Contracting Auctions: the Role of Transparency in Bidding Processes. *Annals of Public and Cooperative Economics, 77(4),* 431-452.
- Bulow, J., & Klemperer, P. (1996). Auctions Versus Negotiations. *The American Economic Review, 86(1*), 180-194.
- Burguet, R., & Che, Y. K. (2004). Competitive Procurement with Corruption. *The RAND Journal of Economics, 35(1),* 50-68.
- Chang, G., Xu, J., Yang, J., He, J., & Zhang, L. (2005). Comparative Analysis on Traditional Procurement and E-procurement Strategy of Supply Chain. *Journal of Systems Science and Systems Engineering*, 14(4), 495-503.
- Chong, E., Staropoli, C., & Yvrande-Billon, A. (2010). Auction versus Negotiation in Public Procurement: Looking for Empirical Evidence. Chaire Economie des Partenariats Public-Privé Institut d'Administration des Entreprises Working Paper No. 2010-04.
- Chong, E., Staropoli, C., & Yvrande-Billon, A. (2012). Auctions versus Negotiations in Public Procurement: The Implication of Political Scrutiny.
- Compte, O., Lambert-Mogiliansky, A., & Verdier, T. (2005). Corruption and Competition in Procurement Auctions. *The Rand Journal of Economics, 36(1),* 1-15.
- Drugov, M., Hamman, J., & Serra, D. (2014). Intermediaries in Corruption: An Experiment. *Experimental Economics, 17(1),* 78-99.
- Estache, A., Guasch, J. L., Iimi, A., & Trujillo, L. (2009). Multidimensionality and Renegotiation: Evidence from Transport Sector Public-Private Partnership Transactions in Latin America, *Review of Industrial Organization, 35(1),* 41-71.
- Lambsdorff, J. G. (2002). Making corrupt deals: contracting in the shadow of the law. *Journal of Economic Behavior & Organization*, *48*(3), 221-241.
- Hasker, K., & Okten, C. (2008). Intermediaries and Corruption. *Journal of Economic Behavior & Organization, 67(1),* 103-115.
- Kauffman, R. J., & Wood, C. A. (2005). The Effects of Shilling on Final Bid Prices in Online Auctions. *Electronic Commerce Research and Applications, 4(1),* 21-34.
- Laffont, J. J., & Tirole, J. (1991). Auction Design and Favoritism. *International Journal of Industrial Organization*, *9*(1), 9-42.
- Lengwiler, Y., & Wolfstetter, E. (2006). Corruption in Procurement Auctions. *Available at SSRN 874705*.
- Moszoro, M. and P. T. Spiller (2012). Third-Party Opportunism and the Nature of Public Contracts. *NBER Working Paper No. 18636.*
- Søreide, T. (2002). Corruption in Public Procurement. Causes, Consequences and Cures. *Chr. Michelsen Institute Development Studies and Human Rights 1*, 1–43.

Appendix 1

Proof of Proposition 2. We should find Nash equilibrium in pure strategies in corruption game between two companies. We have assumed earlier that each company may have high and low production costs, hence, these events may arise with equal probability:

1. $c_1 = c_2 = \bar{c}$,
2. $c_1 = c_2 = \underline{c}$,
3. $c_1 = \underline{c};\ c_2 = \bar{c}$,
4. $c_1 = \bar{c};\ c_2 = \underline{c}$.

Choosing between strategies "offer a bribe" and "refuse" each company knows its own type, i.e. the size of production costs, but does not know the type of the other company. However as we have assumed earlier, each company knows the distribution of production costs. Thus, the companies play a Bayesian game with incomplete information.

Matrixes 1.1-1.4 contain payoffs of companies in events 1-4.

Matrix 1.1 Both companies have high production costs

		The company 2 ($\bar{c}$)	
The company 1 ($\bar{c}$)		Give a bribe	Refuse
	Give a bribe	$\frac{r-\bar{c}-b}{2};\frac{r-\bar{c}-b}{2}$	$r-\bar{c}-b;0$
	Refuse	$0;r-\bar{c}-b$	$0;0$

Matrix 1.2 Both companies have low production costs

		The company 2 ($\underline{c}$)	
The company 1 ($\underline{c}$)		Give a bribe	Refuse
	Give a bribe	$\frac{r-\underline{c}-b}{2};\frac{r-\underline{c}-b}{2}$	$r-\underline{c}-b;0$
	Refuse	$0;r-\underline{c}-b$	$0;0$

Matrix 1.3 The company 1 has low production costs, the company 2 has high production costs

		The company 2 ($\bar{c}$)	
The company 1 ($\underline{c}$)		Give a bribe	Refuse
	Give a bribe	$\frac{r-\underline{c}-b}{2};\frac{r-\bar{c}-b}{2}$	$r-\underline{c}-b;0$
	Refuse	$0;r-\bar{c}-b$	$\bar{c}-\underline{c};0$

Matrix 1.4 The company 1 has high production costs, the company 2 has low production costs

		The company 2 ($\underline{c}$)	
The company 1 ($\bar{c}$)		Give a bribe	Refuse
	Give a bribe	$\frac{r-\bar{c}-b}{2};\frac{r-\underline{c}-b}{2}$	$r-\bar{c}-b;0$
	Refuse	$0;r-\underline{c}-b$	$0;\bar{c}-\underline{c}$

We should prove that if the intermediary sets low bribe, $b < r - \bar{c}$, in each considered matrix the set of strategies <give a bribe, give a bribe> is a unique Nash equilibrium in pure strategies. Choosing the strategy each company knows that the strategy “give a bribe” strictly dominates the strategy “refuse” for competitor of any type if the intermediary sets low bribe. If competitor of any type gives a bribe, it is more beneficial for each company also to give a bribe to the intermediary independently of the level of its production costs. Hence, companies always agree to give a low bribe to the intermediary. The set of strategies <give a bribe, give a bribe> is a unique Nash equilibrium in pure strategies. Q.E.D.

