UMEÅ UNIVERSITY

The Price of Few Tenders

Evidence from Public Procurement of Internal Cleaning Services in Sweden

Samielle Drake

Master thesis I, 15 hp
Master program in Economics, 120 hp
Spring semester 2020

Acknowledgements

I would like to thank my supervisor, [redacted], for his support and constructive suggestions throughout this process as well as [redacted] for his guidance with the data set and thoughts on the econometric analysis.

Abstract

The key objective of a procuring entity is to ensure that it procures services and goods with satisfactory quality at a reasonable cost, but how does the competitive environment effect the realization of these ambitions? The empirical analysis aimed to investigate the effect of qualifications criteria, interpreted as a mean to ensure high-quality services, on the number of submitted tenders as well as the effect of the number of tenders on the size of the bids of public procurement of internal cleaning services in Sweden during 2015-2017. The expectation is that qualification criterions imposes both entry costs and costs associated with fulfilling the contract. With increased prerequisite costs, firms could choose not to participate as the cost associated with becoming a qualified tender are considered too high. Further, increased competition is expected to reduce the size of the placed bid. The diminution of the size of the bid is expected as a consequence of reduced mark-ups with increased level of competition. To test the hypotheses, an instrument variable 2SLS regression was considered. The main results of the empirical analysis concluded that there are costs associated with few tenders. The direction of effects of setting qualification criteria did not yield cohesive results, as some increased the number of tenders and other decreases them, while some had no significant effect.

Keywords: Competition, auction theory, public procurement, cleaning services, 2SLS

Abstrakt

Det huvudsakliga målet vid offentlig upphandling är att anskaffa högkvalitativa varor och tjänster till en rimlig kostnad, men hur påverkar konkurrensen bland anbudsgivarna de upphandlande myndigheternas möjligheter att uppnå dessa mål? Uppsatsen avser att undersöka ska-kravens effekt, som kan tolkas som ett möjligt medel för att säkerställa en önskad kvalitetsnivå, på antalet inkomna anbud samt effekten av antalet anbud på anbudspriserna inom offentlig upphandling av städtjänster i Sverige under perioden 2015–2017. Förväntningen var att ska-kraven kan förknippas med ökade kostnader för företaget att kvalificera som anbudsgivare samt att uppfylla kontraktet, och att dessa kostnader kan påverka företagens vilja och möjlighet att lägga ett konkurrenskraftigt bud. Vidare förväntades anbudets storlek att minska när antalet anbudsgivare ökar, då ökad konkurrensnivå enligt ekonomisk teori minskar möjligheten till prispåslag. För att testa dessa hypoteser användes en instrumentvariabel regression. Resultatet av den empiriska studien visar att det finns en kostnad förenad med bristande konkurrens inom offentlig upphandling av städtjänster. Effekten av ska-kraven visade ingen entydig bild av att dessa konsekvent skulle påverka antalet anbud negativt.

Nyckelord: Konkurrens, auktionsteori, offentlig upphandling, städtjänster, 2SLS

Table of Content

1. Introduction

Public procurement measures up to a substantial share of public spending each year, as a considerable portion of the governmental cost is associated with procuring a variety of goods and services. The share of governmental spending on public procurement were roughly 17% in Sweden during the year of 2017. Approximately 14% of GDP in the European Union is spent on purchasing supplies, services and works during recent years (European Commission, n.d.; Upphandlingsmyndigheten & Konkurrensverket, 2019). A total of 1155 governmental agencies initiated at least one public procurement procedure during 2018 in Sweden.

The goods and services procured by governmental agencies are necessary to acquire, but is the price paid by the procuring entity at a premium due to lack of competition? Economic theory implies that lack of competition, in terms of a firm facing fewer participating firms in a first-price sealed-bid auction with symmetric strategies, increases firm mark-ups (Sundström, 2016). If economic theory applies, designing procurements which entice more firms to participate could reduce the governmental cost, thus allowing additional allocation of governmental means to other areas such as law and order, education, infrastructure and health care.

However, the contracting entity has several vital objectives to take into consideration during the procurement process (Bergman et al., 2011). Besides following the laws and regulations of public procurement, the contracting entity needs to ensure that they procure the service or good at a reasonable cost. Further, the contracting entity must design the contracting documents and choose a proper evaluation method to guarantee a high level of quality from the supplier without undermining the level of competition between tenderers (Bergman & Lundberg, 2009).

Objective and Question at Issue

The main purpose of this study is to determine if the size of the bid placed by participating firms decreases with an increased level of competition, through the number of participating firms in public procurement contracts of internal cleaning services in Sweden during the years of 2015 to 2017. This paper will further investigate whether the qualification criteria of public procurement of internal cleaning service contracts affect the number of participating bidders, and thereby the level of competition.

There are two main hypotheses which this study aims to answer:

Does the size of the bid per square meter and year decrease with an increase in the number of bidders participating in the public procurement auction of internal cleaning services in Sweden?

$$H_0: \frac{\partial B_i}{\partial N} = 0$$

$$H_a: \frac{\partial B_i}{\partial N} < 0$$

where N represents the number of tenderers participating in the public procurement contract and B_i is the size of the bid placed by firm i in SEK per square meter per year.

Do qualification criteria decrease the number of bidders participating in public procurement contracts of internal cleaning services in Sweden?

$$H_0: \frac{\partial N}{\partial Q_k} = 0$$

$$H_a: \frac{\partial N}{\partial Q_k} < 0$$

Where Q_k represents k different qualification criteria and N represents the number of tenderers participating in the public procurement contract.

Limitations

A fair amount of different goods and services are procured by governmental agencies, governmental owned companies, regions and municipalities each year, adding up to substantial sums each year. Analysing the economic effects of the level of competition and qualification criteria on the price paid for each market are of great interest to contracting agencies.

As a limitation, due limited access to sufficient data, the analysis in this study is restricted to internal cleaning services from 2015 to 2017. Only contracts with complete information regarding sizes to be cleaned, frequencies of the cleaning and the bids placed by the

participating firms are considered. Tenders for framework agreements[1] as well as disqualified bids are excluded from the analysis.

Data and Method

The data set contains microdata including bids and contract details of 480 contracts from public procurements of internal cleaning services from 2015 to 2017. The analysis is conducted through an instrument variable regression, using the two-stage least square estimator. The exogenous instruments used in this study are the size of the population and the share of left-wing and social-democratic seats at the local council.

Research Contribution

This paper aims to contribute to past research by examining a unique data set of internal cleaning services procured by governmental agencies in Sweden. Additional knowledge of the effects on qualification criteria and competition levels on the cost associated with public procurements of internal cleaning services may aid local and national decision-makers on how to perform and design their procurements in the future. By examining these effects, insights can be provided which can increase competition, reduce governmental costs and more efficiently reach the goals concerning the procurements set by the contracting entities.

Disposition

In the second section of the study, background information regarding the public procurement process and its importance is presented. A literature review of past studies and findings will be presented in the third section of this study, followed by the fourth section with a presentation of the economic theories which this research is based upon. In the fifth and sixth section, the data is presented through descriptive statistics and the chosen methods used to analyse the data are defined. The results are presented in section seven, followed by the discussion, conclusion and future research ideas in section eight.

[1] In framework agreements, several bidders can win in the same contract.

2. Background

Public procurement is an important part of the Swedish economy as it measures up to approximately 17% of public spending each year (Upphandlingsmyndigheten & Konkurrensverket, 2019). A wide-ranging variety of goods and services are procured through public auctions, and as a substantial amount of money is involved in public procurement in Sweden it is of great importance to understand and analyse the economic interpretations of both regulations and policies (Lundberg, 2005b).

Bergman and Lundberg (2009) state that the primary purpose of public procurement is to acquire good quality at a low cost. To achieve this, four fundamental circumstances are essential; Efficient competition, low transaction costs, no corruption or favouritism and means to assure that a sufficient level of quality is provided by the winner. Issues with establishing these conditions are evident. Existing mechanisms which may aid in establishing one of the conditions could, in fact, impair the formation of another. Increased transparency is an instrument which can be used to avert both favouritism and corruptions, but increased transparency simultaneously enhances potential collusions between the tenderers.

The Swedish Competition Authority is responsible for supervising public procurement in Sweden and making sure that government agencies are following the current laws of public procurement. They further aim to safeguard and increase healthy and efficient competition in Swedish markets. The Swedish Competition Authority states that the necessary prerequisites to sustain a healthy and sustainable competition between firms participating in public procurement exist today (Konkurrensverket, n.d.-a, n.d.-b).

2.1. The Laws and Regulations of Public Procurement

In this study, three of the acts of public procurement will be considered. The Act on Public Procurement[2] (LOU) which applies to purchases of public services and public goods. The Act of Public Procurement in the Utilities Sector[3] (LUF) which applies to procuring entities in fields such as transport, postal services, water services and firms within the energy sector. The last

[2] Lag (2016:1145) om offentlig upphandling
[3] Lag (2016:1146) om upphandling inom försäljningssektorerna

and final act is the Defence and Security Procurement Act[4] (LUFS) which applies to both defence procurements and security procurements. The basic principles, of which the regulations governing public procurement rests upon, are non-discrimination, equal treatment, proportionality, transparency and mutual recognition (Konkurrensverket, 2018a). The procurement acts are to be interpreted with these five principles taken into account.

Public procurement in Sweden is not only regulated through the Public Procurement Act, but it also follows the ordinances set by the European Union. One of the directives from the European Union is designed to promote a healthy competition among bidders for public contracts and secure that procurements are to be carried out without neither influence nor corruption (Konkurrensverket, 2012; Lundberg, 2005b).

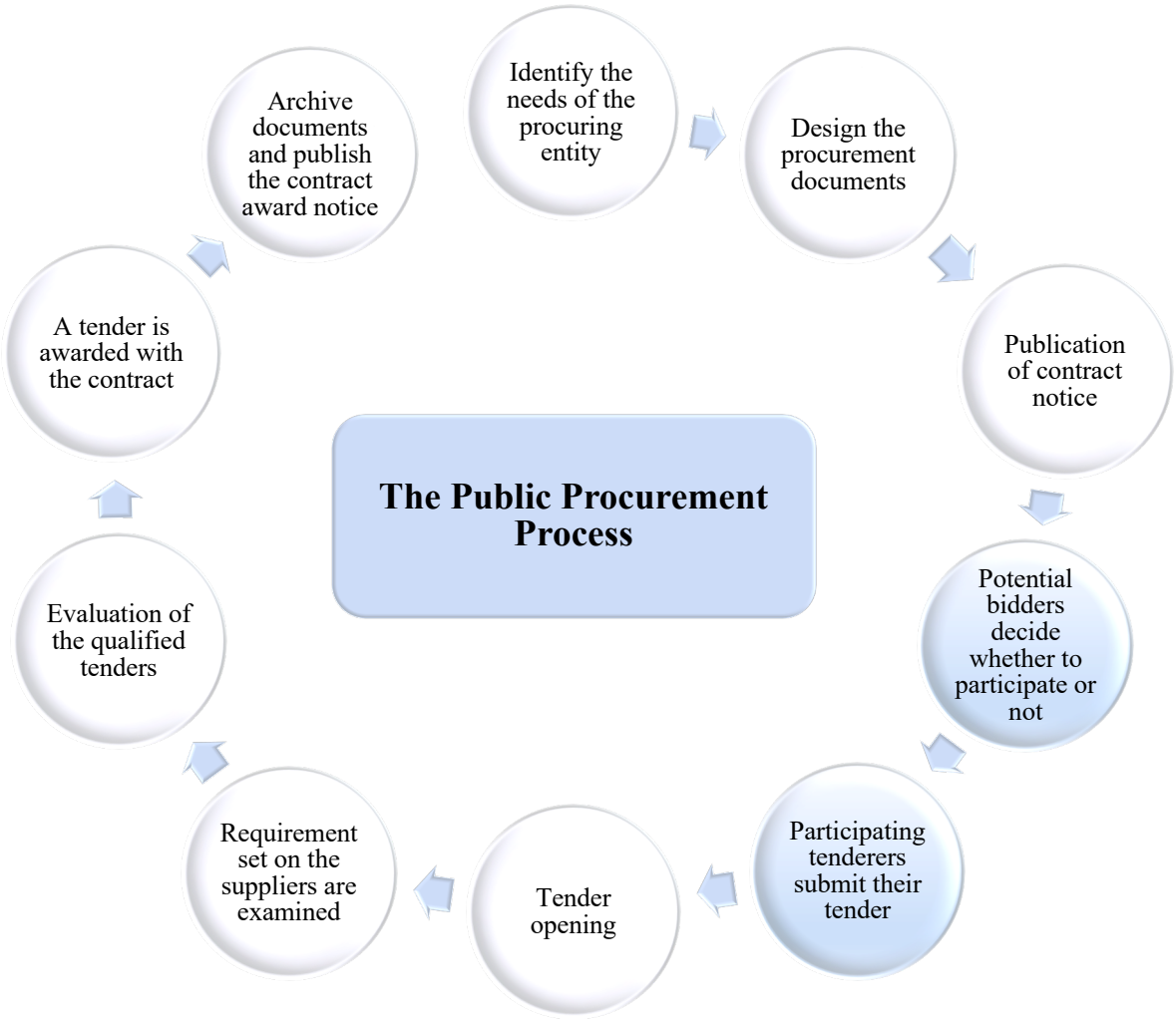
The value of the procurement is a determinant to which laws and regulations to consider for the public procurement auction. The threshold value differs between types of procuring entities and is revised every other year. The procuring entity evaluates the presumed total value of the contract. If this presumed value is above the threshold value, the laws of the EU and the acts of public procurement needs to be followed (Konkurrensverket, 2020). If the presumed value of the contract is below the threshold value, only the acts of public procurement are applicable. Procuring entities, therefore need to compel to the procuring laws from the European Union as well as the acts of public procurements, depending on the value of the contract.

