Essays on quality evaluation and bidding behavior in public procurement auctions
To Linnea and Erik
Essays on quality evaluation and bidding behavior in public procurement auctions
Abstract


In this dissertation, I investigate how different aspects of the procurement process and evaluation affect bidding behavior.

In essay 1, we attempt to map public procurements in Sweden by gathering a representative sample of procurements. We find that framework agreements and multiple-contract procurements represent a very large share of total government spending. The total value procured by government authorities, municipalities and counties accounts to 215 BSEK yearly, which we believe is an underestimate due to data issues.

Essay 2 suggests a simple method for estimating bidding costs in public procurement, and are empirically estimated to be approximately 2 percent of the procurement value using a comprehensive dataset and approximately 0.5 percent for a more homogeneous road re-pavement dataset. Our method provides reasonable estimates with, compared to other methods, relatively low data requirements.

Essay 3 investigates the effect of quality evaluation on small and medium-sized enterprises (SMEs). Contrary to common belief, SMEs’ participation does not increase when evaluating quality, and their probability to win procurements decreases compared with that of large firms.

In essay 4, the bidders’ decision to apply for a procurement review “appeal” is investigated. Contrary to procurers’ beliefs, evaluating quality is found not to have any statistically significant effect on the probability of appeals. Instead, I empirically confirm theoretical prediction of the 1st runner-up’s decision to claim the evaluation to be redone, as well as free-riding in appealing.

In essay 5, we test whether spatial econometrics can be used to test for collusion in procurement data. We apply this method on a known cartel and test during and after the period the cartel was active. Our estimates support the proposition that spatial econometrics can be used to test for collusive behavior.

Keywords: public procurement, quality evaluation, bidding behavior, cartels, SMEs, transaction cost, litigation, spatial econometrics

Johan Y. Stake, Örebro University School of Business.
Örebro University, SE-701 82 Örebro, Sweden, johan.y.stake@sh.se
Acknowledgements

Finishing my master’s thesis in 2009, I was positive that I would not continue in academia. After five years, I had finally received my degree and did not want to continue studying. I intended to enter into “the real world” and leave academia forever…

…apparently, I was severely mistaken.

Attempting to summarize everything I have done during these past five years of PhD studies, I am very happy and very grateful for how wrong I was. I have had a fantastic and extremely learning experience that I will always cherish. I have learned a great deal from the courses that I have taken (and thought I would never pass), from teaching introductory microeconomics at Södertörn, from discussions regarding economics at the very local level to the world level during lunches, from conducting, writing and structuring research and from being solely responsible for finishing on time.

During my research in this area, I have had the opportunity to talk to many practitioners with different outcomes. Certain practitioners are the sole procurers in their municipality, whereas others belong to a group of procurers in large municipalities or counties and purchase many millions worth of goods and services every year. These differences may be one of the causes for the very different ways in which procurements are conducted throughout the country and for their very different quality. This finding by no means suggests that the procurements conducted by many experienced practitioners are more successful; the sole practitioner in a small municipality may have a much better understanding of the demands of the citizens in that area, whereas this may be more difficult to achieve for large procurement organizations.

I first want to thank my supervisor Mats Bergman, first, for believing me to actually be able to pursue a PhD in Economics. You have been a tremendous support to me, and I have felt very confident that I could always knock on your door with any question. You have always taken my concerns seriously and been very pragmatic. Thank you for this opportunity and for all your support.

I also want to thank my co-supervisors, Lars Hultkrantz and Anders Lunander, at Örebro University for their support and valuable comments on my work and for making me feel welcome at Örebro.
Thank you also Erik Lindqvist, who made a very thorough review of the papers in this thesis. Your comments were very good and of high value to me.

To all of my colleagues at Södertörn, I want to say thank you for all of the discussions regarding both economics and other subjects and for the support during both my PhD studies and my teaching. You have made me feel that I am a part of the collegium and not a student, which has made the journey much easier. Thank you to Xiang for all your wise input on econometric issues, Staffan for cheerful hellos and boat discussions, Leo for the support when I taught your course, Stig for a healthy dose of cynicism, and Anh Mai for fun discussions over our many lunchboxes. Additionally, thank you all for a great time in Venice!

I also want to thank everybody at Örebro and Södertörn University that have helped me throughout the years, and contributed in one way or another for this thesis to actually come together.

I am also grateful for having the possibility to co-author a paper with two brilliant researchers in Umeå, Sofia and Johan. It has been great fun and very developing to collaborate and develop our paper together. I also want to thank certain fellow PhD students, without whom these years would have been more difficult and not as much fun: Emilie Värja, Elon Strömbäck, Kristofer Odolinski and Niklas Elert.