Appendix 2

Tables 2.1 and 2.2 contain payoffs of players and probability of the company 1 wins the auction if it has high or low production costs.

Table 2.1 Results of the game if the company 1 has high production costs

	The expected utility of the public procurer	The expected profit of the company 1	The probability the company 1 wins
$< B; A; 1 >$	$EU_{PR} = \alpha \cdot v(1) + \frac{1}{2} B$	$E\pi_1 = \frac{1}{2}(r - \bar{c} - B)$	$P_1 = \frac{1}{2}$
$< B; R; 0 >$	$EU_{PR} = \alpha \cdot \left(\frac{5+\varphi}{8}\right) \cdot v(1) + \alpha \cdot \left(\frac{3-\varphi}{8}\right) \cdot v(0)$	$E\pi_1 = \frac{\varphi}{2} \cdot o$	$P_1 = \frac{1+\varphi}{4}$
$< B; R; 1 >$, $< 0; 1 >$	$EU_{PR} = \alpha \cdot v(1)$	$E\pi_1 = \frac{1}{2}(r - \bar{c}) + \frac{\varphi}{4} \cdot o$	$P_1 = \frac{1+\varphi}{4}$
$< 0; 0 >$	$EU_{PR} = \alpha \cdot \left(\frac{5+\varphi}{8}\right) \cdot v(1) + \alpha \cdot \left(\frac{3-\varphi}{8}\right) \cdot v(0)$	$E\pi_1 = \frac{\varphi}{2} \cdot o$	$P_1 = \frac{1+\varphi}{4}$

Table 2.2 Results of the game if the company 1 has low production costs

	The expected utility of the public procurer	The expected profit of the company 1	The probability the company 1 wins
$< B; A; 1 >$	$EU_{PR} = \alpha \cdot v(1) + \frac{1}{2} B$, если $B > \bar{c} - \underline{c} + o$	$E\pi_1 = \frac{1}{2}(r - \underline{c} - B)$	$P_1 = \frac{1}{2}$
	$EU_{PR} = \alpha \cdot v(1) + \frac{1}{2} B$, если $B < \bar{c} - \underline{c} + o$	$E\pi_1 = \frac{1}{2}(r - \bar{c}) + \frac{\bar{c} - \underline{c}}{4} + \frac{\varphi}{4} \cdot o - \frac{3}{4} B$	$P_1 = \frac{3}{4}$
$< B; R; 0 >$	$EU_{PR} = \alpha \cdot \left(\frac{7-\varphi}{8}\right) \cdot v(1) + \alpha \cdot \left(\frac{1+\varphi}{8}\right) \cdot v(0)$	$E\pi_1 = \frac{\bar{c} - \underline{c}}{2} + \frac{\varphi}{2} \cdot o$	$P_1 = \frac{3-\varphi}{4}$
$< B; R; 1 >$, $< 0; 1 >$	$EU_{PR} = \alpha \cdot v(1)$	$E\pi_1 = \frac{1}{2}(r - \underline{c}) + \frac{\bar{c} - \underline{c}}{4} + \frac{\varphi}{4} \cdot o$	$P_1 = \frac{7-\varphi}{8}$
$< 0; 0 >$	$EU_{PR} = \alpha \cdot \left(\frac{7-\varphi}{8}\right) \cdot v(1) + \alpha \cdot \left(\frac{1+\varphi}{8}\right) \cdot v(0)$	$E\pi_1 = \frac{\bar{c} - \underline{c}}{2} + \frac{\varphi}{2} \cdot o$	$P_1 = \frac{3-\varphi}{4}$

Let us prove Propositions 3.1 and 3.2 when the company 1 has low production costs. We compare expected utilities of the public procurer in case when the company 1 does not offer a bribe and find out that the strategy “set requirements” dominates the strategy “set no requirements”, if $v(1) > v(0)$. Thereby, the public procurer sets restrictive requirements if the utility of the contract with restrictive requirements is higher than the utility of the contract without them. Proposition 3.1 is proved.

In order to find optimal bribe, we should equate expected utilities of the public procurer when he chooses the strategy “accept a bribe” and the strategy “reject a bribe”. We find out that if the company 1 has low production costs and a bribe to the public procurer prevents the company 1 from making bid in the auction, $B > \bar{c} - \underline{c}$, optimal bribe equals:

$$B^* = \alpha \cdot \frac{(1+\varphi)}{4} \cdot \left(v(0) - v(1)\right).$$

If the company 1 has low production costs and a bribe to the public procurer does not it from making bid in the auction, $B < \bar{c} - \underline{c}$, optimal bribe equals:

$$B^* = \alpha \cdot \frac{(1+\varphi)}{6} \cdot \left(v(0) - v(1)\right).$$

Thus, in all subgames bribes to the public procurer depend positively on the share of the contract utility that the public procurer receives and the difference between the utility from the two types of contracts.

Having compared the expected utility of the public procurer in cases when the company 1 chooses the strategy “offer a bribe” or “offer no bribe” we obtain the following. If the company 1 offers a bribe, the public procurer sets restrictive requirements if the utility of the contract with requirements is lower than the utility of the contract without requirements, $v(1) < v(0)$. Proposition 3.2 is proved.