Bribery and Allocation Efficiency: Evidence from Public Procurement Auctions in Korea

Sungwon Kang
Korea Environment Institute, swkang@kei.re.kr

Daehwan Kim
Department of Economics, Konkuk University, dkim@konkuk.ac.kr

Geonhyeong Kim
Department of Economics, Konkuk University, kunhyzan@konkuk.ac.kr

July 2019

Abstract

Bribery may result in efficient allocation as more productive firms pay larger bribes to corrupt officials and as a result obtain more government contracts (the grease-the-wheels hypothesis), or may result in inefficient allocation as corrupt officials favor less productive firms to maximize bribe receipts (the grabbing-hand hypothesis). We examine the relationship between bribery and allocation efficiency under the institutional setting of Korea where all the public procurement contracts are allocated via competitive auctions. Our game-theoretic analysis confirms both possibilities regarding bribery and allocation efficiency. We carry out empirical analysis using the data of Korean firms participating in public procurement auctions. Firm-level bribe payments are identified from the changes in corporate entertainment expenses in response to a recently adopted anti-corruption regulation (Improper Solicitation and Antigraft Act of 2016). The empirical analysis shows that less productive firms pay larger bribes and bid more aggressively in procurement auctions, resulting in inefficient allocation.

Keywords

Bribery, allocation efficiency, public procurement auction, corporate entertainment expenses, anti-corruption regulation

1. Introduction

The competitive-bribery-game literature suggests two opposite possibilities regarding bribery and allocation efficiency. According to the grease-the-wheels hypothesis of Lui (1985), Beck and Maher (1986), and Lien (1986), bribery may increase allocation efficiency as more productive firms pay larger bribes to corrupt officials and as a result obtain government contracts. That is, a competitive bribery game takes the role of the competitive market and thus ensures efficient allocation.[1] On the other hand, according to the grabbing-hand hypothesis of Lien (1990), Shleifer and Vishny (1993), and Clark and Riis (2000) corrupt officials may discriminate against more productive firms as they "charge according to the ability to pay." As a result, less productive firms obtain government contracts and allocation becomes inefficient.

In this paper, we have another look at the relationship between bribery and allocation efficiency, in particular, under the institutional setting of Korea where all the public procurement contracts are allocated via competitive auctions. To properly examine the consequences of bribes, it is necessary to consider the institutional setting in which public procurement contracts are allocated. All the studies mentioned in the previous paragraph assume that public officials have full discretion regarding whom to give procurement contracts to. This is not the case in Korea and in many other countries.[2] In these

[1] For the grease-the-wheels hypothesis, Meon and Weill (2010), Dreher and Gassebner (2013), and Huang (2016) present macro-level evidences and Sharma and Mitra (2015) present firm-level evidences. For the grabbing-hand hypothesis, Mauro (1998) and Meon and Sekkat (2005) present macro-level evidences, and Kaufman and Wei (2000), Svensson (2003) Fisman and Svensson (2007), and Cheung, Rau, and Stouraitis (2012) present firm-level evidences.

[2] World Bank encourages the recipient countries to adopt auctions for allocating public procurement contracts, as noted by Decarolis (2014). Allocation via auctions is also common among advanced

countries, competitive auctions, often online auctions, are the main (if not the only) mechanism to allocate procurement contracts. Our goal is to develop a new set of analyses that are applicable to this situation.

We first present a game-theoretic analysis of the optimal behavior of the firms participating in public procurement auctions. The main feature of our model is that bribes reduce the cost of provision as corrupt officials allow bribe-payers to provide lower-cost goods and services. In our model (as is the case in many countries), the award of contracts and their prices are determined via transparent and competitive auctions. This eliminates the possibility of bribe-taking public officials to award contracts to, or to lower contract prices for, bribe-paying firms, for example, as described by Millington and Wilkenson (2005). This leaves only one possibility of rewarding bribe-paying firms: allowing bribe payers to supply low-quality goods and services so that bribe payers can earn higher profit from the contracts.

The effect of bribes on the expected cost of provision can be illustrated by a scandal involving a large public enterprise in Korea, Korea Electric Power Corporation (Kepco).[3] Kepco awards contracts to suppliers via online procurement auctions, so the contract prices were determined competitively and transparently. In 2012, however, it was revealed that suppliers bribed the officials of Kepco and in return were allowed to provide poor-quality goods. Suppliers installed more than 10,000 sub-standard components in nuclear power plants, some of which are critical components such as "cables used to send signals to activate emergency measures in an accident." Suppliers were able to pass inspection as they maintained corrupt ties with inspectors, sometimes paying outright bribes and sometimes

---

countries including the U.S. and Italy. See, for example, Carril and Duggan (2018), Decarolis (2014, 2018), and Decarolis, Giuffrida, Iossa, Mollisi, and Spangnolo (2018).

[3] This scandal drew attention from Western media including New York Times. See Choe (2013).

promising to offer jobs after retirement. Defective components installed by these suppliers led to frequent shutdowns of nuclear power plants over the following years.

Our theoretical analysis shows that the consequences of bribery depends on whether corrupt officials charge the same dollar amounts to different firms or "charge according to the ability to pay" for the unit reduction in the quality of goods and services. If corrupt officials charge the same dollar amounts to different firms, a high-productivity firm becomes the winner of the procurement auction given its cost advantage. In this case, allocation is efficient. On the other hand, if corrupt officials charge according to the ability to pay, a low-productivity firm may overcome its cost disadvantage by aggressively bribing officials and become the winner of the procurement contract. In this case, allocation is inefficient. Note that corrupt officials may prefer the latter situation as it leads to larger bribes amounts.

Which of the two possibilities is a better description of reality needs to be resolved via empirical analysis. For this, we use the data of Korean firms participating in public procurement auctions. The design of our empirical analysis is straightforward: For each of our sample firms, we measure productivity, the amounts of bribes paid to public-sector officials, and the typical bid amount in procurement auctions. If we find positive correlation between productivity and bribe amounts (i.e. high-productivity firms pay more bribes), then we may conclude that bribery enhances allocation efficiency. On the other hand, if we find negative correlation between productivity and bribe amounts, then we can conclude that bribery reduces allocation efficiency. As for the correlation between bribe amounts and the typical bid amount, the theory predicts that it must be negative (i.e. firms paying large bribes bid lower so that they are more likely to win auctions).

The main challenge in the empirical analysis is to identify the amounts of bribes paid to public-sector officials. For this, we take the perspective of three recent studies (Cai, Feng, and Xu, 2011; Chen, Liu, and Su, 2013; Zeng, Lee, and Zhang, 2016) that corporate entertainment expenses can be characterized as the bribe payment to public officials. To better identify the bribe component of corporate entertainment expenses, we consider the changes in corporate entertainment expenses in response to a recently adopted anti-corruption regulation (Improper Solicitation and Antigraft Act of 2016). This regulation imposed a new limit on the business entertainment of public-sector employees, so we use the reduction in entertainment expenses after the adoption of regulation as a measure of the pre-regulation entertainment expenses spent for public-sector employees.

The results of the empirical analysis support the efficiency-reducing role of bribery. We find that firm productivity is negatively correlated with the amount of entertainment expenses spent for public officials. We add several control variables in the regression analysis, and the conclusion is the same. We also find that those firms spending more for entertaining public officials bid lower in public procurement auctions. Since lowest bidders get contracts, public-sector contracts tend to go to low-productivity firms. Thus, the allocation by procurement actions is inefficient.

Our paper makes two contributions to the literature. First, we extend the theory of the competitive bribery game so that it is applicable to the institutional setting where public procurement contracts are allocated via transparent and competitive auctions. Given that transparent and competitive auctions are a common mechanism of allocating procurement contracts in many countries, we are filling an important gap in the literature. Second, our empirical analysis presents firm-level evidence from a relatively large sample. Given that the existing evidence is either from cross-country data (Mauro, 1998; Meon and Sekkat, 2005) or from relatively small samples of firms (Kaufman and Wei, 2000; Svensson, 2003; Fisman and Svensson, 2007; Cheung et al., 2012), the new evidence that we present adds value to the literature.

The rest of the paper is organized as follows. In Section 2, we present a game-theoretic analysis of firms participating in public procurement auctions. In Section 3, we discuss our measure of bribes and relate it to the extant literature. In Section 4, we describe the sample and variables that we have constructed. In Section 5, we present empirical findings. We conclude in Section 6. Two appendices provide further details on the model and the data set.