2.2. The Procurement Process

The procurement process, which can be seen in figure 1, begins with the governmental entity identifying a need for a good or service which can be met either internally or externally through public procurement. It is not always considered cost-effective to meet these needs internally, by producing the good or service in-house, compared to acquiring it externally. It is considered more cost-efficient to procure externally when the production of the good or service is far from the entities core task. The closer the service or good is to the public sectors core task, the more apparent it is that the service or good should be produced in-house (Bergman & Lundberg, 2009). Therefore, the governmental authorities can be assumed to have cost disadvantages compared to the firms who operate in a competitive market regarding goods and services.

[4] Lag (2011:1029) om upphandling på försvars- och säkerhetsområdena

Figure 1: The public procurement process



The figure above presents the procurement process; from evaluating and planning, to implementing and finally completion of the public procurement.

Identify Needs and Design the Procurement Documents

During the establishment of the procurement process, the contracting agencies identifies their needs and design a procurement document with a set of demands on the participating firms. Some of these demands are set as a part of the public procurement act or ordinance of the European Union and others are specific requirements asked to meet the needs of the contracting entity.

Through the procurement document, the contracting entity is to secure that the contract meets the need of the entity, exploits rivalry in the market and is implemented both legally and efficiently (Upphandlingsmyndigheten, 2019h).

A wide set of information regarding the contract is provided in the procurement document, such as requirements regarding administrative terms, the demands set on the supplier, the demands set on the service or good, the base for the award of the contract, term of delivery and the terms of the contract. All requirements set on the suppliers must be relevant to the good or service procured (Konkurrensverket, 2018a). According to the principle of proportionality, the contracting entity is not allowed to place other requirement or higher requirements on the suppliers than what is necessary to meet the needs of the contracting entity.

The set of requirements include exclusion criteria, which allows the contracting entity to exclude tenders guilty of certain misconducts. It also includes qualification requirements, which are set on the supplier to make sure they can provide the good or service. The qualification requirements can be economic and financial standing, terms of delivery or environmental criteria. The requirements also include selection rules, which means that in some cases a contracting entity can decide that only a certain number of qualified tenders' bids will be considered. If this is the case, the decided number of participants must be stated in the document as well as the criteria determining the selection of these. These requirements are set to ensure each participating firm have capacity and resources to provide the good or service.

Publication of Contract Notice

The publication of contract notices for contracts which are below the threshold value is to be posted in a publicly accessible database, with access for all potential bidders, such as E-avrop or Visma Opic. If the contract is appraised to be above the threshold value, it should be advertised in the EU database Tenders Electronic Daily (Upphandlingsmyndigheten, 2019c).

The potential participants evaluate the procurement documents and decide whether to participate in the auction. They must take their resources and capacity, the costs associated with the qualification criteria, entry costs, private costs and the expected level of competition into account when deciding whether to participate. If they do decide to participate, they must decide which bid to place.

Tender Opening

The tenders are sealed until the tender period have passed, as the Public Access to Information and Secrecy Act[5] states that all information must remain under complete secrecy until a decision has been made, whether that decision is to award the contract, redo the process or cancel the contract (Upphandlingsmyndigheten, 2019a).

Evaluation of Tenders

The contracting entity evaluates the suppliers to decide whether they meet all requirements set in the procurement documents (Upphandlingsmyndigheten, 2019f). Only the information given in the tender may be considered and tenderers which have not met all requirements will not be considered in the contract award decision (Upphandlingsmyndigheten, 2019a). The evaluation of tenders must commence after the deadline for tender submission has expired.

Cancelling a contract

It is not entirely uncommon to cancel a contract after being published. If there exist overriding reasons to cancel the contract, the contracting entity is allowed to do so. The contracting entity is responsible to provide evidence supporting the existence of overriding reasons to cancel the tenders. Valid reasons are scarce competition, faulty evaluation methods or unusually high bids.

Contract Award Decision

After the tenders have been evaluated and the suppliers have been examined, the contracting entity will award the contract to the most economically advantageous tender or the tenderer who submitted the lowest bid. The decision is delivered in writing to all tenderers after the decision is made (Upphandlingsmyndigheten, 2019g). After the award decision is made, the information is no longer protected under absolute secrecy under the Public Access to Information and Secrecy Act. Some information could, however, continue to be protected under secrecy if asked by the tenderer.

There are different ways of evaluating tenders. The lowest price is one common evaluation method which implies that the firm which fulfils all qualification criteria and places the lowest bid wins the contract. Pure price competition is stated to be appropriate when a minimum level

[5] Offentlighets- och sekretesslagen (2009:400)

of quality can be verified, and that the attainment of that particular minimum quality level is of great importance (Bergman & Lundberg, 2009). There does also exist evaluation methods which weigh both quality and price.

If a participating firm has placed an abnormally low bid, the contracting entity may need additional information to evaluate whether this bid is reasonable (Upphandlingsmyndigheten, 2019b).

End the Procurement Process

Once the procurement is contracted, the contracting entity archives the documentation produced during the procurement process (Upphandlingsmyndigheten, 2019d). If the estimated value of the contract is above the threshold value, the contract award notice must be published in the European Union database, Tenders Electronic Daily (TED).

Contract Award Notice

Contract award notice is an important part of the procurement process as it increases the transparency of public procurement. The Swedish Competition Authority has noted their concern as they believe the routines of contract award notice to be inadequate in Sweden, which obstruct the obtainment of information and statistics for further development of public procurement procedures. Post-advertisements should, according to LOU and LUF, be submitted no less than 30 days after the contract have been signed (Upphandlingsmyndigheten, 2019e).

The Swedish Competition Authority expresses that procuring entities have shown flaws in terms of well-functioning internal routines of contract award notice, or procuring entities having routines which have not been sufficiently followed (Konkurrensverket, 2017). Results from previous reports directed by The Swedish Competition Authority have shown that procuring entities in Sweden have, in many cases, been violating the rules regarding contract award notice.

3. Literature Review

There exist many empirical studies of public procurement, evaluation methods, bidding strategy and market competition. Different type of goods and services have been considered in these studies, such as internal cleaning services, elderly care, transportations and constructions.

Lundberg and Marklund (2016) analysed the environmental policy instrument Green Public Procurement, or GPP, and its impact on both bids and winning bids in internal cleaning service procurements in Sweden and found that a one percent increase in the number of firms submitting tenders for a contract led to an 0.168 percent decrease in the size of the bid placed by participating tenderers. This is in line with the results found by Sundström (2016), who similarly studied internal cleaning service procurements in Sweden, where an increase in competition by one firm reduced the bids with 1% as a fraction of the mean bid. The results found by Lundberg and Marklund (2016) implied that internal cleaning services can be related with economics of scale, as the price per square meter per year decreased as the size of the object increased. The study did not find any evidence implying that firm size had a significant effect on the winning bid. This could be a consequence of the fact that larger firms place the winning bids more often than small and medium-sized firms. They further argue that larger firms could be expected to already have met the qualification requirements prior to the procurement, and therefore no additional cost is associated with meeting these, resulting in the insignificant coefficient for the winning bids.

Public agencies can be regarded as a buyer with significant market power, they have the power to influence firms to reduce their environmental impact through including green qualifications criteria. The empirical evidence that the implementation of Green Public Procurement as an environmental policy instrument has an efficient effect is weak. Evidence showed that Green Public Procurement could be defined as an imperfect environmental policy instrument as it's not cost-effective nor objective effective (Lundberg & Marklund, 2016). Neither environmental management systems nor environmental standards had any significant effect on the bid prices, but there were additional costs associated with routines of usage of chemicals. These results indicate that the environmental criteria which the procuring entity set for the contract could be too weak to encourage participating and potential firms to invest in costly environmental adjustments. However, other studies have found a positive statistically significant effect of the

number of GPP criteria on the placed bids implying that a higher count of environmental criteria would increase the price, which is argued to be a consequence of a raise of the firms' private costs (Sundström, 2016). The number of qualification criteria did however not have a significant effect of the placed bids in the same study.

A study investigating competitive effects on costs of public procurement auctions in Turkey, comprising all public auctions for the years of 2004-2006, found that a more competitive setting significantly reduced the procurement costs of the contracting agency (Onur et al., 2012). The results of the analysis showed that an increase in the number of bidders would significantly decrease the difference of the winning bid and estimated costs with 3.8% on average. Implying that increased competition leads to a reduced procurement price relative to the predicted costs. The same study further found that procurements of goods and services were more sensitive to changes in competition than construction contracts.

Studies have further shown that an increased level of competition significantly reduces the ratio between the expected price and the actual award price (Hanák & Muchová, 2015). By ensuring the involvement of a sufficient number of participating tenderers, the cost of the contracting entity can be reduced significantly. Hanák and Muchová (2015) state that even though they believe that the contracting entities should encourage a high degree of participation, to increase the level of competition of the contract, proper qualification requirements set on the suppliers must remain to ensure satisfactory quality.

Bids can vary in size for other reasons as well. Alexandersson and Hultén (2005) explain that large oligopolistic firms may have placed their bids in strategic ways, for example, to signal to their competitors if they intend to capture the market or perhaps signal that they are not interested. By placing very high bids or very low bids for public procurement contracts, the firms could according to their hypothesis deliver this information to the competition. Two possible explanations to why placed bids could be very high or very low could be that the calculations regarded the expected cost could be different between the tenderers concerning assumptions made, for example, cost of inputs and economies of scale. Another reason could be that firms signals competition with either aggressive bids or bids which shows other firms that they are blasé about the particular market (Alexandersson & Hultén, 2005).

Under high-level uncertainty of the cost of attaining different levels of quality, Lundberg and Marklund (2017) found that contracting entities are more likely to use the economically most advantageous tender as their decision award method than the lowest price method. The effect is the same as of uncertainty regarding highly non-verifiable quality, as the results imply a significantly lower probability of contracting entities using the lowest price evaluation over the economically most advantageous tender. An international study from Italy found that when the public administration in Turin adapted the first price sealed bid auction with the evaluation method of lowest tender, the winning price became substantially lower as well as the performance of the winning tenderers (Decarolis, 2014). The results imply that using the evaluation method of the lowest price created a trade-off between quality and cost for the contracting entity. They did, however, find that the ultimate cost of the contracts declined roughly 8%, despite a partial loss of savings due to increased cost overruns, when using the first price sealed auction with lowest price decision award method.

According to Stake (2017), using the most economically advantageous tender as award decision method is recommended by the EU as they claim that the evaluation method gives an advantage to small and medium enterprises. Firms which can be considered as a spring of modernization and innovation. By using the evaluation method of most economically advantageous tender, the contracting entity allow for competition among tenderers regarding both quality and price (Bergman et al., 2011). An analysis of public procurement contracts in Sweden found no significant evidence supporting that small and medium-sized enterprises are given an advantage, in terms of participation, by using most economically advantageous tender over lowest price (Stake, 2017). Instead, evidence of the opposite was found. Small and medium-sized firms had a disadvantage when the most economically advantageous tender evaluation method was used rather than the lowest price, as the probability of smaller firm winning the public procurement contract decreased.

Previous studies have investigated the possibility of using government's choice of renewal policy as a mechanism in public procurement to provide suppliers with additional incentives to supply high levels of quality (Dalen et al., 2006). The study found that the suppliers' incentive to deliver high-quality services were maximized when half of the contracts were renewed. However, they further stated that implementing this policy would not be optimal and the contracting agencies should offer contract renewals more often.

Lundberg (2005a) further found that the length of the renewal period could be a determinant of the degree of competition in public procurement, where a longer renewal period increased the number of participating firms in public procurement contracts of internal cleaning services in Sweden during 1992 to 1998. The same study further found that the share of seats assigned to socialists in the local council significantly decreased the level of competition. The results further imply that both contract specifications and municipality characteristics could affect the number of bidders as well as the volumes of the procurement.

4. Theoretical Frame of References

This section will present the first price sealed bid auction in public procurement and discuss the effect of competition on the bids placed by participating firms. The utility of the procuring entity will be conferred as well as how these procuring entities value costs and quality. Finally, the structure and strategy of the bids as well as the cost structures of the firms will be discussed.

4.1. Auction Models

Auction models are used as an allocation instrument for public procurement, which can be used as an equilibrium mechanism. In game theory, a mechanism can roughly be interpreted as a set of rules to oversee the interactions between parties (Milgrom, 2004).

There exist several different auction models which are used in public procurement. The most common sealed-bid auctions are the first-price and second-price sealed-bid auction. In some cases, firms are however allowed to revise their bids if the procurement agency is using a sequential, or open, procurement (Bergman et al., 2011).

In a selling procurement procedure, the higher bidder wins the item while in the procuring auction procedure, the lowest bidder wins the contract. The bid in public procurement represents the compensation which the firm is willing to accept to perform the contract. In auction theory, we assume that a seller faces n potential bidders for an indissoluble[6] good and that the participating firms compete for the good by submitting bids (Montet & Serra, 2003).