Thank you also Erik Hegelund, Hans Christian Sundelin Svendsen and Björn Backgård for great work and a good time during our collection of procurement documents all over Sweden to compile the datasets.

I would not have been able to finish without the support and cheers from friends who never had any doubt that I would actually finish. Thank you all. I would also like to specially thank Marcus for being the best friend one could ever have, and Nisse and Johan for great times.

Last, but most important in my life, I want to thank my amazing wife Linnea and our fantastic son Erik for more support than I could ever ask for, for always listening when it felt difficult, for keeping me down-to-earth, for always making it fantastic to return home and for taking my mind off work every day. I love you both very much.

Erik, you do not yet realize how fantastic it was to be on parental leave with you after a year of hectic courses, travelling back and forth to Örebro. I loved every second of our time together, and hopefully, I will one day be able to explain to you how much that meant to me.

Linnea, I can never explain how much you mean to me.
Table of Contents

INTRODUCTION ............................................................................................................. 9

ESSAYS ....................................................................................................................... 10
The anatomy of public procurement in Sweden ......................................................... 10
Bid distribution and transaction costs ...................................................................... 11
Evaluating quality or lowest price: Consequences for small and medium-sized enterprises in public procurement ................................................... 13
Causes of litigation in public procurement .............................................................. 14
Using spatial econometrics to test for collusive behavior in procurement auction data .............................................................................................................. 15

REFERENCES ............................................................................................................. 17

ESSAY 1: The anatomy of public procurement in Sweden. With Mats Bergman

ESSAY 2: Bid distribution and transaction costs. With Mats Bergman. *(Submitted to Journal of Applied Economics 2015-08-13)*

ESSAY 3: Evaluating quality or lowest price: Consequences for small and medium-sized enterprises in public procurement. *(Conditionally accepted by Journal of Technology Transfer 2015-03-03)*

ESSAY 4: Causes of litigation in public procurement

ESSAY 5: Using spatial econometrics to test for collusive behavior in procurement auction data. With Mats Bergman, Johan Lundberg and Sofia Lundberg
Introduction

The most common argument to justify research in public procurement is the relatively large share of government expenditure that it represents. Its share is in the magnitude of 15-20 percent of GDP\(^1\); therefore, it is important that the process is efficient and purchases the optimal product under budgetary restrictions. A central principle to achieve this is to make sure that all firms have the same opportunities to submit bids and are treated equally in the evaluation process.

The large amount of public spending, effectiveness and equal opportunities are all important arguments and, in their own right, justify research in public procurement to increase the understanding of different mechanisms and thereby improve the purchasing process.

This dissertation consists of five studies that can hopefully contribute to a better understanding of certain aspects of public procurement and, perhaps, to the way in which procurements are conducted. Several aspects of public procurement are explored in the five essays.

A simple method to estimate the cost of bidding in a procurement auction is discussed and tested. In another study, quality evaluation is shown to not increase SME bidding in the manner in which it is claimed to do (according to the EU). Contrary to its expected outcome, it instead improves the competitiveness of large firms. The third paper shows that there is no general effect of quality evaluation on the risk of appeals; however, theory suggests that the 1st-runner up has incentives to appeal the evaluation, which is confirmed. Also confirmed is the existence of free-riding in the process of appealing, where the probability for each non-winning firm to appeal decreases with increasing number of non-winning bidders. Finally, we show that spatial econometrics can be used to confirm collusive behavior in procurement auctions, a method that has not previously been applied to this problem.

\[^1\] Bergman 2008.
Essays

The anatomy of public procurement in Sweden

The objective of the first essay is to establish certain empirical facts regarding how public procurement is conducted. Although public procurement is a common process that virtually all government entities use, it is a relatively unexplored area, and reliable statistics were scarce when we began this project. There were portals run by private firms, but these aimed to present upcoming procurements to facilitate access for bidding firms rather than to assemble a dataset for ex post analysis. Additionally, as we noticed later, these portals were incomplete; certain procurements in our sample did not exist in theirs.

We randomly selected authorities from two strata, which provided us with 20 central government authorities and 20 municipalities or counties from which, in a subsequent step, we sampled procurements. Large central government authorities had a higher probability of being selected and vice versa because we weighted their probability of being selected by the number of employees. For the other strata, i.e., municipalities and counties, we assigned probabilities in the same manner but used the number of inhabitants in the geographical area as proxy.

Using gross lists of all procurements conducted by the selected authorities during 2007 and 2008, we selected a maximum of 20 procurements. Random with equal probabilities were used if the authority had conducted more than 20 procurement during the two-year period.