2. Optimal Behavior of Firms Participating in Procurement Auctions

In this section, we present game-theoretic analysis of the optimal behavior of firms participating in public procurement auctions. Our starting point is the model of Lien (1990) and Clark and Riis (2000), which is often called the "competitive bribery game with discrimination" as it allows the possibility that corrupt officials may discriminate against certain firms. We modify the model for the institutional setting where the allocation is determined by a fair auction. This setting corresponds well to actual public procurement procedures in many countries.

Two features of our model are noteworthy: First, the bribery affects the allocation only indirectly by reducing the cost of provision. This is the natural consequence of letting a fair auction determine the allocation. Second, "discrimination" against high-productivity firms is generated when corrupt officials choose to charge different firms differently according to their ability to pay. Then high-productivity firms need to pay larger dollar amounts to have the unit reduction in *quality* of goods and services (though they may pay the same dollar amounts for a *dollar* reduction in cost).

Setup

There are n firms. These firms participate in a competitive bribery game. Their goal is to win a contract to supply a product to a government agency and to extract maximum profit from this contract. The winner is selected via a first-price auction, and bribes do not influence the outcome of this auction. However, bribes do affect the minimum quality of the product to be supplied. Bribe-paying firms expect to be able to supply a lower-quality, lower-cost product if they win the contract.

Firm i observes its own type τ_i ($\tau_i \in [0,1]$ is an index of productivity; higher values correspond to lower production cost) and knows the distribution $F(\quad)$ from which other firms draw their types. Firm i strategically determines its bribe x_i and bid y_i. The objective function of firm i can be stated as

$$(1) \qquad \max_{x_i, y_i} \Pr(i\ wins)\,[y_i - c_i] - x_i$$

where c_i is the cost of provision. Bribes cannot be recovered even if firm i was not successful in the auction. Since $\Pr(i\ wins)$ depends on the strategies of other firms, to solve this problem we need to consider the problems of n firms simultaneously. Below we will consider a symmetric Nash equilibrium where n firms adopt identical strategies.

The auction is a first-price sealed-bid auction. Thus, given the bids of n firms, $y_1, \cdots, y_n$, the lowest bidder wins the contract and receives its own bid as the contract price. If there are more than one winning bids, one bidder is randomly selected as the winner. The type τ_i is private information. Thus, firm i knows its own type, but not other firms' types. Firm i also does not observe other firms' bribes.

The cost of provision of firm i, $c_i = c(\tau_i, x_i)$, is determined as

$$(2) \qquad c(\tau_i, x_i) = unit\ cost \times quality\ index$$

$$= p(\tau_i) \times [1 - q(x_i) r(\tau_i,)]$$

where $p(\tau_i)$ is the unit production cost for a reference-quality product, $q(x_i)$ represents the effect of bribes on quality, and $r(\tau_i)$ represets the adjustment for "discrimination" against high-productivity firms by public officials. We assume that

$$(3) \qquad p'(\tau) = -1,\ p''(\tau) = 0$$

$$(4) \qquad q'(x) > 0,\ q''(x) < 0$$

$$(5) \qquad r'(\tau) \leq 0,\ r''(\tau) \leq 0$$

Since τ is an index of productivity, we normalize $p(\tau_i)$ to be a linear function of the unit cost. (That is, any shape can be generated for $p(\tau_i)$ by choosing an appropriate distribution of τ_i.) As for $q(x)$, we assume that the effect of bribe is concave (i.e. the initial bribe is very effective but its marginal effectiveness declines as bribe amount increases).[4] As for $r(\ )$, we assume that discrimination is initially mild but becomes very severe as we move toward highly productivity firms).[5]

Why do public officials give favor to low-productivity firms by making $r(\tau)$ decreasing in τ? Favoring firms with specific characteristics may increase the amounts of bribes to be extracted. In the example to be presented below, the lowest-productivity firm ($\tau = 0$) end up paying the maximum bribe amount of 1. The amount of bribe is less than 1 when all firms are treated equally. Even so, why not favor high-productivity firms rather than low-productivity firms? Encouraging high-productivity firms to be aggressive is difficult since they already have advantage over low-productivity firms. It is easier to encourage low-productivity firms to be aggressive.

Main Results

We first establish the existence of efficient- and inefficient-allocation equilibria. We focus on symmetric Nash equilibria where all the firms adopt the same strategy. We limit our attention to the equilibria where both $x(\tau)$ and $y(\tau)$ are strictly monotonic. This simplifies our analysis substantially without affecting the main finding of the analysis.

---

[4] If $q(\ )$ is linear in x, the marginal cost does not depend on x, and this may lead to a situation where there is no symmetric Nash equilibrium. We exclude this possibility by requiring $q(\ )$ to be strictly concave.

[5] The concavity of $r(\ )$ is necessary to ensure that the cost function is increasing in τ in an inefficient allocation. See Lemma 2 (ii).

Lemma 1. The following statements are true. (i) If $c(\tau, g(\tau))$ is decreasing in τ, then there exists an "efficient-allocation" symmetric Nash equilibrium $\big(x(\tau), y(\tau)\big)$ where $x'(\tau) > 0$ and $y'(\tau) < 0$ for all τ. (ii) If $c(\tau, h(\tau))$ is increasing in τ, then there exists an "inefficient-allocation" symmetric Nash equilibrium $\big(x(\tau), y(\tau)\big)$ where $x'(\tau) < 0$ and $y'(\tau) > 0$ for all τ.

Proof. See Appendix A. □

Lemma 1 shows that both efficient and inefficient allocations are possible, and it is a matter for empirical analysis to determine which allocation obtains in reality.

The conditions stated in Lemma 1 are sufficient, but not necessary. In the following lemma, we present three different necessary conditions for inefficient allocation so that we have better understanding of what makes inefficient allocation more likely.

Lemma 2. Suppose that there exists an "inefficient-allocation" symmetric Nash equilibrium $\big(x(\tau), y(\tau)\big)$ where $x'(\tau) < 0$ and $y'(\tau) > 0$ for all τ. Then the following statements are true: (i) $x(1) = 0$. (ii) $c(\tau, x)$ is strictly increasing in τ for some x. (iii) $r(\tau)$ is strictly decreasing at some τ.

Proof. See Appendix A. □

What Lemma 2 suggests is the following: if public officials do not discriminate against high-productivity firms, then a higher-productivity firm wins the contract and efficient allocation obtains. An inefficient allocation may obtain only if public officials discriminate against high-productivity firms by making $r(\tau)$ strictly decreasing.

The following lemma states what is already obvious in Lemma 1: optimal bid is a decreasing function of optimal bribe. As this is one of the main empirical patterns that we examine, we state this as a separate lemma.

Lemma 3. In the equilibria discussed in Lemma 1, optimal bid is a decreasing function of optimal bribe. That is, $\frac{dy}{dx} < 0$.

Proof. It is immediate from Lemma 1. □

An Example

We study an example where an inefficient-allocation equilibrium obtains. Let n be 3. The cost function is given as

(6) $$c(\tau, x) = (5-\tau)\left(1-(1-\tau)^{\frac{1}{5}}x^{\frac{1}{5}}\right),\ \tau \in [0,1], x \in [0,\infty)$$

The probability distribution function of τ is given as

(7) $$F(\tau) = 1-(1-\tau)^{\frac{1}{5}}$$

In this case, the bribe function is (see Appendix A):

(8) $$x(\tau) = \left(\frac{1}{5}\right)^{\frac{5}{4}}(1-\tau)^{\frac{1}{4}}(5-\tau)^{\frac{5}{4}}\left(1-F(\tau)\right)^{\frac{5}{4}(n-1)}$$

We can verify:

(9) $x(0) = 1$

(10) $x(\tau)$ is decreasing over (0,1)

(11) $x(1) = 0$

For the cost function of Eq. (6), we can verify:

(12) $c\big(0, x(0)\big) = 0$

(13) $c(\tau, x(\tau))$ is increasing in τ

(14) $c\big(1, x(1)\big) = 4$

The bid function is (see Appendix A):

(15) $$y(\tau) = c(\tau, x(\tau)) + \frac{\int_{\tau}^{1} [1-F(t)]^{n-1} \frac{dc(t,x(t))}{dt} dt}{[1-F(\tau)]^{n-1}}$$

We can also verify:

(16) $y(0) \approx 1.9918$

(17) $y(\tau)$ is increasing over (0,1)

(18) $y(1) = 4$

In this example, the lowest-productivity firm ($\tau = 0$) pays maximum bribe ($x = 1$) and ensures that the probability of winning is 1. Its net profit is $y - x \approx 1.9918$. On the other hand, the highest-productivity firm ($\tau = 1$) pays no bribe ($x = 0$) and has zero probability of winning. Thus, its net profit is zero. In this example, the contract is awarded to the firm having the lowest productivity. This happens because bribes turn the advantage of a high-productivity firm into a disadvantage. By paying bribes more aggressively, a low-productivity firm can create cost-advantage and compete better than a high-productivity firm.