4.1.1. First Price Sealed-Bid Auction

A sealed-bid auction is when each of the bidders submits their bid in a sealed envelope to the auctioneer, without knowledge of the bids placed by the other tenders (Varian, 1992). The sealed-bid auction provides a considerable competitive effect on the bids for public procurement, as the lowest bidder offers to complete the contract for the lowest cost and thereby wins the auction.

[6] If something is indissoluble, it cannot be divided.

If firm cost is assumed to be private[7], it is possible to assume the bids to be decreasing as the number of bidders in the auction increases (Lundberg, 2005b).

All of the bids are then opened simultaneously, whereas the tender with the lowest, or highest, bid wins the contract or item. In auctions where the bidder is the buyer, the player with the highest bid wins the auction whereas in reversed sealed-bid auctions in public procurement, the tender with the lowest bid usually wins the auction and gets the contract. How the winning bid is decided depends on the evaluation method, which is determined before the bid is placed. In Sweden, sealed-bid auctions are often used by governments and governmental agencies when purchasing both physical goods and services.

The interpretation of first-price auctions where the bidder is the buyer and where the bidder is the seller are mathematically the same as a bid to sell, as it can be modelled as an exchange at a negative price where the lowest bidder would have a bid closest to zero and thus the highest bid. Therefore, the same auction theory applies to bids to sell as well as bids to buy (Milgrom, 2004).

Under the assumption that the valuation of a contract is uniformly distributed on the interval $[0,1]$, and that all players believe that this is true; the Bayes Nash equilibrium to this game will be a function $b(v)$ where b is the bid and v is the valuation of the item, which also determines the players' type. The function $b(v)$ indicates that the optimal bid, b, for a player of that particular type (Varian, 1992).

An assumption can be made that $b(v)$ is a strictly increasing function where the optimal bid for an item will increase with the valuation of the same item (Varian, 1992). To compute the Bayes Nash equilibrium of this auction game, assumptions must be made that the players are risk-neutral and that no participant would place a bid which is higher than their valuation (Montet & Serra, 2003). Since the model is symmetrical, only Bayes Nash equilibriums where strategies are identical are considered, which implies that players with the same valuation will place the same bid, i.e. $b_i(v_i) = b(v_i)$ for all i. We further assume that $b(v)$ is invertible and that $V(b)$ is the inverse of that function, i.e, the valuation of a firm who bids b.

[7] Private costs are costs which are only known to the player in question.

Under the postulation that the valuation of an item is uniformly distributed, the probability of winning the item is equal to the probability that all other tenders have lower valuation, i.e. $V(b)$ (Varian, 1992). Subsequently, if a player places a bid b with the valuation v, the expected pay-off, in a sealed-bid auction where the bidder is the buyer, can be expressed as:

$$(v - b)V(b) + 0(1 - V(b))$$

The first term of the expression above can be described as the expected surplus if that player places the highest bid, while the second term of the expression can be described as the expected surplus if the player does not place the highest bid (Varian, 1992). The optimal bid can, therefore, be derived from the maximum of the expected surplus, $(v - b)V'(b) - V(b) = 0$. This first-order condition states that for each value of v, the optimal bid for each of the players would be a function of v. The expression can be revised such that:

$$(V(b) - b)V'(b) \equiv V(b)$$

Assuming $V(b)$ describes the relationship of the optimal bid and the valuation, the above expression will be true of all b. The solution could then be stated as:

$$V(b) = b + \sqrt{b^2 + 2C}$$

where C is a constant of integration. The boundary condition of the bid is $0 \leq b(v_i) \leq v_i$, for all v_i, which is essential for the assumption of a reasonable bid from each participant to hold. This further implies that $b(0) = 0$, and hence that $C = 0$ (Montet & Serra, 2003). This suggests that $V(b) = 2b$ or $b = \frac{V(b)}{2}$ for an auction with two players (Varian, 1992).

In the auction model where the bidder is the buyer, an equilibrium exists where each of the two participants submits a bid half of their true valuation of the object. The trade-off which creates this equilibrium is that higher bids increase the chance of winning the good, and lower bids increase the payoff when winning (Montet & Serra, 2003).

The equilibrium derived above can similarly be interpreted for auction where the bidder is the supplier, where prices are interpreted as negative. The bids b_i placed by tenderers would successively become larger, meaning it would become less negative, as the valuation of the

object of the auction increases. Here, the trade-off generating the equilibrium is that lower bids increase the chance of winning the auction, while higher bids increase the payoff when winning.

Similarly, if the values of the participants in an auction are uniformly distributed on $[0,1]$, the optimal bids placed in auctions with N players can be expressed as:

$$b(v_i) = \frac{N-1}{N} v_i$$

which imply that the equilibrium strategy of the participants is to place a bid which is a constant fraction of its valuation of the item (Krishna, 2003).

Figure 2: Players bids as fractions of firms' value with different levels of competition

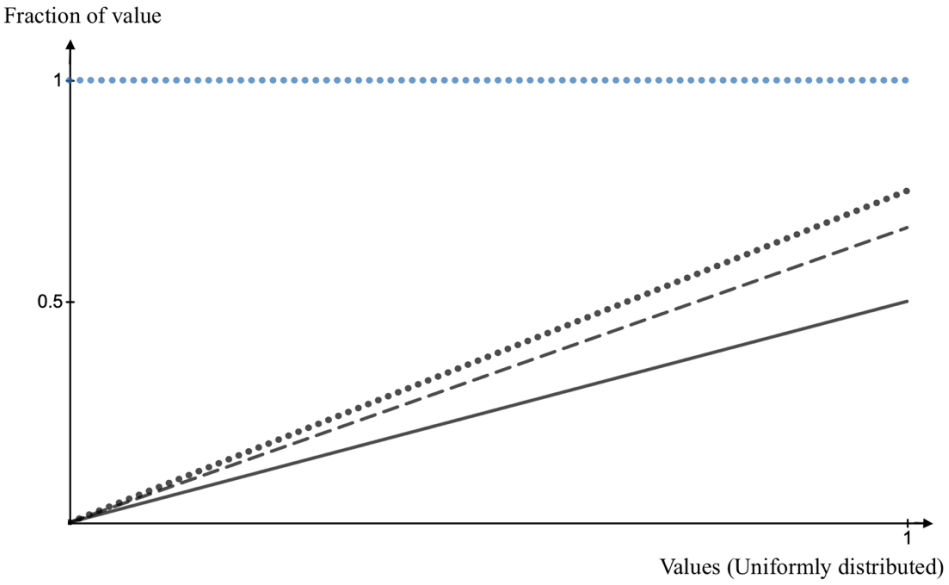


Figure 2 above presents the constant fraction of the bids placed by firms under the assumption of uniformly distributed values in the classical sealed-bid first-price auction. The lines embody auctions with two, three and four participants, where the line steepens as the number of participants increase. This suggests that, in an auction where the bidder is the buyer, the equilibrium strategy is to place a bid closer to the firms' true value as the number of participants rises (Krishna, 2003). For the reversed auction, the equilibrium strategy is to lower the bid as the competition level intensifies.

In the first price sealed bid auction in public procurement, the firms can be expected to act like Bayesian Nash players as they do not know other firms cost but are aware of the distribution of their costs.

The firm can be expected to take the following expected profit in making its decision on the size of their bid:

$$(b_i - c_i)P\big(b_i < b_j \big| c_i\big), \forall_j \in I_{-i}$$

In the equation above, firm i is assumed to have the cost c_i and place the bid b_i, while I_{-i} represents all bidders except for bidder i and $P(\cdot)$ is the probability that firm i place the lowest bid and wins the auction. Following the conjecture that all bidders follow the same bidding strategy, this would lead to a Bayesian Nash Equilibrium (Sundström, 2016). The optimal bid for a firm, who maximizes their expected profit, under Bayesian Nash Equilibrium assumptions can be expressed as

$$b_i = c_i + \frac{[1 - G(b_i)]}{g(b_i)} \frac{1}{N-1}$$

where the functions $G(\cdot)$ and $g(\cdot)$ are the cumulative distribution functions and probability functions of the bids (Guerre et al., 2000, as cited by Sundström, 2016). The expression $\frac{1}{N-1}$ on the right-hand side represents the mark-up of firm i, where each of the firms faces a known number of competitors.

By differentiating the bid of firm i on the number of bidders for the contract (N), conclusions can be made that the bid is decreasing in the number of bidders, $\frac{\partial b_i}{\partial N} < 0$.

$$\frac{\partial b_i}{\partial N} = -\frac{[1 - G(b_i)]}{g(b_i)} \frac{1}{(N-1)^2} < 0$$

This effect on the bid is caused by a decrease of the mark-up from a higher number of participating bidders. An increased number of bidders, and therefore lower mark-up as a result of increased competition, is beneficial for the procuring agency as it reduces their costs. Consequently, the competition effect of a change in the number of competitors affects the tenderers optimal decision in the first-price sealed-bid auctions.

4.2. Utility of the Contracting Entity

The utility of the procuring entity can according to Bergman and Lundberg (2009) be described as a function of the utility gained from the cost and the quality of the product or service, given the assumption that it is costlier for the suppliers to deliver higher levels of quality:

$$U(Q, C) = V(Q) + B - C$$

Where the utility of the procuring entity from the quality Q can be described as a function $V(Q)$, the procuring entity's fixed budget can be defined as B and the cost as C. Under the assumption that it is costlier for suppliers to deliver goods and services with higher quality, the price can subsequently be expected to increase with quality as well. Simultaneously, the utility of the contracting entity also increases as quality increase.

From an economic perspective, it would be possible to find an optimal quality level, Q^* for a fixed cost C^*. This optimal quality level would be where the marginal increase of quality no longer provides higher utility than the cost associated with that increase (Bergman et al., 2011).

Figure 3: Optimal quality with alternative production costs of the suppling firm.

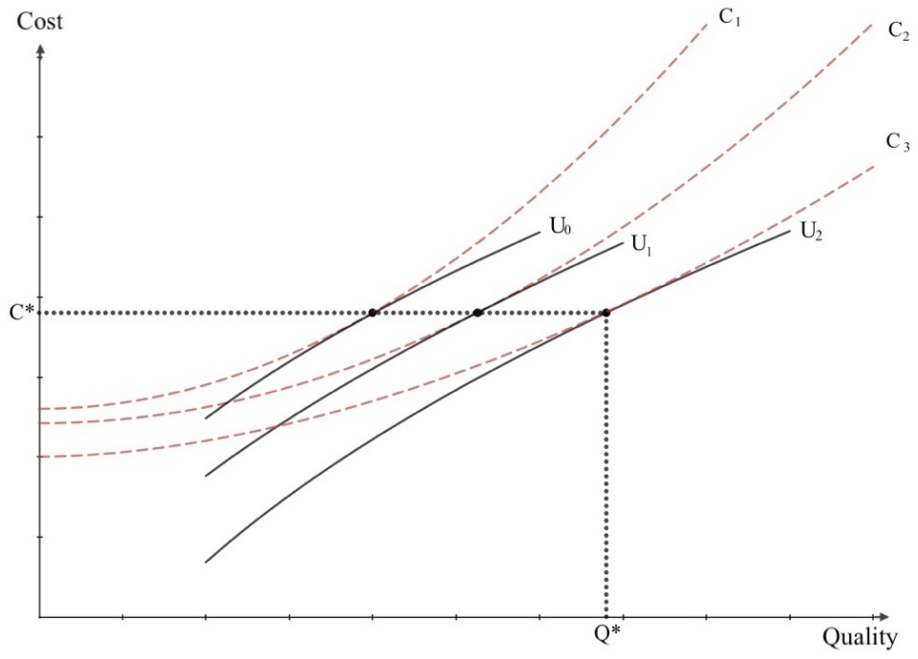


Figure 3 above presents the optimal quality Q^* for a fixed cost C^* given tenderers with cost functions C_1, C_2 and C_3. The figure presents different production costs of participating tenderers, as the production costs can be considered unknown to the contracting entity.

The indifference curves represent the contracting entities preferences, or utility functions, which are denoted U, for the qualitative characteristics of the good or service procured. Each of the indifference curves represents combinations of quality and prices for which the contracting entity is indifferent at a static level of utility, U. The contracting entity receives a higher utility for indifference curves further down to the right, that is:

$$U_0 < U_1 < U_2$$

Hence, the contracting entity prefers a higher quality over lower quality if the price is fixed. The contracting entity further prefers lower price over higher price if the quality is fixed, see figure A1 in the appendix.

4.3. Bidding of the Firm

4.3.1 Structure of the Bid

When determining the size of the bid placed by participants in the public procurement, each firm takes the information given in the procurement documents into consideration. A great amount of thorough information is given to the potential bidders regarding volume, delivery and other demands which may affect the production cost of fulfilling the contract. More demands set on the firms can be assumed to raise the production cost, leading to a higher bid (Bergman et al., 2011). As cleaning services can be considered a rather homogenous good, potential issues with heterogeneity of the objects are assumed to be low (Sundström, 2016).