When we use our sample to scale to the entire population, our estimates show that approximately 8,700 procurements were conducted by these government entities annually, which can be compared with a subsequent estimate showing that 12,206 procurement were conducted in 2009. We estimated the total value of procurements to be 216 billion SEK per year, which we believe is an underestimate; a commonly cited value is 500 billion SEK per year. This difference is primarily due to our data not including government-owned firms; however, another contributing factor is that certain procurements are not covered and because contract-value data are

---

2 In addition, all counties’ probabilities were decreased by 0.5 compared with municipalities due to their lower budget per capita; the reduction was 20.7 percent for municipalities and 10.8 percent for counties in 2008.

3 Swedish Competition Authority (SCA) 2012:6. Hence our method may suffer from undercoverage.
available less often for large-value procurements. We attempt to extrapolate the missing values for the large procurements using existing estimates; however, this could, of course, underestimate the largest values.

We also examine the structure of the procurement. The most frequent type of procurement is a single-contract procurement, which is not a framework agreement. However, framework agreements and multiple-contract procurements represent a significant value because these procurements have a larger mean value.

Goods are both most the frequently procured and have the highest share of total value. A- and B-services\(^4\) represent approximately the same value above the threshold, 15 billion SEK, although the mean value of B-services is higher than that of A-services.

From our data, not scaling to the entire population, we observe that a procurement on average receives 5.5 bids. Separating single- and multiple-contract procurements, we observe 4 and 14 bids, respectively. Finally, we examine the winners and conclude that micro firms bid the most, submitting 42 percent of all bids, whereas large firms have the highest success rate, submitting 16 percent of all bids, of which 35 percent win.

**Bid distribution and transaction costs**

One important question regarding public procurement and of special concern for the bidders is the cost of preparing and submitting a bid in public procurement auctions. A lower cost of bidding, or transaction cost, will increase the number of bidders (Lang & Rosenthal, 1991; Fan & Wolfstetter 2008); this could be achieved, e.g., by reimbursing bidders for their bidding costs. Other theories suggest decreasing the transaction cost by limiting the number of bidders through a restricted procedure (Fan & Wolfstetter, 2008; Gal et al., 2007; Perry et al., 2000; Ye, 2007).

In this paper, we derive a simple method for estimating bidding costs in public procurement auctions, under the assumption of deterministic en-

---

\(^4\) A-services are defined as services that can be exposed to international competition and use the EU Directives 2004/18/EG and 2004/17/EG above the threshold value, whereas B-services are considered more difficult to compete on across national borders and therefore use national regulation (LOU 2007:1091, which replaced the former public procurement law LOU 1992:1528) both below and above the threshold.
try⁵, from a pool of potential bidders. Firms are assumed to be ex ante symmetric and to learn their private cost after paying the entry cost for the procurement. Finally, firms submit their bids to the authority.

We show that under these assumptions, the total bidding cost in the procurement can be approximated by the difference between the lowest and the 2nd lowest bid in the auction. Therefore, the per-firm bidding cost in the procurement is, approximately,

\[ d_i = \frac{(b_{i2} - b_{i1})}{n_i} \]

where \( d \) is the transaction cost, \( b_{i1} \) is the lowest (winning) bid in the auction, \( b_{i2} \) is the second lowest bid and \( n \) is the number of bidders in procurement \( i \).

We test this method on the dataset described in Essay 1 and on another, more homogeneous dataset that consists of the Swedish Road Administration’s (SRA) procurements during 2002-2009. The SRA dataset consists of similar products and services that are repeatedly procured, which results in a more homogeneous dataset and possibly lower transaction cost.

Our estimates show that the total transaction or bidding cost is approximately 6 percent of the contract value for the general sample, which results in a per-firm bidding cost of 2 percent when the number of bidders is set at the average (3). For the SRA dataset, the bidding cost is lower, at 1.9 percent in total and 0.5 percent of the contract value when we use the average number of bidders (4).

If we compare our estimates with other studies of bidding costs, our estimates are slightly higher than those obtained in surveys and time studies (EU Commission 2011a, 2011b, Holm 2011) but smaller than those found in studies using structural equations to estimate bidding costs (Li and Zhen 2009, Athey et al. 2011, and Bajari and Hortacsu 2003). Thus, our simple method performs well compared with other methods that are significantly more complicated, time-consuming or data-demanding.