Relation to Auction Theories

The auction part of our model (i.e. Eq. (1) with a fixed the value of x_i) is an example of "asymmetric independent private-value first-price auction." The cost distributions of different firms are "asymmetric" in that they depend on firm types. The cost of one firm does not reveal anything about the cost of another firm, so we have an "independent private-value" auction. It is a "first-price" auction where the lowest bidder pays its own bid. Lebrun (1999) and Maskin and Riley (2000) have studied this type of auctions. In particular, Lebrun (1999) has shown the existence of Bayes-Nash equilibrium in this auction. Note, however, that Lemma 1 is not immediate from Lebrun's (1999) analysis since the existence of bribes changes the nature of the problem. The reason is that the problem cannot be solved sequentially (i.e. first for bid y and then for bribe x). The problem needs to be solved simultaneously for y and x. Thus, Lebrun's (1999) analysis is not directly relevant. Similarly, Lemma 3 of our paper is comparable to Corollary 3 of Lebrun (1999) and Proposition 3.3. (ii) of Maskin and Riley (2000) in that the bidders with lower cost bid lower, but our results are not immediate from the results of these papers.

3. Measuring Bribes from Entertainment Expenses

As Donnelly and Holton (1962) put it, there is a long-standing view that "business entertaining is but institutionalized bribery." Several recent studies support this view. Cai et al. (2011) and Zeng et al. (2016) find that the entertainment expenses of Chinese firms include significant amounts of bribes paid to government officials and that the bribes have consequences on firm productivity and stock market values. In a similar vein, Chen et al. (2013) find that bribes to bank officials is an important component of the entertainment expenses of Chinese firms, and that the bribes influence how much loans individual firms obtain.

Following this line of research, we develop a firm-level proxy for bribes amount from entertainment expenses for Korean firms. About two thirds of exchange-listed firms in Korea report entertainment expenses in their income statements.[6] Entertainment expenses of these firms include the cost of

[6] The remaining one third of exchange-listed firms include entertainment expenses in a higher category of selling, general, and administrative expenses. The entertainment expenses recorded in

providing meals and drinks, arranging travels and sports activities (e.g. golf outings), and giving gifts for the purpose of "enhancing social relationship and smoothing business transactions" (Kim, 2012). Perhaps reflecting the importance of social relationship in doing business in Korea, the regulation of entertainment expenses is relatively weak (Kim, 2012). For example, in the U.S., there is requirement that food and beverages must not be lavish and that an employee of a firm must be present during the meal. No such requirement exists in Korea. Also, there is a limit on the value of the gifts in the U.S. whereas there is no such limit in Korea. In 2016, new regulation was introduced that has the effect of tightening entertainment expenses, which we will describe further below.

We focus on the part of entertainment expenses incurred while doing business with public officials. We characterize this part of entertainment expenses as "bribes." In law, bribes are defined as "illicit" payments made with the intention of "improperly" influencing an official (Jordan, 2016). In economics literature, the requirement of "impropriety" is often omitted as in the following definition cited by Zeng et al. (2016): "the offering, promising, or giving of something in order to influence a public official in the execution of his/her public duties." We adopt the latter definition of bribery, and do not attempt to separate illicit payments from ordinary payment.

We utilize a unique feature of Korea's institutional setting: the adoption of an anti-corruption regulation called Improper Solicitation and Antigraft Act of 2016, also known as Kim Yeong Ran Law after its author, a former supreme court justice. The adoption of this regulation was widely discussed in popular press in Western countries such as New York Times. (See Choe (2016).) The law prohibits public-sector employees from receiving entertainment and gift exceeding 30,000 KRW (approximately 30 USD) and 50,000 KRW, respectively. This law reflects the popular idea that

---

income statements are not necessarily identical to the entertainment expenses recorded in tax filings. While the latter is probably more informative, it is not publicly available.

corporate entertainment expenses spent for public officials are a form of bribery and need to be curtailed.

In response to this law, there was a significant reduction in corporate entertainment expenses. Figure 1 shows the quarterly entertainment expenses of an average firm for the 10 quarters around the enactment of the Antigraft Act of 2016. The law became effective at the beginning of 2016Q4. We have selected the 5 quarters preceding the enactment of the law (2015Q3 ~ 2016Q3) and the 5 quarters following the enactment of the law (2016Q4 ~ 2017Q4). In the last quarter before the law became effective, our sample firms, on average, spent 138 million KRW (approximately 138,000 USD) for entertainment expenses; however, after the law became effective, this figure drops to 108 million KRW. That is a decline of 22%. If we consider 5-quarter total instead of one-quarter numbers, the numbers are 678 million KRW vs. 582 million KRW. That is still a 14% decline.

[Figure 1 about here]

The new regulation only concerns the entertainment expenses for public officials. Thus, the reduction in the entertainment expenses in response to the new regulation is likely to reveal the part of pre-regulation entertainment expenses that went for public officials. Considering this, we use the reduction in entertainment expenses as a new measure of the bribe component of entertainment expenses.[7] It is true that the anti-corruption law only sets the ceiling for, instead of eliminating, business entertainment of public officials. Thus, corporations are likely to spend some money for entertaining public officials even after the enactment of the anti-corruption law. Therefore, the new measure is likely to underestimate the true amount of entertainment expenses spent for public officials.

[7] For example, if the entertainment expenses of a firm are \$100 and \$70 before and after the enactment of the law, respectively, we infer that \$30 of \$100 entertainment expenses before the enactment of the law was spent for public officials.

Nonetheless, given that corporations substantially reduced their entertainment expenses in response to the law, the new measure is likely to be informative. In the empirical analysis, we consider this new measure together with unadjusted entertainment expenses.

Our measure of briber has advantages over the existing measures. Cai et al. (2011) and Zeng et al. (2016) use the part of entertainment expenses that is correlated with proxies of government services and expropriations (questionnaire responses and tax amount).[8] Our measure is cleaner than these since it is not based on regression and survey responses, which often introduces biases. Mauro (1995) and Svensson (2003) measures examine bribery from the questionnaire of perception or self-reported bribery, which has obvious limitations as emphasized by Banerjee, Hanna, and Mullainathan (2013). Cheung et al. (2012) examine court records, but the sample is necessarily highly selective. Only those who are caught are included in the sample, and those countries actively punishing corruption will report more of corruption.

4. Sample Firms and Variables

Sample

Our sample includes the firms that (i) participated in public procurement auctions via the largest auction system-- Korea Online E-Procurement System (KOEPS)--between 2015 and 2017 and (ii) were subject to mandatory financial disclosure for the same period.

[8] Jun (2014) adopts a similar approach to investigate the bribe component of entertainment expenses of Korean firms. The focus of this paper is on the effect of alleged bribes on firm performance.

Public entities including central and local governments[9] are required to purchase goods and services via online procurement auction systems.[10] There are 24 online procurement auction systems, the largest of which is KOEPS. In 2017, the public sector purchased 137 trillion KRW (approximately 137 billion USD) worth of goods and services, of which 84 trillion KRW were bought through KOEPS. Detailed bidding records of every auction occurred in the KOEPS are available on the KOEPS web site. Bidding records include the identity and bid amount of every bidder regardless of whether the bid was successful or not. Detailed description of each project is also present. We collected these records using a custom-made web scraping program. KOEPS make some of the data available in spreadsheet format, but these data are not complete.

All the Korea-Exchange-listed firms are required to file financial statements with the Korea Financial Supervisory Commission (an agency comparable to Security Exchange Commission). Also, non-listed firms whose assets and sales are above certain thresholds are required to file financial statements as well. We have obtained financial statements data of these firms from KIS Value, a data vendor comparable to Compustat. Entertainment expenses are an item of the income statements. While a majority of firms report entertainment expenses, some firms choose to report related expenses under a more general category of selling, general, and administrative expenses.[11]

---

[9] Public entities include government-funded institutions such as schools, universities, research institutes, and business enterprises with majority government ownership. Formally, these institutions are not government institutions, but are regulated like government institutions.

[10] Under certain circumstances, a contract can be negotiated with a single firm selected by the buying agency; this arrangement is called a single-source contract. In later analysis, we examine the possibility that the participation in single source contracts is affected by bribes.

[11] After excluding firms with missing total assets and sales, there are 1,839 firms in our financial data set. Out of these 1,839 firms, 1,302 firms reported entertainment expenses.

We merged the financial data set and the auction data set using the tax-payer identification numbers and the names of the firms. In the financial data set, there are 1,302 firms which have reported non-zero entertainment expenses for the period between 2015Q3 and 2016Q3. Out of these 1,302 firms, 353 firms participated in KOEPS auctions in this period. Thus, our baseline sample consists of these 353 firms.