The following model can be assumed to explain the structure of the bid:

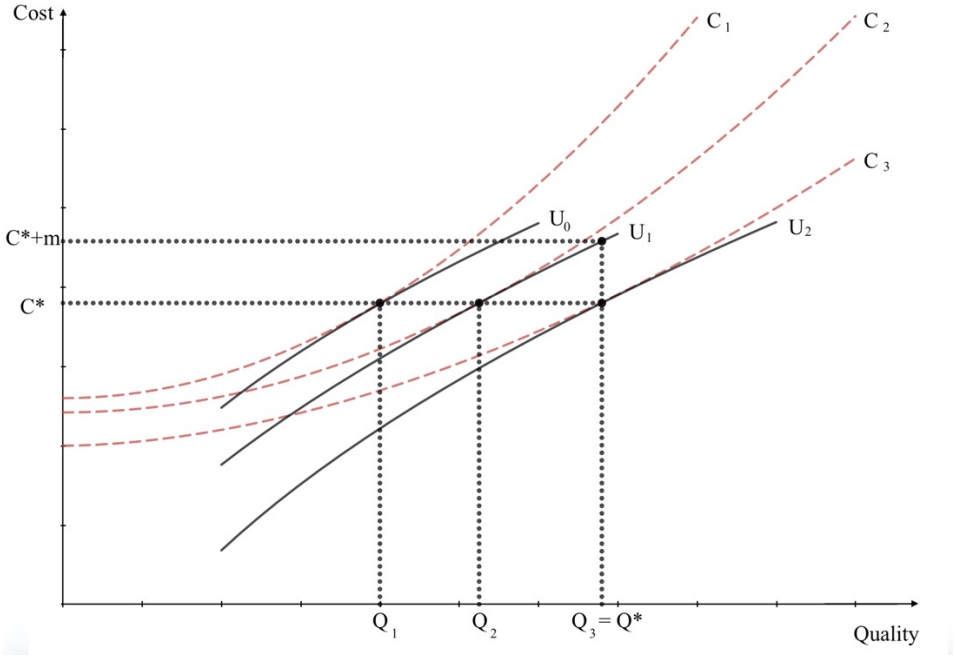
$$B(Q, N) = c(Q) + m(N)$$

The bid can be presumed to be determined by the cost to fulfil the contract given the quality criteria set on the contract (Q) and an added cost, or mark-up, which depends negatively on the number of firms that places bids on the contract (N) (Bergman et al., 2011; Sundström, 2016). The magnitude of the competition for the contract can, therefore, be assumed to be of importance of the size of the bid placed on each contract. The level of competition is not only important for the procuring agency, who will gain from more competition, but also for the bidders who prefer a lower rate of competition to increase their potential profits. The payment from the procuring entity to the winner of the contract could be assumed to become lower with

a higher degree of competition as increased competition, in general, leads to lower bids from the individual firms (Lundberg, 2005a).

As the contracting entity can be assumed to maximize their utility, the evaluation method should be designed in such a way that the firm with cost function C_3 wins the auction at the price $P = C^*$ at the quality level $Q_3 = Q^*$ (Bergman et al., 2011), see figure 4. A faint level of competition could, however, generate a struggle to prevent the firm with the cost function C_3 to place a bid equal to $C^* + m$, producing a bid equivalent to the utility of the firm with cost function C_2 placing a bid $P = C^*$ with the quality Q_2. According to economic theory, the firm mark-ups diminishes as the level of competition increases (Bergman et al., 2011; Krishna, 2003; Sundström, 2016).

Figure 4: The effect of the mark-up on bids when firms can compete in prices and quality



Assuming that firms have complete knowledge of the cost structures of the competitive firms as well as the utility functions of the contracting entity, the firm with cost structure C_3 could increase their price compared to their actual costs with mark-up m and place a bid equal to $C^* + m$ for quality Q_3 and still win the contract, see figure 4 above. The bid $C^* + m$ at quality Q_3 could win since it is equivalent to the utility of the contracting entity of the combination of quality Q_2 and cost C^* placed by the firm with cost function C_2. Bergman et al. (2011) state that

evaluation methods should be designed such that a tender with the cost function C_3 wins the contract at $P = C^*$ which maximizes the utility of the procuring entity.

The cost of the firms, which affects the cost function of each of the participating firms, can be categorized into known and unknown costs, and then subcategorized into shared or firm-specific costs. The sum of these costs will add up to the total cost of a firm to fulfil the contract. Bergman et al. (2011) explain that shared known cost will be similar for all the potential bidders and can be calculated without considerable effort as the volumes and price of most input factors can be presumed to be known for all firms. The shared costs will thus affect the price of the bid directly. Private known costs are those which are known only to the firm and affects their cost structure. Some input factors can be considered private costs, as the different firms may have prices which are more or less beneficial. If a firm has lower private costs, they can place a lower bid than the competitors with the same profit margins.

Depending on the type of contract, shared or private costs can be dominating. For cleaning services, private costs can be assumed to be the most dominating cost after known shared costs have been taken into consideration (Bergman et al., 2011). Shared unknown costs are not as common for services than for constructing as the production cost for cleaning services are determined by observable factors. The production cost is to a great extent determined by frequency, size and cleaning method as well as employees, transportation and cleaning materials. Assumptions could be made that the firm's costs are fairly certain, while the cost of competitors is rather uncertain.

Each participant in public procurements can expect their competitors to analyse each other's past and present behaviour as signals of their costs as well as intentions. Alexandersson and Hultén (2005) explain that there are two fundamental reasons to place either abnormally low bids or abnormally high bids. The first reasons are founded on the assumption that firms may have dissimilar ideas of which they base their calculations on. The firms can have different assumptions with regards to costs, potential market revenues and economics of scale of the inputs associated with the fulfilment of the contract. The other reason is that the firm designs their tender in such a way that they may signal their competitors that they are either uninterested in the market by placing a high bid, or that they are planning on winning the market by placing an aggressive bid. There do however exist other explanations to high bids, such as the

expectation that no other firm will participate in the auction or that the firm has real cost disadvantages compared to their competitors.

The ideal situation for a sealed bid auction would be one where all tenders would place bids which are in line with their own best estimate of costs and revenues of the contract in question. If all firms were to place realistic bids, the most effective tender would place the lowest bid and win the sealed bid auction. This would give incentive to the other firms to further improve their competitiveness to increase their chances of successfully placing a winning bid (Alexandersson & Hultén, 2005). Idyllically, one would like to assume that the lowermost bid is placed by a firm with a unique cost structure which allows them to offer to provide the service with as high quality as a firm placing a higher bid. If the bidding behaviour of the firm were to be similar to the strategy of predatory pricing, the firm could try to intimidate their competitors by making less profit in one contract and counterbalance by increasing profit on another.

The most desirable reason for tenders to place aggressive bids is that the firm possesses competences which allows them to more effectively produce the service or good for the contract which provides them with a unique cost structure, and thereby additional revenue possibilities, compared to competitive firms (Alexandersson & Hultén, 2005). Lower bids from tenderers are on the other hand not always considered better from a socio-economic perspective. Firms may dump prices by placing substantial lower bids, low enough to cause a loss, to weaken the position of competitors in that market. These conscious losses can be followed through by using profits gained from other contracts. This bidding strategy is called predatory pricing. The strategy could, however, be hard to distinguish from bids placed by firms with unique cost structures, allowing the firm to place lower bids with profit.

According to Alexandersson and Hultén (2005), the idea of predatory pricing has become common as the development regarding theories based on decision theory and game theory have shown that such behaviour could be considered rational under asymmetric information.

4.3.2. Economics of Scale

Economics of scale can be described as cost advantages achieved by increased production and reduced average costs due to the scale of the operation. Since cost can be both fixed and variable, distributing the cost over a larger number of goods can reduce the average cost of each unit and increase cost-efficiency, see figure A2 in the appendix. If a firm wins in a larger

number of contracts than a competitor, assumptions regarding the differences between their average costs can be made. Subsequently, a firm who have won more contracts and have larger production can be assumed to have lower average costs and thus have economics of scale.

4.4. Qualification Criteria and Entry Costs

4.4.1. Evaluating Quality and Setting Qualification Criteria

Bergman and Lundberg (2009) state that the fundamental purpose of public procurement is to acquire good quality at a low cost. Quality is not easily definable, and without a clear definition of the level of quality desired in contracting documents, it would become even more difficult to evaluate if that level of quality was attained through public procurement (Bergman et al., 2011). To reduce the uncertainty of the level of quality in public procurement, the process should be designed in such a way that the contracting entity can ensure that sufficient quality level is both offered and delivered by the winning tenderer (Bergman & Lundberg, 2009).

If the contracting entity procures goods or services with observable but non-verifiable quality characteristics, it becomes difficult to incorporate in the contract. Even if the procuring entity believes that the quality level attained is lower than what was required in the contracting document, they will not be able to cancel the contract or demand endorsements as the level of provided quality cannot be measured nor verified. Hence, it is difficult to impose legal and economic consequences on the supplier if the quality cannot be measured. Without the opportunity of legal or economic sanctions on the supplier for delivering poor quality, there is diminutive incentive to provide high quality. By offering the possibility for the contracting entity to extend the contract with the supplier, some level of incentives can be considered to be provided to deliver the expected level of quality.

The definition of the contracting documents must, therefore, be set so that the attainment of the preferred level of quality can be achieved. It is not uncommon that contracting entities set requirements on tenderers to provide references, which to some extent can describe the level of quality of services or goods provided in the past. Other approaches to ensure high-level quality is to require internal quality management systems as well as internal or external quality control systems with fines related to substandard quality.

4.4.2. Entry Costs

The qualification requirements can be interpreted as entry costs, since firms must fulfil certain requirements to qualify as a tender. Such entry costs, or barriers to entry, are fixed costs borne by new entrants in order to enter a market (Mcafee et al., 2004). These barriers provide an advantage of the established firms over new entrants, as the cost is borne by new entrants and not borne by firms which are already established in the market. Entry barriers can therefor interfere with the natural market mechanisms of market competition: the entrance of new participants (Organisation for Economic Co-operation and Development, 2007).

Entry barriers can either be structural or strategic, where structural barriers condenses circumstances including costs or demands rather than actions of established firms. Strategic barriers are created by the firms established on the market as a mean of preventing new entrants. If there is high costs associated with participating in an auction market, the equilibrium size of the market can be considered to be determined exogenously by the expected profitability of the auction (Meyer, 1993). If the entry costs are higher than the expected profitability of a certain auction, firms would subsequently choose not to participate. Meyer (1993) states that the market size and the entry fees are contrariwise related, as an increase in entry costs decreases the number of participating players in the general form of the Nash equilibrium bidding strategy.

The optimal bidding function, given uniformly distributed valuations from the distribution $U(v_1, v_2)$, can be describes as:

$$b^* = v_i + \frac{n-1}{n}(v - v_i)$$

where n is the number of participating bidders and the entry cost c are considered sunk costs, which do not affect the optimal bid. The agents are expected to participate in an auction as long as the expected profitability exceeds the entry costs. By setting the expected profit equal to the entry costs, one can obtain the optimal number of participating bidders (Meyer, 1993). The profit function can be defined as $\pi = \frac{v_2 - v_1}{n(n+1)}$.

By setting the expected profitability of participating in the auction equal to the entry cost associated with participating, c, and solve for the optimal number of firms, n^*, an expression of the optimal number of bids can be found:

$$n^* = 0.5\sqrt{1 + 4\left(\frac{v_2 - v_1}{c}\right)} - 1$$

By differentiating the number of optimal numbers of participating firms on the entry costs, the following expression shows that there is an inverse relationship between the optimal number of participating players in the auction and the entry costs (Meyer, 1993).

$$\frac{\partial n^*}{\partial c} = -(1 + 4\frac{v_2 - v_1}{c})^{-0.5}\frac{v_2 - v_1}{c^2} < 0$$

An increase in the costs associated with entry would subsequently lead to fewer participating firms in the auction. This could be interpreted as increased costs associated with fulfilling the qualification criterions set in the contracting documents reduces the number of participating firms which have not already fulfilled these investments.

5. Data

[redacted]. The data consists of microdata of public procurement contracts and tenders of internal cleaning services in Sweden between 2015 and 2017, which was gathered through the public procurement website Visma Opic[8]. The contract documents were not all complete, and additional information was gathered from the procuring agencies through email and postal mail.

5.1. Descriptive Statistics

All bids, both winning and losing, are defined as the price per year of cleaning one square meter in Swedish Krona (SEK), see table 1. All prices have been taking inflation into account through the consumer price index, using 2015 as reference (SCB, 2020). The disqualified tenders, a total of 720 tenders, were excluded in the descriptive statistics.

Table 1: Descriptive statistics of the bids placed by participating firms

Variable	Obs.	Mean	Std. Dev.	Min	Max
Winning bids, in SEK/m^2/year	480	418.4426	3 230.845	1.9696	59 493.13
Losing bids, in SEK/m^2/year	1 569	705.2566	5 316.221	3.1338	97 502.72
All bids, in SEK/m^2/year	2 049	638.0674	4 908.606	1.9696	97 502.72

The mean price from winning tenderers per square meter per year was approximately 418 SEK while the mean price of losing tenderers per square meter per year was approximately 705 SEK. The bids vary considerably, which could be a consequence of differences in cleaning areas, frequencies, level of competition, evaluation method, type of object, level of quality requirements set on the tenderers as well as other factors which affect the cost of providing the internal cleaning service.

The lowest winning bid was, for example, an object with a cleaning area of over 170 000 m^2, which was asked to be cleaned once a week. The highest bid per square meter and year were an

[8] *Visma Commerce AB*

object with a cleaning area of roughly 1 100 m^2, placed by a tenderer which was not rewarded with the contract.

A considerable number of qualifications criteria were identified in the original data set. To reduce dimensionality, a handful of criteria of interest were aggregated into categories based on their characteristics. The category variables take the value one if the requirement is specified in the call for the tender, otherwise it takes the value zero. These aggregated categories were Chemicals, Capital, Employees, Insurance, Environmental standards, Vehicle and Quality Management System, see table 2.