Variable Construction

Below we describe the key variables used in our analysis. As a first measure of bribes, we use the **entertainment-expenses-to-sales ratio** defined as:

$$(19) \qquad EntExpToSale_i = \frac{1}{5}\sum_{t=1}^{5}\frac{EntExp_{i,t}}{Sale_{i,t}}$$

In the formula above, $t = 1, \cdots, 5$ represesnt the 5 quarters preceding the enactment of the Antigraft Act of 2016 (i.e. 2015Q3, 2015Q4, 2016Q1, 2016Q2, 2016Q3). $EntExp_{i,t}$ is the quarter-t entertainment expenses of firm i, and $Sale_{i,t}$ is the quarter-t sales of firm i. Scaling entertainment expenses by sales is convention adopted by Cai et al. (2011), Chen et al. (2013), and Zeng et al. (2016). As we discussed earlier, this is a rather crude measure since it does not exclude the part of entertainment expenses used for the purpose of maintaining relationship with private companies.

As an improved measure of the bribe component of entertainment expenses, we use the **reduction in entertainment-expenses-to-sales ratio** around the enactment of the Antigraft Act of 2016:

$$(20) \qquad \Delta EntExpToSale_i = \frac{1}{5}\sum_{t=1}^{5}\frac{EntExp_{i,t}}{Sale_{i,t}} - \frac{1}{5}\sum_{t=6}^{10}\frac{EntExp_{i,t}}{Sale_{i,t}}$$

In the formula above, $t = 6, \cdots, 10$ represesnt the 5 quarters following the enactment of the Antigraft Act of 2016 (i.e. 2016Q4, 2017Q1, 2017Q2, 2017Q3, 2017Q4).

As a measure of profitability, we use the **net-income-to-sales ratio**:

$$(21) \qquad NetIncomeToSale_i = \frac{1}{5}\sum_{t=1}^{5} \frac{NetIncome_{i,t}}{Sale_{i,t}}$$

$NetIncome_{i,t}$ is the quarter-t net income of firm i.

To measure the significance of long-term business relationship for individual firms, we use the **accruals-to-sales ratio** defined as

$$(22) \qquad AccrualToSale_i = \frac{1}{5}\sum_{t=1}^{5} \frac{Receivable_{i,t} + Prepay_{i,t}}{Sale_{i,t}}$$

In the formula above, $Receivable_{i,t}$ is the account receivable of firm i at the end of quarter t, and $Prepay_{i,t}$ is the prepayment (payment made prior to the purchase of goods and services) of firm i at the end of quarter t. Note that we do not adjust the sign for prepayment as our interest is not in determining the short-term financial position of firms, but in determining whether accruals components are significant. See Zeng et al. (2016) for further relevance of this variable to entertainment expenses.

To measure the private benefit of paying bribes, we use the **relative bids** defined as:

$$(23) \qquad RelativeBid_i = \frac{1}{5}\sum_{t=1}^{5} \left(\frac{1}{n_{i,t}} \sum_{j=1}^{n_{i,t}} \frac{Bid_{i,t,j}}{WinningBid_{i,t,j}} - 1 \right)$$

In the formula above, $j = 1, \cdots, n_{i,t}$ index the auctions that firm i participated in quarter t. $Bid_{i,t,j}$ and $WinningBid_{i,t,j}$ are the bids of firm i and the winner, respectively, for the j-th auction that firm i participated in quarter t. We subtract 1 so that the range of this variable is comparable to those of other variables. Note that $WinningBid_{i,t,j}$ is not necessarily the lowest bid. Bids lower than certain threshhold values are excluded, and since the threshold values are determined randomly after the bidding, some bidders end up bidding too low. See Appendix A for further discussion of this feature.

As an alternative measure of the private benefits of paying bribes, we use the **share of single-source contracts** (in which a buyer invites, and negotiate the contract with, a particular supplier) in all the public-sector contracts that a firm was awarded. It is defined as:

$$(24) \qquad SingleSourceShare_i = \frac{1}{5}\sum_{t=1}^{5} \frac{SingleSourcePublicContract_{i,t}}{PublicContract_{i,t}}$$

In the above formula, $SingleSourcePublicContract_{i,t}$ is the total value of the single-source contracts that firm i was awarded in quarter t, and $PublicContract_{i,t}$ is the total values of all the public-sector contracts that firm i was awarded in quarter t.

To measure the share of the public-sector sales to the overall sales of individual firms, we use the **public-contract-to-sales** ratio defined as:

$$(25) \qquad PubContractToSale_i = \frac{1}{5}\sum_{t=1}^{5} \frac{PublicContractValue_{i,t}}{Sale_{i,t}}$$

Table 1 shows the summary statistics of the key variables. All the key variables are in the form of ratios so that the typical value is a small positive number close to 0. However, there are often extreme values, and these extreme values are likely to have excessive influence on regression results. Thus, in our regression analysis, we make the logarithmic transformation, i.e. we use $\log(1+x)$ instead of x. When the value of x is small, $\log(1+x)$ is close to x.

[Table 1 about here]

Industry Classification

To control for the possible effects of industry heterogeneity, we construct a new set of variables by subtracting industry means. For this purpose, we modified the Korea Standard Industrial Classification (Statistics Korea, 2018). Starting from 6-digit industry codes (about 200 industries), we created 34 industry groups so that, on average, about 10 firms belong to each industry. Further details on the industry classification are included in Appendix B.

5. Empirical Results

Productivity and Bribes

We consider four alternative proxies for the bribe component of entertainment expenses. The first proxy ($EntExpToSale$) includes all the entertainment expenses; the second ($EntE\widetilde{xpT}oSale$) is obtained after removing industry means. The third proxy ($\Delta EntExpToSale$) is our most preferred: it is based on the reduction in entertainment expenses in response to the Antigraft Act of 2016. The last ($\Delta Ent\widetilde{ExpT}oSale$) is obtained after removing industry means from the third.

We run the regression of the four measures of bribes on firm profitability. Table 2 shows the results. Across the specifications, the profitability measure has statistically significant negative correlation with the measures of bribes. That is, less profitable firms pay more bribes. As will be shown later, those firms paying more bribes bid more aggressively and win the auctions. Thus, procurement contracts go to less profitable firms, leading to inefficient allocation.

[Table 2 about here]

In the regressions reported in Table 2, we have included two other control variables: $PubContractToSale$ represents the size of the public-sector business, and $AccrualToSale$ represents the importance of maintaining long-term relationship with other private firms. We expect $PubContractToSale$ to be positively correlated with bribe amounts. If a firm does not sell much to the public sector, it has less reasons to bribe public officials. Of course, bribes can be paid to public officials who regulate the industry that the firm belongs to. Nonetheless, it is reasonable to expect that a large fraction of bribes is related to public-sector business. As expected, all the proxies for bribes are highly correlated with the measure of public-sector business. Our most preferred measure $\Delta EntExpToSale$ has the most significant relationship with public-sector business. As for $AccrualToSale$, it is likely to be correlated with the "ordinary component" of entertainment expenses if the amount of accruals represents the importance of maintaining long-term business relationship (Zeng et al., 2016). Accruals do not have expected relationship with entertainment expenses. Maintaining long-term relationship with other private firms may not be a primary goal of spending entertainment expenses for our sample firms since our sample includes only those firms participating in public procurement auctions.

Bribes and Bids

In Table 3, we examine how bid amounts, $RelativeBid$, are correlated with our four measures of bribes. It turns out that $RelativeBid$ is signifcantly correlated with three of the four bribe measures.

The correlation is negative, indicating that when firms bribe public officials more, they expect greater benefits, thus bidding lower. Our of the four bribe measures, our most preferred measure, $\Delta EntExpToSale$, is the most significant with the t statistic of -4.36. The next significant measure is $\Delta Ent\widetilde{ExpT}oSale$. This pattern corresponds to our intuition that the reduction in entertainment expenses in response to the Antigraft Act of 2016 is a good measure of the true bribe component of entertainment expenses. $EntExpToSale$ is marginally significant, suggesting that using the total amount of entertainment expenses reveal the right direction, but not the right magnitude of the true relationship.

[Table 3 about here]

We have included the net-income-to-sales ratio to control for the possible effects of the profitability on the size of relative bids. It is plausible to expect that more profitable firms will bid lower because these firms are likely to have lower cost of providing goods and services. It turns out that this possibility is mostly theoretical. More profitable firms tend to bid lower, but this pattern is not statistically significant. In any case, the results shown in Table 3 confirm that the relationship between bids and entertainment expenses remains strong even when we control for the effects of differences in firm profitability.