The category Chemicals (*CHEM*) is defined as that the supplier is required to follow certain restrictions from the Swedish Chemical Agency[9] or The Nordic Swan Ecolabels, or having routines concerning reporting or listing of chemicals used. Capital (*CAP*) concerns economical and financial position and solidity of the firm.

The category Employees (*EMP*) condenses demands on supervisors and employees, such as having the PRYL[10] or SRY[11] certifications. The certifications demonstrate that the personnel fulfil certain demands of knowledge, both theoretical and practical, leading to a higher degree of cleaning professionalism as well as to attest that they are presently operating in the cleaning business. The category Insurance (*INS*) comprises the requirement of having certain insurances, such as liability insurance.

Demands on environmental standard (*ECO*) includes having criteria set on the participants such as having an Eco-Management and Audit Scheme to report, evaluate and improve their environmental performance. Vehicle (*VEH*) comprises environmental standards set on vehicles, such as the European Union norms for emissions of motor vehicles, criterions concerning the fuels used for the vehicles, or the requirement of Eco Driving. The category Quality Management System (*QMS*) includes the requirement of having a quality management system.

[9] Kemikalieinspektionen (KEMI)
[10] ”Project Professional Cleaner Certificate”, or *Projekt Yrkesbevis Lokalvårdare*.
[11] A certificate issued by *Servicebranchens Yrkesnämnd*

In table 2 below, the descriptive statistics of the qualification criteria included in this analysis is presented. The qualification criteria were converted into categories, which apprehend whether such a criterion were set for the contract or not by taking the value one if any qualification criteria in that category were set on the contractors.

Table 2: Descriptive statistics of qualification criteria of the individual contracts

Variable	Obs.	Mean	Std. Dev.	Min	Max
CHEM	480	0.3271	0.4696	0	1
CAP	480	0.4625	0.4991	0	1
EMP	480	0.8938	0.3085	0	1
INS	480	0.7104	0.4540	0	1
ECO	480	0.6563	0.4755	0	1
VEH	480	0.0583	0.2346	0	1
QMS	480	0.8417	0.3654	0	1
REF	480	0.8979	0.3031	0	1

Demands on the suppliers regarding chemicals (*CHEM*) are set in approximately 33% of the contracts. Financial requirements (*CAP*) concerning financial position and solidity of the firm are set in close to half of the procurement documents.

Requirements which include employees or supervisors (*EMP*) can be found in 89% of the contracting documents, while requirements regarding insurances (INS) and environmental standard (ECO) were set in 71% and 65%, respectively.

Criteria regarding the vehicles (*VEH*) used were set in approximately 6% of the contracts, including environmental standards set on vehicles, criterions concerning the fuels used, and the requirement of Eco Driving. Quality management systems (*QMS*), which are used to ensure that the level of quality is sufficient, were set on suppliers in 84% of the contracts. Quality management systems comprise guidelines and methods which can be used to measure, control and improve the performance and procedures of the firm. References (*REF*), which is defined as the contracting entity requiring the suppliers to submit at least one reference with their tender, were included as a qualification criterion in just under 90% of the contracts in this data set.

Table 3: Descriptive statistics of contract, demographic and firm characteristics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Tenders	480	6.0021	3.9762	1	22
Qualified tenders	480	4.7979	3.3599	1	19
Frequency	460	241.2761	74.2892	7	390
Area	480	12 866.14	22 073.39	110	171 108
Activity	480	126.2354	100.3962	1	284
Renewal	480	0.9146	0.2798	0	1
Lowest price	480	0.3604	0.4806	0	1
Municipalities	480	1.1521	0.8172	1	9
Share of left rule	480	0.3931	0.0743	0.1176	0.6154

The number of participating tenderers (*Tenders*) varied among the contracts from just 1 participant to 22 participants, while the highest number of qualified tenders (*Qualified tenders*) for one single contract was 19. The mean number of tenders varied to some extent over the years, with a mean of 8 participants in 2015 to just over 4 participants in 2017, see figure A3 in the appendix.

The frequencies (*Frequency*), defined as the number of times which the cleaning was to take place per year, ranged from once a week to more than once a day. The cleaning area (*Area*) also varied substantially in size. The smallest object was no more than 110 m^2 while the largest object was more than 170 000 m^2. Activity (*Activity*) is defined as the number of tenders each firm have submitted during these three year, the firm which submitted the most tenders during this period participated in close to 60% of the contracts included in this data set.

The share of contracts which offered the possibility of renewal (*Renewal*) of the contract was over 90%. The mean number of municipalities which was asked to be cleaned in one single contract (*Municipalities*) were just over 1.15, while the largest number of municipalities in a single contract was 9. The share of left-wing and social-democratic seats (*Left rule*) in the local council varied from just slightly below 12% to just over 61.5%.

5.2. Potential Issues

Since the number of tenders is determined within the model, problems with endogeneity are expected if an OLS estimator is used to predict the regression coefficients. By using instrumental variables, this issue could be avoided. Previous studies have found a strong correlation between the political situation in the geographical region, which is defined as the share of seats in the local council assigned to the social-democratic and left-wing parties, and the number of participating tenderers in public procurement contracts. This instrument is chosen as it is assumed to explain some of the variations in competition between firms in that location. Further, the instrument of the size of the population has been chosen as population density has been proven to be a strong and relevant instrument in similar analyses. An assumption made is that the size of the population to some extent capture municipal characteristics comparable to those which the population density captured in former analyses conducted.

A drawback of the data is that many procuring authorities have chosen to publish limited information on the different bids when presenting the result of the public procurement. Often, full information was presented for the winning bid while some information was classified. For many contracts, the classified information was eventually provided by the agencies under the Swedish Public Access to Information and Secrecy Act while other procuring agencies never provided full information.

6. Empirical Methodology and Model

In this section, the method used to analyse the data is presented as well as the model specification studied. This paper aims to analyse if the number of bids affects the size of the winning bid, and which qualification criterions affect the number of bids. As the number of tenderers can be considered endogenous, an instrument variable regression will be conducted. The endogenous variable, bid count, will be instrumented using the share of the left-wing and social-democratic shares in the local council.

6.1. The Two-Stage Least Square Instrument Variable Model

In the OLS regression model, we undertake that the regressors do not correlate with the error and that the error term only represents omitted factors which determine the dependent variable. If one or several of the regressors correlate with the error term, the OLS estimator will be inconsistent and the assumptions of the Gauss Markov Theorem is violated. The variables can be considered either predetermined or jointly determined, where the endogenous variables are considered jointly determined within the model and the exogenous variables are called predetermined (Maddala, 2001). The predetermined variables are independent of the error term while the jointly determined variables are correlated with the error term. In the IV model, one or several instrumental variables are included to isolate the part of the regressor which is uncorrelated with the error term which allows for consistent estimations of regression coefficients (Green, 2003; Stock & Watson, 2015).

The two-stage least square estimator is not always considered a proficient instrument variable estimator for these analyses. If there are issued with heteroskedasticity, the generalized method of momentum is considered a better estimator, as the two-stage least square estimator can only be considered when the data set contains homoscedastic stochastic variables. The Generalized Method of Momentum (GMM) estimator, on the other hand, automatically produces heteroskedasticity consistent standard errors (Green, 2003).

Instead of using the GMM estimator, the 2SLS estimator with heteroskedastic robust standard errors will be used in this empirical analysis. The two-stage least square estimator has been used to analyse similar data sets of public procurement of internal cleaning services before (Lundberg & Marklund, 2016; Onur et al., 2012).

6.1.1. Assumptions of the Instruments

There are two conditions which need to be fulfilled to have a valid instrument. These two conditions are instrument exogeneity and instrument relevance (Stock & Watson, 2015). The instrument exogeneity condition is fulfilled if the part of the variation of the endogenous regressor which is captured by the instrumental variable is exogenous. The instrument relevance condition is fulfilled if the instrumental variable is related to the variation of the endogenous regressor.

Instrument exogeneity condition:

$$corr(Z_i, u_i) = 0$$

Instrument relevance condition:

$$corr(Z_i, X_i) \neq 0$$

If an instrumental variable Z satisfies the conditions of instrument exogeneity and relevance, the regression coefficients can be estimated by the two-stage least square estimator, which will be called 2SLS.

6.1.2. Two-Stage Least Squares Estimator

The 2SLS regression is conducted in two stages. The first stage decomposes the endogenous regressor into two different components, one which can be considered problem-free which can be used to estimate the regression coefficient and another component which may be correlated with the error term. The first regression links the endogenous regressor and the instrumental variable:

$$X_i = \pi_0 + \pi_1 Z_i + v_i$$

As stated earlier, if the instrumental variable Z is a relevant and exogenous instrument, the component $\pi_0 + \pi_1 Z_i$ is the part of X_i which can be predicted by the instrument. Since Z_i is exogenous, the component $\pi_0 + \pi_1 Z_i$ does not correlate with the error of the second part of the 2SLS regression, u_i (Stock & Watson, 2015). By using the problem-free component of X_i, one

can disregard the component v_i which correlates with u_i through the endogenous regressor. The predicted values of the coefficients in the first stage can be predicted using OLS regression:

$$\hat{X}_i = \hat{\pi}_0 + \hat{\pi}_1 Z_i$$

The F-statistic from the first stage regression is often used as a threshold to determine whether the instruments are sufficiently correlated with the instrumented endogenous variable. The Staiger and Stocks rule-of-thumb is defined as; the instrument is sufficiently correlated with the instrumented variable if the F-statistic from the first stage regression is greater than 10 (Andrews & Armstrong, 2017).

In the second stage, the dependent variable of entity $i = 1,2,..,n$ is regressed on the predicted $\widehat{\mathrm{X}}$ and the k exogenous explanatory variables:

$$Y_i = \beta_0 + \sum_{k=1}^{k} \beta_k W_{k,i} + \alpha \widehat{X}_\iota + u_i$$

The estimated coefficients of the second stage regression can be considered reliable and consistent, as all regressors in this stage are exogenous.

6.1.3. Overidentification

When conducting a two stage least square instrument variable regression, it is of great importance that the overidentification conditions are satisfied, meaning that the instruments can be considered valid. The definition of econometric identification is that the model parameters are uniquely determined from the dataset, and the function is considered identified when consistent estimation of the parameters can be attained (Lewbel, 2019; Maddala, 2001). If the identification assumptions are satisfied, the structural and reduced form presents the same information.

Lewbel (2019) states that a model which is overidentified, meaning that there are more instruments than endogenous variables, should be jointly tested for validity. There exists several overidentification test which are appropriate to use when conducting an instrument variable regression. If the two stage least square instrument variable regression is used to analyse a

dataset, the Sargan's and Basmann's chi-square test can be performed to test for the overidentifying restrictions.

6.2. Econometric Model

The econometric model specification for this 2SLS IV regression is conducted in two stages, and these are defined as:

$$\log(Bid\ count_i) = \gamma_0 + \sum_{k=1}^{14} \gamma_k W_{k,i} + \rho Z + v_i$$

$$log(Bid_i) = \beta_0 + \sum_{k=1}^{14} \beta_k W_{k,i} + \alpha \log(\widehat{Bid\ count_\iota}) + u_i$$

Where the k exogenous variables W are cleaning frequency per year (*Frequency*), area of the object in square meters (*Area*), the activity level of the firm (*Activity*), criteria regarding chemicals (*CHEM*), financial status and solidity (*CAP*), employees and supervisors (*EMP*), insurances (*INS*), environmental standards (*ECO*), vehicles (*VEH*), quality management system (*QMS*), the number of municipalities included in the contract (*Municipalities*), references (*REF*), an opportunity of renewal of contract (*Renewal*) and the award decision method lowest price (*Lowest price*).

The two instruments, Z, used to capture the effect of changes in competition in the instrument variable regression are the share of left-wing and social-democratic seats at the local council (*Left rule*) and the natural logarithm of the population size (*log(Population)*).

Two regressions will be considered in this study, one where all bids are included and a subsample where only the winning bids are included.

6.2.1. Instruments

For this study, the share of the left-wing and social-democratic seats at the local council (*Left rule*) and the population of the municipality (*log(Population)*) for which the service is provided will be used to instrument the number of bids for each public procurement contract. The

assumption is that a higher share of the left-wing and social-democratic seats will reduce the competition in the market, whilst not correlate with the size of the bid and that the bid count will increase with a larger population. By using the political environment and demographic characteristics as instruments, which are assumed to be both relevant and exogenous, a 2SLS regression can be performed. Lundberg (2005a) found that the share of seats assigned to left-wing and social-democrats in the local council significantly decreased the level of competition while analysing a similar data set.

In other studies concerning public procurement contracts of cleaning services, the population density and unemployment level have been used as instruments to explain the number of participants in public procurement auctions of cleaning services (Lundberg & Marklund, 2016). In a study of public auctions in Turkey, the instruments used in the 2SLS were two dummy variables capturing if the contract is a construction contract or if the auction is to take place in a large city (Onur et al., 2012). A third instrument was further included in the Turkish study, which captured the share of the population with a high school degree.

6.3. Expected Effects on Bids and Number of Tenderers

As the alternative hypothesis of this study state, the anticipated effect of the size of the tenders (B) from an increase in the number of participating tenderers (N) should be negative.

$$\frac{\partial B}{\partial N} < 0$$

Economic theory state that the bids from the individual firms should become smaller as the number of firms in the auction for the contract increases (Bergman et al., 2011; Lundberg, 2005a; Sundström, 2016).

If firms have a good understanding of the competition of the contract with consideration of contract types, location and similar characteristics, the bids they place should become smaller with an increased number of bids to have a chance of winning. The diminution of the size of the bid occurs as a consequence of reduced mark-ups with increased level of competition for the public procurement contract.

The second objective of this study is to analyse the expected direction of effects on the number of tenderers (N) of the existence of qualification criteria (Q), which is expected to be negative.

$$\frac{\partial N}{\partial Q} < 0$$

The number of firms competing for the contract could potentially decrease with additional qualifications criteria, as firms costs of fulfilling the prerequisite demands are assumed to increase with additional demands of the individual firms. Such requirements could affect the firm capability or desire to participate. With increased prerequisite costs associated with, for example, diplomas and environmentally friendly vehicles, some firms could choose not to participate as the cost associated with becoming a qualified tender is considered too large. These costs can be interpreted as entry costs, and economic theory implies that increased entry costs reduces the optimal number of participating players in auctions (Meyer, 1993). Further, larger bids in public procurement auctions reduces the firm's probability of winning the public auction. If investments associated with qualifying as a tender are too great, potential firms may decide not to submit any bid as the probability of winning diminishes with increased bids. Conceivably, some of the qualification criteria could, on the other hand, be common enough to have no significant effect on the number of tenderers.

7. Results

In this section of the paper, the empirical results will be presented for the two subsamples investigated through an instrument variable (2SLS) regression with heteroskedasticity robust standard errors. The first sample includes both winning and losing bids (*Spec. 1*) while the second subsample only includes the winning bids (*Spec. 2*).

Table 4: First Stage Regressions

	Specification 1: All bids		Specification 2: Winning bids	
Log(Bid count)	Coeff.	Robust Std. err.	Coeff.	Robust Std. err.
Frequency	-0.0004**	0.0002	-0.0006	0.0004
Area (m^2)	0.0000***	0.0000	0.0000**	0.0000
Activity	-0.0013***	0.0001	-0.0011***	0.0003
CHEM	-0.0373	0.0329	-0.0492	0.0811
CAP	0.2473***	0.0315	0.0947	0.0777
EMP	-0.0070	0.0359	-0.0525	0.0842
INS	0.0055	0.0306	0.0079	0.0644
ECO	0.1203***	0.0287	0.2843***	0.0677
VEH	-0.0307	0.0435	0.1173	0.0993
QMS	0.1473***	0.0379	0.1614**	0.0809
Municipalities	-0.0439**	0.0222	-0.0527	0.0476
REF	-0.1301***	0.0439	-0.0968	0.0953
Lowest price	0.0749***	0.0265	0.0798	0.0570
Renewal	0.0529571	0.0345	-0.0132	0.0845
Left rule	-3.6548***	0.1568	-3.5342***	0.3423
Log(population)	0.1035***	0.0095	0.1160***	0.0217
Constant	1.9606	0.1326	1.6296***	0.3494
Adjusted R^2:	0.4010		0.3806	
P-value:	p<0.10*, p<0.05**, p<0,01***			

From the results of the first stage regression including all bids, see specification 1 in table 4 above, it is distinct that some of the qualification criteria significantly decreases the number of submitted bids, while other appear to significantly increase the number of bids in the contracts

for internal cleaning service in the data set. Requirements regarding references (*REF*) significantly reduces the average number of participating firms on a 5% significance level, while requirements such as quality management system (*QMS*), environmental standards (*ECO*) and financial status and solidity (*CAP*) increase the number of participants. If the cleaning area (*Area*) increased in size or the evaluation method of lowest price were used, the bid count would increase while if the number of municipalities (*Municipalities*) which the contract covered would decrease.

A total of 40.1% of the variation of the number of bids were explained by the model specification including all bids. Both instruments were significant at 1% significance level, where an increase in the left-wing and social-democratic seats at the local council decreases the number of submitted bids and an increase in the population would increase the number of submitted bids.

The results from the first stage regression of the winning bids, see table 4 above, were to a great extent analogous to the specification including all bids. When analysing how the demographics, contract characteristics and qualification criteria affect the winning bids, only cleaning area (*Area*), activity (*Activity*), environmental standards (*ECO*) and quality management system (*QMS*) was significant on 5% significance level.

Larger object showed to have a significantly higher number of participating tenderers on average, which can be visually seen in figure A4 in appendix. The effect of a one-unit increase in average activity (*Activity*) would cut the number of participating firms by 0.13%. If a requirement of having certain environmental benchmarks (*ECO*) is set, the number of participating firms would surge by 28%. Requiring a quality management system (*QMS*) increases the number of tenders by 16% on average.

The instruments, share of left-wing and social-democratic seats at the local council (*Left rule*) and the population (*log(Population)*), were significant at 1% significance level. The instruments further proved to be sufficiently strong concerning Staiger and Stock's rule-of-thumb, in both of the specifications presented in the first stage regressions, see Table A1 and Table A2 in the appendix. Staiger and Stock's rule-of-thumb resembles the worst-case scenario of bias of the 2SLS relative to the OLS (Andrews & Armstrong, 2017)

Table 5: Second stage regression

	Specification 1: All bids		Specification 2: Winning bids	
Log(Bid)	Coeff.	Robust Std. err.	Coeff.	Robust Std. err.
Log(Bid count)	-0.0982	0.0654	-0.3410**	0.1461
Frequency	0.0031***	0.0004	0.0031***	0.0007
Area (m^2)	-0.00002***	0.0000	-0.00001***	0.0000
Activity	-0.0005**	0.0002	-0.0003	0.0005
CHEM	0.0733	0.0593	0.1434	0.1372
CAP	-0.0727	0.0472	0.0038	0.1063
EMP	-0.4302***	0.0767	-0.4407***	0.1531
INS	0.5888***	0.0664	0.6063***	0.1263
ECO	-0.1963***	0.0474	-0.2798***	0.1040
VEH	1.0662***	0.1840	0.9385***	0.2968
QMS	0.0899	0.0617	0.2012**	0.1129
Municipalities	0.0437**	0.0220	0.0352	0.0404
REF	-0.1567**	0.0606	-0.1802	0.1280
Lowest price	-0.2081***	0.0467	-0.3059***	0.0911
Renewal	-0.1778***	0.0562	-0.3554***	0.1181
Constant	5.0479***	0.1981	5.2890***	0.3954
Adjusted R^2:	0.2691		0.3222	
P-value	p<0.10*, p<0.05**, p<0.01***			

The results from the second stage regression, where all bids were included, can be seen in specification 1 in table 5 above. Both frequency (*Frequency*) and cleaning area (*Area*) were significant at 1% significance level, implying that larger objects reduce the price while an increased cleaning frequency increases the price per square meter of internal cleaning service.

The effect of the requirement set on the supplier showed that insurances (*INS*) and vehicles (*VEH*) increases the average bid placed by firms, while requirements set on employees and supervisors (*EMP*), references (*REF*), as well as environmental standards (*ECO*), decreases the bids on at least 5% significance level. Requirements comprising chemicals, financial status and quality management system showed no significant effect on the submitted bids.

An increased number of municipalities (*Municipalities*) covered in the contract would significantly increase the average bid per square meter and using the award decision method of lowest price would yield a significantly lower size of the bids submitted. The opportunity of a potential renewal (*Renewal*) of the contract significantly decreased the size of the bids on a 1% significance level. The effect of an increased number of submitted bids on the price per square meter and year for internal cleaning service proved to be insignificant (p=0.133).

The second specification in table 2, based on winning bids only, showed a significant effect of the number of submitted bids on the price paid by the contracting entity at a 5% significance level. If the number of tenders (*Bid count*) was to increase by 1%, the winning price of the procurement contract would decrease by 0.341 %. This effect is consistent with the economic theory of decreased mark-ups with increased competition. Both cleaning area (*Area*) and frequency (*Frequency*) were significance at 5% significance level, where increased cleaning frequency increased the price and increased cleaning areas decreased the price per square meter and year.

Most of the requirements set in the contracting document on the supplier had a significant effect on the price of cleaning service per square meter for the winning bids on at least 5% significance level. Requirements set on employees and supervisors (*EMP*) showed to decrease the winning bids by 44% on average, criterions set on insurances (*INS*) suggests to increase the submitted bids with roughly 60%, environmental standards (*ECO*) showed to be associated with a 28% decrease in bid size and requests set on the firms' vehicles (*VEH*) implied an 94% increase of the size of the winning bids on average. Requiring a quality management system (*QMS*) implied a 20% increase of the winning bid.

Providing the opportunity of extension of the contract (*Renewal*) significantly reduced the price by more than 35% and using the lowest price award decision method (*Lowest price*) reduced the price by an additional 30% on average.

There was no endogeneity in the second stage of the 2SLS regression of either of the two subsets, see Table A3 and Table A4 in the appendix. The test of overidentifying restrictions showed that the instruments are valid as they are not correlated with the errors of the main regression, see Table A5 and Table A6 in the appendix.

8. Discussion

A discussion of the general results and application of theory will be presented in this section. Comparisons of the results with respect to previous results will be conferred. Furthermore, a presentation of the main conclusions and future research ideas will be offered.

8.1. Discussion and Analysis

This study aimed to answer two research questions. The first one was whether the qualification criterions had a harmful effect on the number of participating firms in public procurement auctions of internal cleaning services in Sweden or not. The second was to analyse if an increase in the level of competition had a negative effect on the size of the bid placed by the tenderers, and subsequently the price paid by the contracting entity for the procured service.

The assumptions on which the hypotheses are based upon is that the number of tenderers were to decrease as qualification criteria are set, due to entry costs interpreted as increased costs associated with qualifying as a tender, and that the optimal bid decreases with an increased level of competition. The results imply that there does not seem to be any significant entry costs associated with public procurement of cleaning services, as most of the qualification criterions have positive or an insignificant effect on the number of participating firms in the public procurement auctions. Only the requirement of references (*REF*) shows to significantly decrease the number of participating firms, see table 4. The results of this analysis further show that many of the qualification criteria which are defined in the contract documents have a direct effect on the price paid by the contracting entity, rather than an indirect effect through the number of participating firms, see table 5.

In recent years, environmental qualification criteria have become more common in public procurement. Firms could have made these green investments associated with large fixed costs but low variable costs, such as fossil-fuel-free cars, implemented quality management system or certain environmental certifications, in an earlier stage. If the investments already have been made and the variable cost is low, the average cost decreases per unit and wouldn't necessarily affect the submitted bids. The results from this analysis showed that the size of the winning bids increased as criteria concerning eco-friendly vehicles and quality management systems were set by the contracting entity, see table 5 specification 2. These results imply that firms

have additional costs associated with supplying a higher level of quality. The increase in price could further be interpreted as the contracting entities willingness-to-pay of obtaining the preferred level of quality. As the contracting entity is assumed to have a utility function where increased quality increase the utility, and therefore the entities willingness-to-pay.

The requirements concerning both environmental standards and the staff of the supplier implied a decrease in the winning bids which could be an effect from no or low additional costs associated with satisfy the requests of the contracting entity, see table 5. If there are no costs associated with fulfilling the criteria but believes that their competitors might have such costs, they could place a more attractive bid and increase their probability of winning the contract.

A possible flaw with the analysis of tender size, which could interfere with the interpretation of the direction of effect, is that firms place a bid even though they know that the bids are too high to be seen as competitive. Placing abnormally high bids can be perceived as a signal to the competitors that they are not interested in that segment of the market. Firms could also have made naive assumptions or extreme estimations of the costs associated with fulfilling the contract and place an abnormally high or low bid. If a quality measurement of the contracting document would have been included in the model, these two effects could potentially have been separated. Since the entities are obligated to ask participating tenderers who places suspiciously low bids for additional information, an assumption can be made that low bids accepted by the contracting entity are placed deliberately, and not as a result of extreme estimations.

Lundberg and Marklund (2016) found that an increase in the number of participating tenderers of 1% would lead to an 0.168% decrease in placed bids and that a 1% increase in the number of participants would decrease the winning bid with approximately 0.3% when including both the size of the firm and quality criteria. The results from the analysis conducted in this study showed a significant effect from the number of participating tenderers on the size of the winning bid. A 1% increase in participating firms implied a 0.34% decrease in the size of the winning bid per square meter, while no significant effect was found for all bids from an increase in the number of observed participants. This can be interpreted as an increase from one to two participating tenderers reduces the winning bid by 34% and an increase from 10 to 11 tenderers would decrease the winning bid by 3.4% on average. Thus, a more competitive environment seems to reduce the cost of the procuring entity. The Swedish Competition Authority states that the number of participating tenderers in public procurement don’t necessary capture the

complete representation concerning the competitive environment. They state that fewer operating firms in a market could imply that the competition is less efficient than if there are a large number of firms competing for market shares (Konkurrensverket, 2018b). However, they suggest that even if the number of firms in a market is scarce, the competition between the firms can still be sufficient if the competitive atmosphere between those firms are considered prosperous.

Issues with a high level of uncertainty regarding non-verifiable quality or costs associated with attaining different levels of quality have shown to significantly affect the award decision method. If there is such uncertainty, contracting entities have shown to prefer the evaluation method of economically most advantageous tenderer rather than the lowest price (Lundberg & Bergman, 2017). In this data set, only 36% of the contracts were awarded through the evaluation method of the lowest price, which could imply that the contracting entities believe that there exists such uncertainty. The contracts which used the evaluation method of the lowest price when awarding the tender did significantly decrease the cost of the procured service. The results in this study presented evidence that using the lowest price as the evaluation method reduces the price paid by the contracting entity with roughly 30%, see table 5. These results must, however, be read with some precaution as other characteristics of the contracts using this method could also affect the large difference in the winning bid.