The results so far indicate that less profitable firms pay more bribes and bid lower in auctions. Thus, these firms are more likely to provide goods and services to the public sector, leading to inefficient allocation.

Single-Source Contracts

Occasionally, contracts are awarded without going through competitive auctions, i.e., via single-source contracts. We verified that those firms paying large bribes are more likely to obtain those contracts as well. If this is the case, we may conclude that the pattern that we reported above (i.e. less productive firms pay more bribes, bid lower, and get more procurement contracts) is applicable even when contracts are awarded via single-source contracts. In Table 4, we report the relationship between the share of the single-source contracts in the overall public-sector business ($SingleSourceShare$) and our four measures of bribes. Three out of four measures of bribes are significantly correlated with $SingleSourceShare$. In this specification, the unadjusted measure $EntExpToSale$ is the most significant variable. The correlation is positive, indicating that those firms bribing public officials more are rewarded with more single-source contracts.

[Table 4 about here]

We have included the profitability measure as well. Unlike the previous results shown in Table 3, the profitability measure is strongly correlated with the share of single-source contracts, suggesting that merit does play an important role in determining which firm will be awarded with single-source contracts.

6. Conclusion

When corrupt officials attempt to extract different amounts of bribes from different firms according to their ability to pay, low-productivity firms have stronger incentive to comply. By bribing corrupt officials aggressively, low-productivity firms overcome their cost disadvantage and ultimately win procurement auctions, which leads to inefficient allocation. Our empirical analysis of firms participating in public procurement auctions in Korea confirms this scenario. We find that low-productivity firms pay larger bribes than high-productivity firms and bid lower in procurement auctions. It is often suggested that competitive auctions are an effective tool to fight corruption in public procurement. Our analysis indicates that competitive auctions themselves do not eliminate corruption and that strong oversight is still needed.

We have extended the theoretical analysis of bribery and allocation efficiency by considering the situation where public officials do not have full discretion regarding whom to give procurement contracts. In empirical analysis, we have developed a firm-level measure of bribes from the changes in corporate entertainment expenses in response to a new anti-graft regulation, which allowed us to present firm-level evidence on bribery and allocation evidence.

Appendix A. Proof of Lemma 1, Lemma 2, and Other Formula

We assume that the probability distribution is such that there are more high-productivity firms than low-productivity firms. While we adopt this assumption for technical reasons, this has the effect of encouraging high-productivity firms to pay more bribes. When there are more high-productivity firms, their cost advantage is not very secure, and they are willing to pay more bribes. More specifically, we assume that

(A1) $\left(F(\tau)\right)^{n-1} p(\tau) r(\tau)$ is increasing τ

Proof of Lemma 1

For the proof of Lemma 1, we define function $g(\tau)$ and $h(\tau)$ as

(A2) $g(\tau) = q_1^{-1}\left(\frac{1}{\left(F(\tau)\right)^{n-1} p(\tau) r(\tau)}\right)$

(A3) $h(\tau) = q_1^{-1}\left(\frac{1}{\left(1-F(\tau)\right)^{n-1} p(\tau) r(\tau)}\right)$

where $q_1(\ \ )$ is the first derivative of $q(\ \ )$, and $q_1^{-1}(\ \ )$ is its inverse. The inverse function exists since $q_1(\ \ )$ is strictly monotonic.

(i) Let $x(\tau)$ and $y(\tau)$ be

(A4) $\quad x(\tau) = g(\tau)$

(A5) $\quad y(\tau) = c(\tau, g(\tau)) + \frac{\int_0^\tau [F(t)]^{n-1}\left[-\frac{dc(t,x(t))}{dt}\right]dt}{[F(\tau)]^{n-1}}$

To show that $(x(\tau), y(\tau))$ is a Nash equilibrium, we verify that $(x_1, y_1) = (x(\tau_1), y(\tau_1))$ is firm 1's best response when firm 1 believes every other firm adopts $(x(\tau), y(\tau))$. When firm 1 believes that all the other firms adopt $x(\tau)$ and $y(\tau)$,[12]

(A6) $\quad \Pr(1\ wins) = [\Pr(y_1 < y(\tau))]^{n-1} = [\Pr(\tau > y^{-1}(y_1))]^{n-1} = [F(y^{-1}(y_1))]^{n-1}$

The problem of firm 1 is to solve

(A7) $\quad \max_{x_1, y_1} [F(y^{-1}(y_1))]^{n-1}[y_1 - c(\tau_1, x_1)] - x_1$

The first order condition with respect to x_1 is:

(A8) $\quad [F(y^{-1}(y_1))]^{n-1}\left(-\frac{\partial c(\tau_1, x_1)}{\partial x_1}\right) = 1$

Substituting the components of $c(\ \ )$,

(A9) $\quad [F(y^{-1}(y_1))]^{n-1} p(\tau_1) r(\tau_1) q_1(x_1) = 1$

It is straightforward to verify that $(x_1, y_1) = (x(\tau_1), y(\tau_1))$ satisfies the above condition. The first order condition with respect to y_1 is

(A10) $\quad (n-1)[F(y^{-1}(y_1))]^{n-2} f(y^{-1}(y_1)) y^{-1\prime}(y_1)[y_1 - c(\tau_1, x_1)]$

---

[12] If y_1 does not belong to the image of y, the above formula is not applicable. We may define y^{-1} so that if y_1 is too small, $y^{-1}(y_1) = 1$, and if y_1 is too large, $y^{-1}(y_1) = 0$. Even so, we will have to check the possibility that the interior solution is a local optimum and the true global solution occurs at the boundary. We have verified that the interior solution here is the global solution.

$$+\left[F\left(y^{-1}(y_1)\right)\right]^{n-1} = 0$$

Note that

(A11) $$y^{-1\prime}(y_1) = \frac{1}{y'(\tau_1)} = -\frac{1}{(n-1)F(\tau)^{-n}f(\tau)\int_0^{\tau}[F(t)]^{n-1}\left[-\frac{dc(t,x(t))}{dt}\right]dt}$$

Using the expression above, it is easy to verify that $(x_1, y_1) = \left(x(\tau_1), y(\tau_1)\right)$ satisfies the second of the first-order condition. We can also verify that the problem satisfies the second order condition. [To be expanded.] Thus, we have shown that $(x_1, y_1) = \left(x(\tau_1), y(\tau_1)\right)$ is firm 1's best response when firm 1 believes every other firm adopts $\left(x(\tau), y(\tau)\right)$, from which we may conclude that $\left(x(\tau), y(\tau)\right)$ is a symmetric equilibrium. To show that $x(\tau)$ is increasing, we can directly evaluate the derivative of $x(\tau)$. Similarly, to show that $y(\tau)$ is increasing, we can directly evaluate the derivative of $y(\tau)$.

(ii) Let $x(\tau)$ and $y(\tau)$ be

(A12) $$x(\tau) = h(\tau)$$

(A13) $$y(\tau) = c\left(\tau, h(\tau)\right) + \frac{\int_{\tau}^{1}[1-F(t)]^{n-1}\left[\frac{dc(t,x(t))}{dt}\right]dt}{[1-F(\tau)]^{n-1}}$$

To show that $\left(x(\tau), y(\tau)\right)$ is a Nash equilibrium, we follow the same steps as in the proof of the first statement. When firm 1 believes that all the other firms adopt $x(\tau)$ and $y(\tau)$, the problem of firm 1 is to solve

(A14) $$\max_{x_1, y_1}\left[1 - F\left(y^{-1}(y_1)\right)\right]^{n-1}[y_1 - c(\tau_1, x_1)] - x_1$$

The first order condition is:

(A15) $$\left[1 - F\left(y^{-1}(y_1)\right)\right]^{n-1}\left(-\frac{\partial c(\tau_1, x_1)}{\partial x_1}\right) = 1$$

and

(A16) $$(n-1)\left[F\left(y^{-1}(y_1)\right)\right]^{n-2} f\left(y^{-1}(y_1)\right) y^{-1\prime}(y_1)[y_1 - c(\tau_1, x_1)]$$

$$+\left[F\left(y^{-1}(y_1)\right)\right]^{n-1} = 0$$

It is straightforward to verify that $(x_1, y_1) = \left(x(\tau_1), y(\tau_1)\right)$ satisfies the above condition. We can also verify that the problem satisfies the second order condition. [To be expanded.] Thus, we have shown that $\left(x(\tau), y(\tau)\right)$ is a symmetric equilibrium. To show that $x(\tau)$ is decreasing, we can directly evaluate the derivative of $x(\tau)$. Similarly, to show that $y(\tau)$ is decreasing, we can directly evaluate the derivative of $y(\tau)$.