In public procurement, there is not only a potential socioeconomic drawback of low tenders – but also of high tenders. If a firm were confident that no other tenderers were to participate in a contract, they could place a bid which maximizes their profits and therefore leads to a higher cost for the procurement agency (Alexandersson & Hultén, 2005). There do exist several natural reasons for a firm to place a higher bid than others, such as firms having a substantial disadvantage regarding their cost structure. Both bureaucracy and lack of economics of scale and scope compared to the competitive firms may result in substantially higher costs. In table A5 in the appendix, the ratio between the highest and lowest bid for each contract is displayed. It is clear that there is large differences between the sizes of the tenders.

Analyses of green public procurements as an environmental policy instrument have concluded that it is neither cost-effective nor objective effective (Lundberg & Marklund, 2016). The results from the 2SLS regression implies similar conclusions, as qualification criteria condensing chemicals (*CHEM*) had no significant effect on the number of participating

tenderers nor the price paid by the contracting entities. Criteria concerning the vehicles (*VEH*) did however significantly increase the size of the winning bid, which could indicate that there are enough incentive to encourage firms to invest in such an environmental adjustment to qualify as a tender.

Since one of the key objectives of public procurement is to attain sufficient quality at a reasonable cost, the procuring entity should design contracts which ensure the proper quality. In the data set analysed, 84% of the contracts required that the tenderers had a quality management system, see table 2. Quality management systems can be interpreted as a mean to ensure that the goods or services of the suppliers are high-quality. The results showed that the qualification criteria concerning quality management system significantly increased the number of tenderers as well as the size of the winning bid, see table 4 and table 5. As the results from the analysis imply both an increasing number of tenderers per contract as well as quality insurance of the procuring entity, it is surprising that some contracting entities choose to omit this qualification criteria. To increase competition as well as to ensure the procurement of high-quality goods and services, the qualification criteria of firms applying a quality management system should be set as a national standard.

8.2. Conclusion

The main results of the empirical analysis of this study correspond, to some extent, with aforementioned conclusions regarding the effect of qualification criteria set on suppliers and the number of tenderers participating in public procurement contract as well as the competitive effect on the winning bids.

The empirical results ultimately concludes that there are costs associated with few tenders as an increase in the number of participating firms in public procurement contract significantly decreases the price paid by the contracting entity for the service, see table 5. Therefore, governmental agencies should emphasis designing contracts which increases the level of competition rather than lowering the demands set on suppliers. Since an increase in the mean activity level of the firm participating in the auction significantly reduces the competition, designing contracts which allows for smaller firms to participate result in an indirect effect of reduced costs for procuring entity. One potential solution could be to divide large contracts into smaller contracts, which could appeal to smaller businesses and thus increasing the competition

for each contract among tenderers. Further, by using the evaluation method of lowest price, the results implied a decrease of the size of the winning bid. Therefore, assumptions can be made that using the lowest price as the evaluation method there is a direct effect which reduces the costs of the procuring entity. However, the procuring entities must be thoroughgoing when defining the quality requirements in the contracting documents to guarantee the level of quality anticipated when exercising the evaluation method of lowest price.

8.3. Future Research Ideas

As a complement to research previously conducted, it's useful to further investigate the effect of the size of the firms and their effect on the competitive level since contracting documents designed to favour larger firms could impair the level of competition of public procurement contracts. Such contracting documents could, for example, comprise strict financial requirements set on the supplier which could be perceived as challenging to fulfil for smaller firms. Contracts designed to enhance the participation of small and medium enterprises could then expand the level of competition and thus reduce the costs associated with procuring cleaning services for the contracting entity. In this study, the size of the firm was aimed to be captured by the number of tenders submitted by each firm during the years of which the data set covers. The average activity of the bid showed to be significantly different between winning and losing tenders, see table A7 and figure A6 in the appendix, but as it does not capture the true size of the firm – no particular conclusions regarding the size of the firm can be made from these results. In future analyses, the turnover could potentially be used to describe the size of the firm as it could depict a more accurate effect of the size of the firm and the level of competition as well as the size of the placed bids.

While examining the data set, differences in the mean number of tenderers per year were found which could be interesting to investigate further. It is possible to expand the analysis to conclude whether the differences in the number of participants per contract varies over the years due to the type of objects, changes in the competitive environment or characteristics of the contracts themselves.

Further, these findings could have provided enriched information if regional differences were to be included in the analysis. Such research could potentially give contracting entities even more valuable insights regarding the local market characteristics of cleaning services.

Additionally, a dummy variable capturing whether the contracts' value exceeded the threshold value, meaning that the contract notice had to be published in Tenders Electronic Daily, could have been included to provide supplemented evidence. It could offer additional information of the competitive environment and market, as procurements with expected values surpassing the threshold value is announced internationally and thus possibly cause a surge in competitiveness.

9. References

Alexandersson, G., & Hultén, S. (2005). *Strategic Pricing by Oligopolists in Public Tenders of Passenger Railway Services*.

Andrews, I., & Armstrong, T. B. (2017). Unbiased instrumental variables estimation under known first-stage sign. *Quantitative Economics*, *8*(2), 479–503. https://doi.org/10.3982/qe700

Bergman, M., Indén, T., Lundberg, S., & Madell, T. (2011). *Offentlig upphandling - På rätt sätt och till rätt pris* (1st ed.). Studentlitteratur AB.

Bergman, M., & Lundberg, S. (2009). *Att utvärdera anbud : utvärderingsmodeller i teori och praktik*. http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A444356&dswid=4074

Dalen, D. M., Moen, E. R., & Riis, C. (2006). Contract renewal and incentives in public procurement. *International Journal of Industrial Organization*, *24*(2), 269–285. https://doi.org/10.1016/j.ijindorg.2005.04.004

Decarolis, F. (2014). Awarding price, contract performance, and bids screening: Evidence from procurement auctions. *American Economic Journal: Applied Economics*, *6*(1 A), 108–132. https://doi.org/10.1257/app.6.1.108

European Commission. (n.d.). *Public Procurement*. Retrieved 7 April 2020, from https://ec.europa.eu/growth/single-market/public-procurement_en

Green, W. H. (2003). *Econometric Analysis* (5th editio). Pearson Education Limited.

Hanák, T., & Muchová, P. (2015). Impact of Competition on Prices in Public Sector Procurement. *Procedia Computer Science*, *64*, 729–735. https://doi.org/10.1016/j.procs.2015.08.601

Konkurrensverket. (n.d.-a). *About the legislation*. Retrieved 12 April 2020, from http://www.konkurrensverket.se/en/publicprocurement/about-the-legislation/

Konkurrensverket. (n.d.-b). *About us*. Retrieved 12 April 2020, from http://www.konkurrensverket.se/en/omossmeny/about-us/

Konkurrensverket. (2012). *The cost of different goals of Public Procurement*. http://www.konkurrensverket.se/globalassets/english/publications-and-decisions/the-cost-of-different-goals-of-public-procurement.pdf

Konkurrensverket. (2017). *Tillsyn av efterannonsering*.

Konkurrensverket. (2018a). *Basic principles for public procurement*. http://www.konkurrensverket.se/en/publicprocurement/about-the-legislation/basic-principles-for-public-procurement/

Konkurrensverket. (2018b). *Konkurrensen i Sverige 2018*. http://www.konkurrensverket.se/globalassets/publikationer/rapporter/rapport_2018-1.pdf

Konkurrensverket. (2020). *Tröskelvärden*. http://www.konkurrensverket.se/upphandling/om-lagstiftningen/troskelvarden/

Krishna, V. (2003). *Auction Theory* (First ed.). Academic Press.

Lewbel, A. (2019). The identification zoo: Meanings of identification in econometrics. *Journal of Economic Literature*, *57*(4), 835–903. https://doi.org/10.1257/jel.20181361

Lundberg, S. (2005a). *Auction Formats and Award Rules in Swedish Procurement Auctions* (CERUM Working Paper, ISSN 1404-5362 ; 79).

Lundberg, S. (2005b). Restrictions on competition in municipal competitive procurement in Sweden. *International Advances in Economic Research*, *11*(3), 329–342. https://doi.org/10.1007/s11294-005-6661-y

Lundberg, S., & Bergman, M. (2017). Tendering Design When Price and Quality is Uncertain. *International Journal of Public Sector Management*, *30*(4), 310–327. https://doi.org/10.4324/9781315853178

Lundberg, S., & Marklund, P. (2016). *Influence of Green Public Procurement*. 1–30.

Maddala, G. S. (2001). *Introduction to Econometrics* (Third Edit). John Wiley & Sons Ltd.

Mcafee, R. P., Mialon, H. M., & Williams, M. A. (2004). When are sunk costs barriers to entry? Entry barriers in economic and antitrust analysis. What is a barrier to entry? *American Economic Review Papers and Proceedings*, *91125*, 461–465.

https://authors.library.caltech.edu/11284/1/MCAaer04.pdf

Meyer, D. J. (1993). First price auctions with entry: An experimental investigation. *Quarterly Review of Economics and Finance*, *33*(2), 107–122. https://doi.org/10.1016/1062-9769(93)90017-E

Milgrom, P. (2004). *Putting Auction Theory to Work*. Cambridge University Press.

Montet, C., & Serra, D. (2003). *Game Theory & Economics*. Palgrave MacMillan.

Onur, I., Özcan, R., & Taş, B. K. O. (2012). Public Procurement Auctions and Competition in Turkey. *Review of Industrial Organization*, *40*(3), 207–223. https://doi.org/10.1007/s11151-011-9299-3

Organisation for Economic Co-operation and Development. (2007). Competition and barriers to entry. *OECD Observer*, *January*, 1–6. http://www.oecd.org/competition/mergers/37921908.pdf

SCB. (2020). *KPI - fastställda tal*. https://www.scb.se/hitta-statistik/statistik-efter-amne/priser-och-konsumtion/konsumentprisindex/konsumentprisindex-kpi/pong/tabell-och-diagram/konsumentprisindex-kpi/kpi-faststallda-tal-1980100/

Stake, J. (2017). Evaluating quality or lowest price: consequences for small and medium-sized enterprises in public procurement. *Journal of Technology Transfer*, *42*(5). https://doi.org/10.1007/s10961-016-9477-4

Stock, J. H., & Watson, M. W. (2015). *Introduction to Econometrics* (3rd ed.). Pearson Education Limited.

Sundström, D. (2016). *On Specification and Inference in the Econometrics of Public Procurement*.

Upphandlingsmyndigheten. (2019a). *Anbudsöppningen*. https://www.upphandlingsmyndigheten.se/upphandla/Processen-for-LOU/upphandlingen/anbudsoppningen/

Upphandlingsmyndigheten. (2019b). *Anbudsprövning*. https://www.upphandlingsmyndigheten.se/upphandla/Processen-for-

LOU/upphandlingen/Prova-och-utvardera-anbudet/

Upphandlingsmyndigheten. (2019c). *Annonsera*. https://www.upphandlingsmyndigheten.se/upphandla/Processen-for-LOU/upphandlingen/annonsera/

Upphandlingsmyndigheten. (2019d). *Avsluta upphandlingen*. https://www.upphandlingsmyndigheten.se/upphandla/Processen-for-LOU/upphandlingen/avsluta-upphandlingen/

Upphandlingsmyndigheten. (2019e). *Efterannonsering - en viktig del av upphandlingen*. https://www.upphandlingsmyndigheten.se/upphandla/Processen-for-LOU/upphandlingen/efterannonsering/

Upphandlingsmyndigheten. (2019f). *Prövning av leverantören*. https://www.upphandlingsmyndigheten.se/upphandla/Processen-for-LOU/upphandlingen/provning-av-leverantoren/

Upphandlingsmyndigheten. (2019g). *Tilldelningsbeslut*. https://www.upphandlingsmyndigheten.se/upphandla/Processen-for-LOU/upphandlingen/tilldelningsbeslut/

Upphandlingsmyndigheten. (2019h). *Utforma upphandlingsprocessen*. https://www.upphandlingsmyndigheten.se/upphandla/Processen-for-LOU/upphandlingen/Utforma-upphandlingsdokument/

Upphandlingsmyndigheten, & Konkurrensverket. (2019). *Statistik om offentlig upphandling 2019. Upphandlingsmyndigheten rapport 2019:5 och Konkurrensverket rapport 2019:3*.

Varian, H. R. (1992). *Microeconomic Analysis* (Third Edit). W. W. Norton & Company, Inc.