Proof of Lemma 2

(i) Since $y'(\tau) > 0$, the probability of the firm with $\tau = 1$ winning the game is 0. Thus, its expected profit is $-x(1)$. The optimal response cannot lead to negative expected profit (since the expected profit of 0 can be always achieved). Thus, $x(1)$ must be 0. (ii) We prove the contrapositive: if $c(\tau, x)$ is decreasing in τ for all x, then we may exclude an inefficient-allocation symmetric Nash equilibrium. We prove this by contradiction. Suppose not. Then $c(\tau, x)$ is decreasing in τ for all x, and there exists an inefficient-allocation symmetric Nash equilibrium $\left(x(\tau), y(\tau)\right)$ where $x'(\tau) < 0$ and $y'(\tau) > 0$ for all τ. Consider the case of $\tau_1 = 0$ and $\tau_2 = 1$. In the equilibrium, firm 2 makes zero profit (as shown in Lemma 2). However, if firm 2 chooses $(x_2, y_2) = (x(0), y(0))$, then its profit is positive. (Since $x(1) = 0$ and $x(\tau)$ is strictly decreasing, $x(0) > 0$. Since $c(\tau, x(0))$ is decreasing in τ, $c\left(0, x(0)\right) \geq c(1, x(0))$. Thus, when firm 2 chooses $(x_2, y_2) = (x(0), y(0))$, its expected profit is higher than that of firm 1. Since expected profit of firm 1 is non-negative, the profit of firm 2 is positive when it chooses $(x_2, y_2) = (x(0), y(0))$.) Thus, $(x_2, y_2) = (x(\tau_2), y(\tau_2))$ cannot be the best response of firm 2, and we reached at contradiction. (iii) It is immediate from Lemma 3.

Derivation of the Formula in the Example

From Lemma 1, we can easily determine the inefficient-allocation equilibrium. Below, we derive an equilibrium in a more direct manner. When firm 1 believes that all the other firms adopt $x(\tau)$ and $y(\tau)$, (A17) $\Pr(1\ wins) = \left[\Pr\left(y_1 < y(\tau)\right)\right]^{n-1} = \left[\Pr\left(\tau > y^{-1}(y_1)\right)\right]^{n-1}$

$$= \left[1 - F\left(y^{-1}(y_1)\right)\right]^{n-1}$$

The problem of firm 1 is to solve

(A18) $$\max_{x_1, y_1}\left[1 - F\left(y^{-1}(y_1)\right)\right]^{n-1}\left[y_1 - (5 - \tau_1)\left(1 - (1 - \tau_1)^{\frac{1}{5}} x_1^{\frac{1}{5}}\right)\right] - x_1$$

The first order condition with respect to x_1 is:

(A19) $$\left[1 - F\left(y^{-1}(y_1)\right)\right]^{n-1}(5 - \tau_1)(1 - \tau_1)^{\frac{1}{5}}\frac{1}{5}x_1^{-\frac{4}{5}} = 1$$

If $(x(\tau), y(\tau))$ is indeed a symmetric equilibrium, then firm 1 uses the same strategy. Thus,

(A20) $$\left(1 - F(\tau)\right)^{n-1}(5 - \tau)(1 - \tau)^{\frac{1}{5}}\frac{1}{5}x(\tau)^{\frac{4}{5}} = 1$$

Therefore,

(A21) $$x(\tau) = \left(\frac{1}{5}\right)^{\frac{5}{4}}(1 - \tau)^{\frac{1}{4}}(5 - \tau)^{\frac{5}{4}}\left(1 - F(\tau)\right)^{\frac{5}{4}(n-1)}$$

The first-order condition with respect to y_1 is

(A22) $$-(n-1)\left[1 - F\left(y^{-1}(y_1)\right)\right]^{n-2} f\left(y^{-1}(y_1)\right) y^{-1\prime}(y_1)[y_1 - c(\tau_1, x_1)]$$
$$+\left[1 - F\left(y^{-1}(y_1)\right)\right]^{n-1} = 0$$

If $(x(\tau), y(\tau))$ is indeed a symmetric equilibrium, then firm 1 uses the same strategy. Thus,

(A23) $$-(n-1)[1 - F(\tau)]^{n-2} f(\tau)\frac{1}{y'(\tau)}[y(\tau) - c(\tau, x(\tau))] + [1 - F(\tau)]^{n-1} = 0$$

Rearranging terms,

(A24) $$-(n-1)[1 - F(\tau)]^{n-2} f(\tau)[y(\tau) - c(\tau, x(\tau))]$$
$$+[1 - F(\tau)]^{n-1}\left[y'(\tau) - \frac{d}{d\tau}c(\tau, x(\tau))\right] = -[1 - F(\tau)]^{n-1}\frac{d}{d\tau}c(\tau, x(\tau))$$

Integrating both sides,

(A25) $$[1 - F(\tau)]^{n-1}[y(\tau) - c(\tau, x(\tau))] = constant - \int_0^\tau [1 - F(t)]^{n-1}\frac{dc(t, x(t))}{dt}dt$$

Thus,

(A26) $\quad y(\tau) = c(\tau, x(\tau)) + \frac{constant - \int_0^\tau [1-F(t)]^{n-1} \frac{dc(t,x(t))}{dt} dt}{[1-F(\tau)]^{n-1}}$

Since we require $y(\tau)$ to be bounded near $\tau = 1$, the constant should be $\int_0^1 [1 - F(t)]^{n-1} \frac{dc(t,x(t))}{dt} dt$. Thus,

(A27) $\quad y(\tau) = c(\tau, x(\tau)) + \frac{\int_\tau^1 [1-F(t)]^{n-1} \frac{dc(t,x(t))}{dt} dt}{[1-F(\tau)]^{n-1}}$

Appendix B. Further Details of the Sample

Our data set includes 353 firms that (i) report entertainment expenses in quarterly financial statements for the period from 2015Q3 to 2016Q3 and (ii) participated in KOEPS auctions at least once during the same period. About two thirds of firms filing financial statements with Korea Financial Supervisory Commission report entertainment expenses. Any firm that wants to win a contract from the public sector (including the central and local government agencies and certain enterprises under effective government control) must participate in online procurement auctions, the largest of which is KOEPS. So, our sample is fairly representative of the Korean firms doing business with the public sector.

The median firm in our sample has the total assets of 116 billion KRW (approximately 116 million USD) and the annual sales of 94.3 billion KRW. The Korean government applies the threshold of 100 billion KRW to determine small and medium-size enterprises. The median firm in our data set is near this threshold. The smallest firm in our data set has the total assets of 5 billion KRW, and the largest firm in our data set has the total asset of 34,700 billion KRW. (The largest corporation in Korea--Samsung Electronics--is not included in our data set since it does not report entertainment expenses.)

The average annual sales of the sample firms are 573 billion KRW. These firms on average spend 0.543 billion KRW for entertainment expenses, which are about 10 basis points of the sales. (Note that the average of entertainment-expenses-to-sales ratios is much higher at around 50 basis points; the distribution of the ratios is skewed to the right.)

Our sample firms participate in about 103.7 KOEPS auctions in a year and succeed in about 3.8 of these auctions. The average contract price is about 1.7 billion KRW, so the average annual revenues from KOEPS auctions are about 6.3 billion KRW, which are slightly more than 1% of the sales. (Note that the average of the public-contracts-to-sales ratio is much higher at around 5%; the distribution of the ratios is skewed to the right.)

In the analysis, we have grouped our sample firms into 34 industries. Table B1 is the tabulation of this grouping. It also presents the description of each industry together with the corresponding Korea Standard Industrial Classification (KSIC) codes.

[Table B1 about here]

References

Banerjee, A., R. Hanna, and S. Mullainathan (2013), “Corruption,” in R. S. Gibbons, and J. Roberts, eds., *The Handbook of Organizational Economics*, Princeton University Press, 1109–47.

Beck, P. J., and M. W. Maher (1986), "A comparison of bribery and bidding in thin markets," *Economics Letters*, 20, 1–5.

Cai, Fang, and Xu (2011), "Eat, drink, firms, government: an investigation of corruption from the entertainment and travel costs of Chinese firms," *Journal of Law and Economics*, 54, 55-78.

Carril, R., and M. Duggan (2018), "The impact of industry consolidation on government procurement: Evidence from Department of Defense contracting," NBER Working Paper 25160.

Chen, Y., M. Liu, J. Su, (2013), "Greasing the wheels of bank lending: evidence from private firms in China," *Journal of Banking and Finance*, 37, 2533–2545.

Choe, S. (2013), "Scandals in South Korea over nuclear revelations," *New York Times*, Aug. 3.

Choe, S. (2016), "Antigraft law stirs up wariness over South Koreans bearing gifts," *New York Times*, Sep 29.

Cheung, Y., R. Rau, and A. Stouraitis (2012), "How much do firms pay as bribes and what benefits do they get? Evidence from corruption cases worldwide," City University of Hong Kong Working Paper.

Clark, D. J., and C. Riis (2000), "Allocation efficiency in a competitive bribery game," *Journal of Economic Behavior and Organization*, 42, 109-124.

Decarolis, F. (2014), "Awarding Price, Contract Performance and Bids Screening: Evidence from Procurement Auctions," *American Economic Journal: Applied Economics*, 6(1), 108-132.

-------- (2018), "Comparing Public Procurement Auctions," *International Economic Review*, 59(2), 391-419.

Decarolis, F., L. M. Giuffrida, E. Iossa, V. Mollisi, G. Spagnolo (2018), "Bureaucratic Competence and Procurement Outcomes," NBER Working Paper 24201.

Donnelly, P. J., and R. H. Holton (1962), "A Note on product differentiation and entertainment expense allowances in the United States," *Journal of Industrial Economics*, 10(2), 134-138.

Dreher, A., and M. Gassebner (2013) "Greasing the wheels? The impact of regulations and corruption on firm entry," *Public Choice*, 155, 413-432.

Fisman, R., and J. Svensson (2007), "Are corruption and taxation really harmful to growth? Firm level evidence," *Journal of Development Economics*, 83, 63–75.

Huang, C. (2016), "Is corruption bad for economic growth? Evidence from Asia-Pacific countries," *North American Journal of Economics and Finance,* 35, 247-256.

Jordan, J. (2016), "World tours and the Summer Olympics: recent pitfalls under the Foreign Corrupt Practices Act in the areas of gifts, entertainment, and travel," *Fordham Journal of Corporate and Financial Law*, 21(2), 295-326.

Jun, J. (2014), "The effects of quasi-taxes and entertainment costs on firm growth in Korea," *Public Finance Research*, 7(4), 149-181. [전주성, "준조세성 지출이 기업 성장에 미치는 효과," 『재정학연구』.]

Kaufman, D., and S. Wei (2000), "Does grease money speed up the wheels of commerce?" IMF Working Paper 00-64.

Kim, J. (2012), "Comparative analysis of entertainment expense in the United States and Korea," *Journal of Korean Law*, 11, 151-178.

Lebrun, B. (1999) "First price auctions in the asymmetric N bidder case," *International Economic Review*, 40(1), 125-142.

Lien, D. H. D. (1986), "A note on competitive bribery games," *Economics Letters*, 22, 337–341.

-------- (1990), "Corruption and Allocation Efficiency," *Journal of Development Economics*, 33, 153-164.

Lui, F. T. (1985), "An equilibrium queuing model of bribery," *Journal of Political Economy*, 93, 760-781.

Maskin, E., and J. Riley (2000), "Asymmetric auctions," *Review of Economic Studies*, 67(3), 413-438.

Mauro, P. (1998), "Corruption and growth," *Quarterly Journal of Economics*, 110, 681–712.

Meon, P. G., and K. Sekkat (2005), "Does corruption grease or sand the wheels of growth?" *Public Choice*, 122(1), 69–97.

Meon, P. G., and L. Weill, (2010), "Is corruption an efficient grease?" *World Development*, 38(3), 244–259.

Millington, A., M. Eberhardt, and B. Wilkenson (2005), "Gift giving, guanxi and illicit payments in buyer-supplier relations in China: analyzing the experience of UK companies," *Journal of Business Ethics*, 57, 255-268.

Sharma, C., and A. Mitra (2015), "Corruption, governance and firm performance: evidences from Indian enterprises," *Journal of Policy Modeling*, 37, 835-851.

Shleifer, A., and R. W. Vishny (1993), "Corruption," *Quarterly Journal of Economics,* 108, 599–617.

Statistics Korea (2018), "Korea Standard Industrial Classification," available at http://kssc.kostat.go.kr.

[통계청, "한국표준산업분류."]

Svensson, J. (2003), "Who must pay bribes and how much? Evidence from a cross section of firms," *Quarterly Journal of Economics*, 118(1), 207-230.

Zeng, Y., E. Lee, and J. Zhang (2016), " Value relevance of alleged corporate bribery expenditures implied by accounting information," *Journal of Accounting and Public Policy*, 35, 592-608.

Figure 1. Entertainment Expenses before and after the Antigraft Act of 2016

Our sample consists of 353 firms that participated in auctions held in KOEPS during the period from 2015Q3 to 2016Q3 and disclosed entertainment expenses in financial statements in the same period. The figure below denotes the average of entertainment expenses (averaged across firms included in our data set) for each of the 10 quarters between 2015Q3 and 2017Q4. Note that the Antigraft Act of 2016 was enacted at the beginning of 2016Q4. The unit of measurement is one million Korean wons.

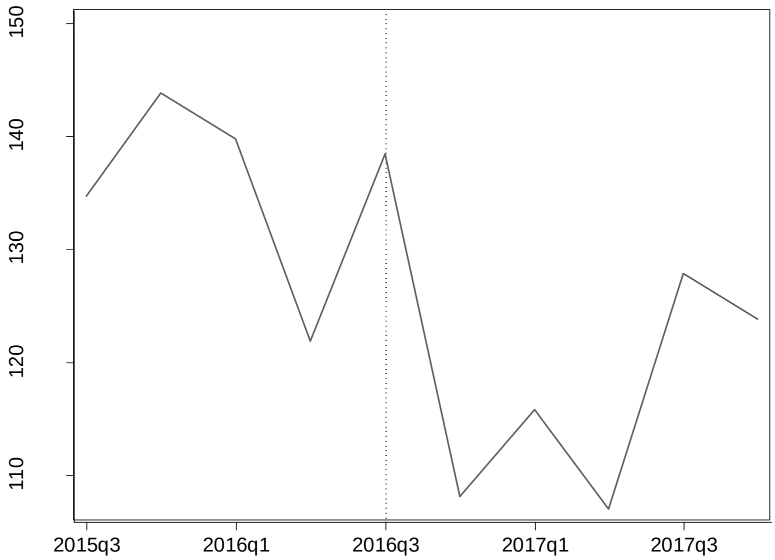

Table 1. Summary Statistics of Key Variables

Our sample consists of 353 firms that participated in auctions held in KOEPS during the period from 2015Q3 to 2016Q3 and disclosed entertainment expenses in financial statements in the same period. $EntExpToSale$ is the entertainment-expenses-to-sales ratio, obtained from the average of quarterly ratios for the 5 quarters between 2015Q3 and 2016Q3. $\Delta EntExpToSale$ is the reduction in the entertainment-expenses-to-sales ratio, calculated as the difference between two averages, the first average being out of the 5 quarters between 2015Q3 and 2016Q3 and the second average being out of the 5 quarters between 2016Q4 and 2017Q4. $NetIncomeToSale$ is the net-income-to-sales ratio, obtained from the average of quarterly ratios for the 5 quarters between 2015Q3 and 2016Q3. $AccrualToSale$ is the accruals-to-sales ratio similarly calculated. Accuruals is defined as the sum of accounts receivable and accounts payable. $RelativeBid$ is the average of 5 quarterly ratios for 2015Q3 through 2016Q3; the ratio for each quarter is calculated as the bid of the firm to the bid of the winner, averaged across all the KOEPS auctions that the firm participated in that quarter. $SingleSourceShare$ is the average of 5 quarterly ratios for 2015Q3 through 2016Q3; the ratio for each quarter is the share of single-source contracts in all the KOEPS contracts that the firm was awarded in that quarter. $PubContractToSale$ is the average of 5 quarterly ratios for 2015Q3 through 2016Q3; the ratio for each quarter is calculated as the sum of all the KOEPS contracts that the firm was awarded in that quarter divided by the sales of that quarter. The figures shown are in percent.