10. Appendix

10.1. Tables

Table A1: Test for instrument validity, all bids

First stage regression summary statistics					
Variable	R^2	Adjusted R^2	Partial R^2	Robust F(2,1915)	Prob>F
Bid count	0.3705	0.3653	0.2463	265.319	0.0000

Table A2: Test for instrument validity, winning bids

First stage regression summary statistics					
Variable	R^2	Adjusted R^2	Partial R^2	Robust F(2,443)	Prob>F
Bid count	0.3819	0.3596	0.2424	58.0535	0.0000

Table A3: Test for endogeneity, all bids

Test for endogeneity		
Robust score chi2(1)	2.48451	p=0.1150
Robust regression F(1,1915)	2.47140	p=0.1161
H_0: Variables are exogenous		

Table A4: Test for endogeneity, winning bids

Test for endogeneity		
Robust score chi2(1)	0.973365	p=0.3238
Robust regression F(1,443)	0.928276	p=0.3358
H_0: Variables are exogenous		

Table A5: Test of overidentifying restrictions, all bids

Test of overidentifying restrictions		
Score chi2(1)	0.029204	p=0.8643
H_0: Overidentifying restrictions are valid		

Table A6: Test of overidentifying restrictions, winning bids

Test of overidentifying restrictions		
Score chi2(1)	3.81649	p=0.0508
H_0: Overidentifying restrictions are valid		

Table A7: Test for differences in mean activity of winning and losing tenders

Two-sample t test with equal variance			
Group	Obs	Mean	Std. Err.
Losing tenders	1,569	98.35054	2.31894
Winning tenders	480	126.2354	4.582437
Combined	2,049	104.8829	2.090763
Diff		-27.88487	4.899039
t-statistic	-5.6919		
$H_0: difference = 0$			
$H_a: difference < 0$	$Pr(T < t) = 0.0000$		

10.2. Figures

Figure A1: Bids and quality when quality is fixed at Q^*.

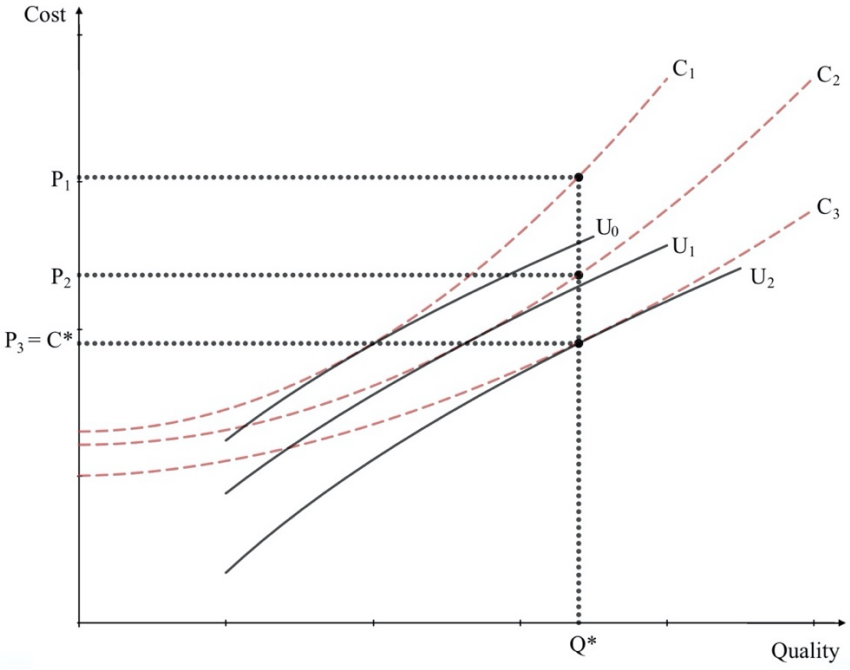


Figure A1 depicts the difference in bids placed by firms given different cost functions och the participating firms. The contracting entity maximizes their utility by awarding the firm with cost function C_3 the contract, at it gives the procuring entity the utility U_2 at quality Q^* and price $P_3 = C^*$. Where $P_3 < P_2 < P_1$ and $U_0 < U_1 < U_2$.

Figure A2: Economics of scale

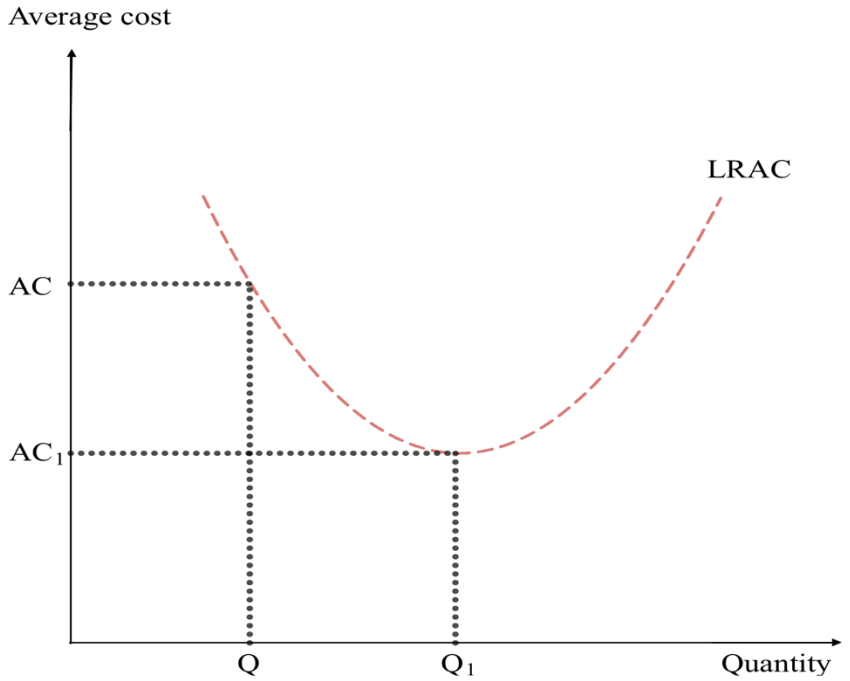


Figure A2, above, presents the change in average cost with increased production from Q to Q_1, given the assumption that a firm exhibits economics of scale.

Figure A3: Bid counts for different years per contract

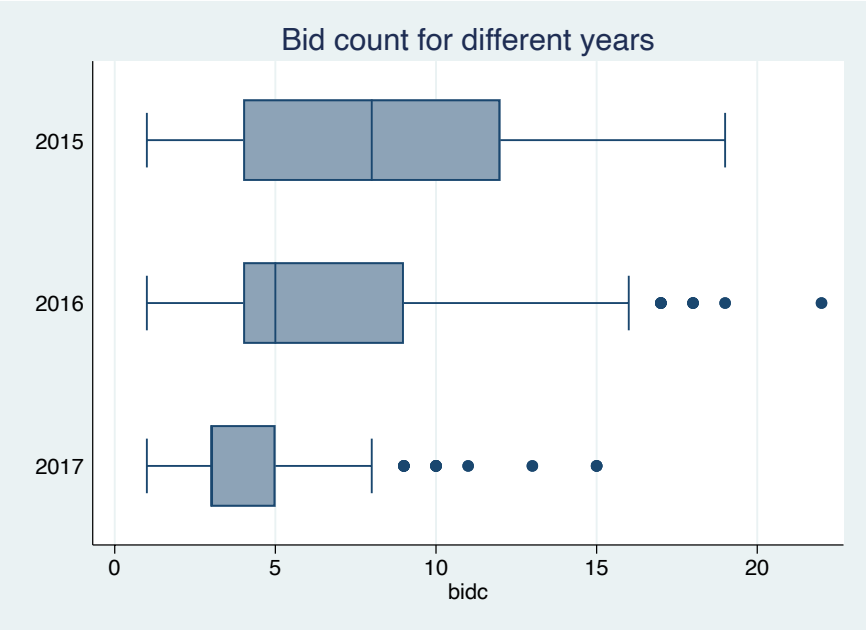


Figure A3 depicts the differences in the number of participants for each public procurement contracts of internal cleaning services for the years of 2015 to 2017. The mean number of participating tenderers in this data set was 8.3 in 2015, 6.6 in 2016 and 4.08 in 2017.

Figure A4: Bid counts per contract and the cleaning areas

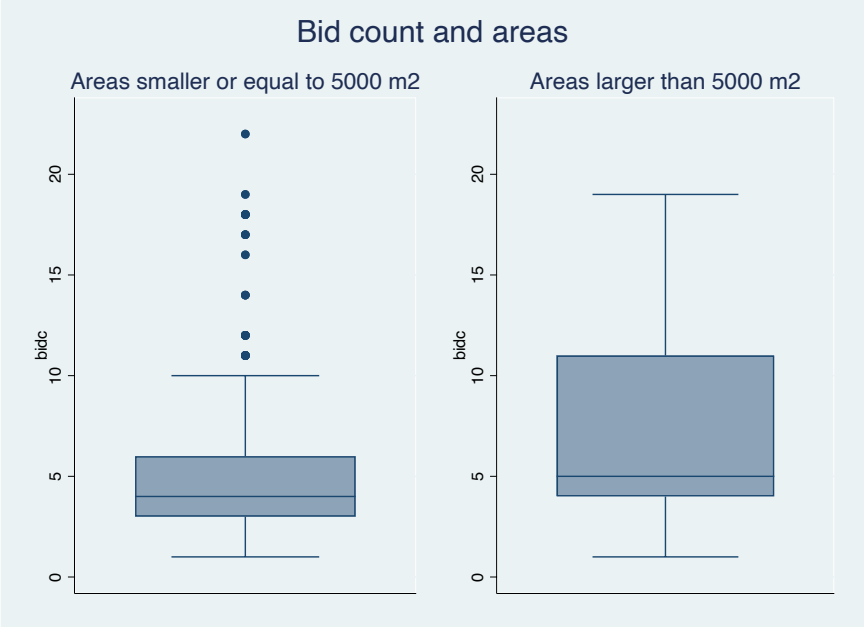
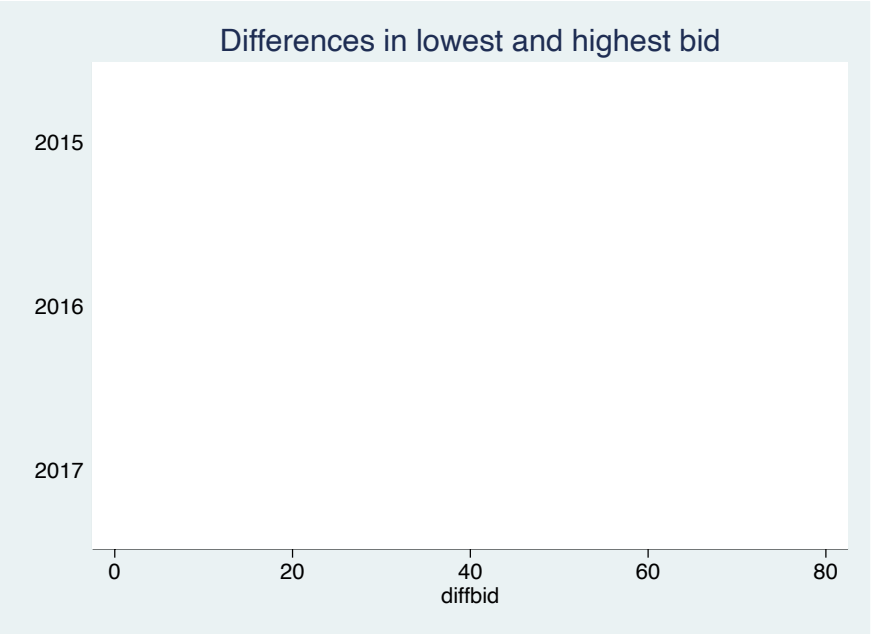


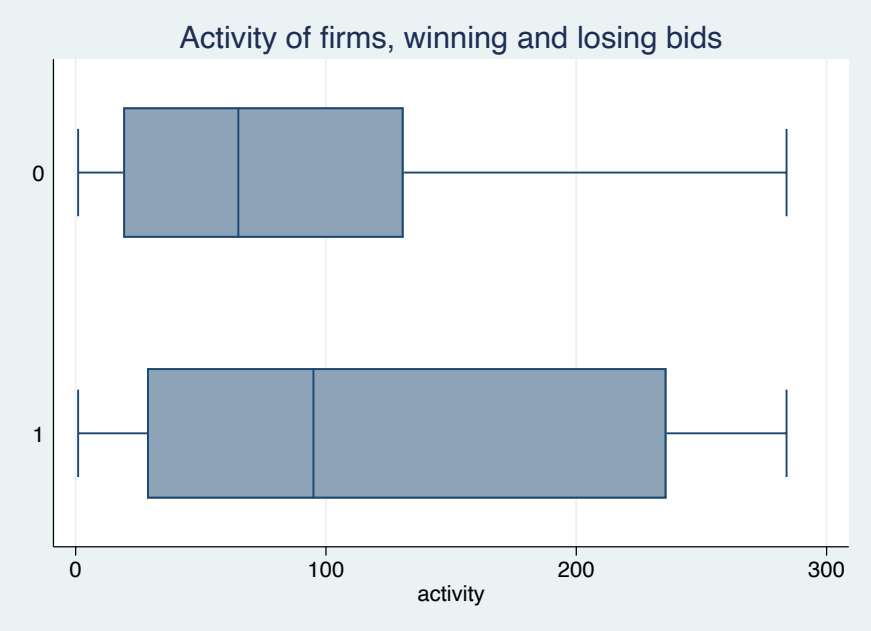
Figure A4 depicts the difference in the number of participating tenderers between contracts with the 50% smallest cleaning areas and the contracts with the 50% largest cleaning areas. The mean number of participating firms is smaller for a smaller object.

Figure A5: Ratio of the lowest and highest bid, by year



The box plot above, figure A5, presents the ratio of the lowest and highest bid placed on each contract for every year covered in the data set.

Figure A6: Mean activity for winning and losing tenderers



The box plot above, figure A6, presents the distribution of the mean activity level for firms placing winning and losing tenders. As can be seen, the activity level, that is the number of auctions which the firm have participated in during 2015 to 2017, is higher for winning bids (1) than for the losing bids (0).