	Obs	Mean	Std	Min	Med	Max
$EntExpToSale$	353	0.46	0.56	0.01	0.27	5.13
$\Delta EntExpToSale$	353	0.07	0.24	-1.84	0.04	1.13
$NetIncomeToSale$	353	2.52	20.95	-90.96	2.47	222.52
$AccrualToSale$	353	26.83	48.19	0	7.47	4.13
$RelativeBid$	353	1.17	2.82	-22.12	0.78	20.81
$SingleSourceShare$	353	23.44	37.43	0	0	100
$PubContractToSale$	353	4.66	11.47	0	0.39	99.54

Table 2. Determinants of Bribes

Our sample consists of 353 firms that participated in auctions held in KOEPS during the period from 2015Q3 to 2016Q3 and disclosed entertainment expenses in financial statements in the same period. $EntExpToSale$ is the average of the entertainment-expenses-to-sales ratios of the first 5 quarters of the period. $\Delta EntExpToSale$ is calculated as $EntExpToSale$ less the average of the last 5 quarters. $NetIncomeToSale$ is the average of the net-income-to-sales ratios for the first 5 quarters. $PubContractToSale$ is the average of the public-contracts-to-sales ratios for the first 5 quarters, where the numerator of the ratio is the total value of the KOEPS contracts awarded in each quarter. $AccrualToSale$ is the average of the accruals-to-sales ratios for the first 5 quarters, where accruals are defined as the sum of accounts receivable and accounts payable. To reduce the effect of outliers, each variable x is replaced with $\log(1+x)$. The tilde over a variable name indicates that industry means have been subtracted from the variable. Numbers shown inside the square brackets are t statistics. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

	Dependent var: $EntExpToSale$ (1)	$\widetilde{EntExpToSale}$ (2)	$\Delta EntExpToSale$ (3)	$\Delta \widetilde{EntExpToSale}$ (4)
Explanatory var:				
$NetIncomeToSale$	-0.0061 [-5.07] ***		-0.002 [-3.92] ***	
$\widetilde{NetIncomeToSale}$		-0.005 [-4.75] ***		0.002 [-3.92] ***
$PubContractToSale$	0.011 [3.50] ***		0.0045 [3.36] ***	
$\widetilde{PubContractToSale}$		0.0052 [1.77] *		0.0039 [2.80] ***
$AccrualToSale$	-0.0027 [-2.62] ***		-0.001 [-2.30] **	
$\widetilde{AccrualToSale}$		-0.0004 [-0.30]		-0.0013 [-2.35] **
Constant	0.0047 [12.88] ***		0.0007 [4.40] ***	
N	353	353	353	353
Adj R sq.	0.0978	0.0611	0.0692	0.0623

Table 3. Determinants of Bids

Our sample consists of 353 firms that participated in auctions held in KOEPS during the period from 2015Q3 to 2016Q3 and disclosed entertainment expenses in financial statements in the same period. $RelativeBid$ is the average of 5 quarterly ratios for 2015Q3 through 2016Q3; the ratio for each quarter is calculated as the bid of the firm to the bid of the winner, averaged across all the KOEPS auctions that the firm participated in that quarter. $EntExpToSale$ is the average of entertainment-expenses-to-sales ratios for the 5 quarters between 2015Q3 and 2016Q3. $\Delta EntExpToSale$ is calculated as $EntExpToSale$ less the average of entertainment-expenses-to-sales ratios for the 5 quarters between 2016Q4 and 2017Q4. $NetIncomeToSale$ is the average of net-income-to-sales ratios for the 5 quarters between 2015Q3 and 2016Q3. To reduce the effect of outliers, each variable x is replaced with $\log(1+x)$. The tilde over the variable name indicates that industry means have been subtracted from the variable. Numbers shown inside the square brackets are t statistics. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

	Dependent var: $RelativeBid$ (1)	$RelativeBid$ (2)	$RelativeBid$ (3)	$RelativeBid$ (4)
Explanatory var:				
$EntExpToSale$	-0.5393 [-1.94] *			
$EntE\widetilde{xpT}oSale$		-0.4321 [-1.32]		
$\Delta EntExpToSale$			-2.8035 [-4.36] ***	
$\Delta EntE\widetilde{xpT}oSale$				-2.5608 [-3.79] ***
$NetIncomeToSale$	-0.0041 [-0.63]		-0.0063 [-1.00]	
$NetInc\widetilde{ome}ToSale$		-0.0024 [-0.35]		-0.005 [-0.76]
Constant	0.0137 [6.98] ***	0.0112 [7.48] ***	0.0131 [8.58] ***	0.0112 [7.61] ***
N	353	353	353	353
Adj R sq.	0.0051	-0.0007	0.0463	0.034

Table 4. Single-Source Contracts

Our sample consists of 353 firms that participated in auctions held in KOEPS during the period from 2015Q3 to 2016Q3 and disclosed entertainment expenses in financial statements in the same period. $SingleSourceShare$ is the average of 5 quarterly ratios for 2015Q3 through 2016Q3; the ratio for each quarter is the share of single-source contracts in all the KOEPS contracts that the firm was awarded in that quarter. $EntExpToSale$ is the average of entertainment-expenses-to-sales ratios for the 5 quarters between 2015Q3 and 2016Q3. $\Delta EntExpToSale$ is calculated as $EntExpToSale$ less the average of entertainment-expenses-to-sales ratios for the 5 quarters between 2016Q4 and 2017Q4. $NetIncomeToSale$ is the average of net-income-to-sales ratios for the 5 quarters between 2015Q3 and 2016Q3. To reduce the effect of outliers, each variable x is replaced with $\log(1+x)$. The tilde over the variable name indicates that industry means have been subtracted from the variable. Numbers shown inside the square brackets are t statistics. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

	Dependent var: $SingleSourceShare$ (1)	$Single\widetilde{Source}Share$ (2)	$SingleSourceShare$ (3)	$Single\widetilde{Source}Share$ (4)
Explanatory var:				
$EntExpToSale$	11.5274 [4.52] ***			
$Ent\widetilde{ExpTo}Sale$		8.0243 [2.90] ***		
$\Delta EntExpToSale$			14.4931 [2.36] **	
$\Delta Ent\widetilde{ExpTo}Sale$				8.9509 [1.53]
$NetIncomeToSale$	0.1489 [2.48] **		0.1093 [1.81] *	
$NetInc\widetilde{ome}ToSale$		0.109 [1.89] *		0.0848 [1.47]
Constant	0.1191 [6.61] ***		0.1622 [11.11] ***	
N	353	353	353	353
Adj R sq.	0.0549	0.0218	0.0153	0.005

Table B1. Industry Classification

See Statistics Korea (2018) for the description of KSIC codes. N refers to the number of sample firms assigned to each industry.

Industry (KSIC codes)	N
Food and beverage (C10403, C10620, C10712, C10720, C10800, C13999)	9
Wood and paper (C10110, C10211, C16212, C17122, C17129, C18119, C19210, C19221)	7
Chemical (C20111, C20121, C20129, C20412, C20421, C20433, C20499, C20501)	10
Pharmaceuticals (C21102, C21210, C21300)	9
Rubber and plastic (C22111, C22199, C22211, C22213, C22229, C22231, C22232, C23221)	8
Mineral (C23311, C23322, C23325, C23999)	8
Steel (C24111, C24112, C24121, C24131, C24132, C24199, C24229)	7
Metal (C25112, C25113, C25122, C25130, C25200)	10
Semiconductor (C26110, C26120, C26294, C26299, C26310, C26329)	10
Communication equipment (C26410, C26421)	10
Audio and video equipment (C26429, C26519, C26529)	9
Medical equipment (C27112, C27191, C27199, C27212, C27214, C27215, C27216, C27322)	5
Generators (C28111, C28112, C28119, C28121, C28122)	11
Electric equipment (C28202, C28301, C28302, C28410, C28422, C28511, C28520, C28903)	10
General purpose equipment (C29133, C29141, C29169, C29171, C29173, C29174, C29180, C29192)	10
Special purpose equipment (C29194, C29210, C29221, C29222, C29241, C29271, C29292, C29299)	11
Transportation equipment (C30121, C30201, C30320, C30399, C31111, C31114, C31119, C31310, C31322, C31991, C32029, C33900)	12
Utilities (D35200, E38210, E38220, E38230, E39009)	5
Residential building construction (F41000, F41100)	11
Nonresidential building construction (F41110, F41112)	6
Infrastructure construction (F41220, F41221, F41225, F41229)	10
Other construction (F42121, F42122, F42131, F42201, F42202, F42311, F42412)	9
Wholesale (G46109, G46461, G46465, G46510, G46592)	6
Retail (G46594, G46599, G46712, G46721, G46799, G46800, G47111, G47430, G47911)	9
Transportation (H49310, H49311, H49390, H52101, H52939, H52942)	12
Publishing (J58111, J58119, J58121, J58211, J58219)	7
System software (J58221)	14
Applied software (J58222)	17
Media contents (J59112, J60221, J60222, J60229, J61220, J62010)	9
Computer system maintenance (J62021)	14
Information technology (J62090, J63112, J63120, J63991, J63999)	12
Science and technology (M70113, M71310, M71520, M72111, M72121, M72129)	14
Business service (N74100, N75211, N75310, N75320, N75991, N75993)	10
Not elsewhere classified (I55113, L68122, L69110, P85502, P85709, R91199, R91249, S95119)	8