---

Evaluating quality or lowest price: Consequences for small and medium-sized enterprises in public procurement

The evaluation process in public procurement is highly important because it reveals the winner of the procurement and the contract. The bids can be evaluated by price, quality or a combination of both. The European Union has suggested evaluating quality as a means of increasing small and medium-sized enterprises’ (SMEs’) access to public procurements, after noting that SMEs, according to the EU, secure a disproportionately small share of public contracts (EC 2008a, 2008b). Certain countries have approached this problem using set-asides and price adjustments; however, this is not possible in the EU because all firms legally must have the same opportunities.

The proposition that SMEs would bid and win more often in a procurement setting in which quality is evaluated is based on the belief that SMEs are more innovative than large firms, thus providing SMEs with an advantage when other aspects than price are evaluated. Earlier research regarding innovation and firm size has not found any clear evidence of SMEs being more innovative than large firms; instead, it points to different means of innovating and suggests that SMEs innovate in response to market demands, whereas large firms “push” their innovations into the market (Nootenboom 1993, Bodewes and De Jong 2003).

Therefore, I analyze the effect that a quality evaluation has on SMEs and large firms using the dataset described above (Essay 1). Because the dataset is very heterogeneous, I use coarsened exact matching, a procedure that was developed to reduce imbalances in the dataset and improve causal inference, (Iacus, King and Porro 2008, 2011, King et. al. 2011). I estimate SMEs’ access to public procurement in three steps. First, I model the number of bids submitted by different firms using a negative binomial model and continue to estimate the probability of bids being rejected. Finally, I estimate the probability of winning for different firm sizes while controlling for the submitted number of bids.

Contrary to the EU’s beliefs, I find no significant effect on participation by SMEs when quality evaluation is used instead of the lowest price; at the same time, large firms participate significantly more when quality is evaluated. More importantly, I find that micro, small and medium-sized firms

---

6 For example, the USA (Federal Acquisition Regulation 2005, Subchapter D, Part 19).
7 Directive 2004/18/EC
all exhibit a smaller winning probability compared with large firms when a quality evaluation is used instead of the lowest price. Additionally, this study shows that SMEs increase their probability of winning if the procurement is divided into several contracts and that the value of the contract has a negative effect on SMEs’ probability to win. These findings suggest that the recommendation to split contracts into smaller lots facilitates SMEs’ access to public procurement contracts.

**Causes of litigation in public procurement**

In my fourth essay, I explore the procurement’s post-evaluation period, in which it is possible for bidders that experience treatment in conflict with the EU’s main principles of non-discrimination, equal treatment, transparency, proportionality, and mutual recognition to apply for a review of the procurement, or to “appeal”.

An appeal can be a costly process for the procuring authority due to delays in the delivery of the procured good or service and due to litigation costs in terms of time and counsel fees. A common notion among practitioners of public procurement is that the procurement process has become excessively biased towards the legal side and often neglects the goal of making the best purchase possible when attempting to avoid appeals. Because of this fear, many practitioners hesitate to evaluate quality, and, as Lennerfors (2007) concludes “the search for the perfect purchasing process has been transformed into the search for a purchasing process without appeals”.

Using theory on litigation and pre-trial settlement (Felsteiner 1981, Cooter and Ulen 2004, Relis 2007), I derive theoretically the decision of a bidder to appeal a public procurement auction and discuss the effects of quality evaluation on the probability to receive an appeal. The 1st runner-up in a procurement auction has high incentives to appeal the evaluation, because this would restrict lower-ranked bidders’ possibility to submit a new bid, thus being the winner if the procurer loses the litigation. Also, theory suggests that free-riding does exist if there are three or more losers in the auction, and could exist when there are only two losing bidders.

---

8 2004/18/EC; 2004/17/EC; 1 chap. 9 § LOU; 1 chap. 24 § LUF; 1 chap. 11 § LUF; 1 chap. 2 § LOV)


10 SOU 2013:12, pp. 141
Using propensity-score matching to determine the causal effect, I investigate whether procurements that use quality evaluation or high quality weights have an increased risk of being appealed. I find no general evidence that quality evaluation increases the probability to receive an appeal. Furthermore, I test the theoretical findings and can confirm that the 1st runner-up in the procurement auction has a significantly higher probability to appeal the evaluation to be redone, while there is a negative but not significant effect of claiming the procurement to be redone.

The existence of free-riding is tested by modelling the bidder’s decision to appeal dependent on the number of losers in the auction. I find that the sole loser in an auction has a significantly higher probability to appeal compared to auctions with three or more losers, and can therefore confirm that there exists free-riding in this setting.

**Using spatial econometrics to test for collusive behavior in procurement auction data**

The fifth and final essay investigates whether spatial econometrics can be used to test for collusive behavior in procurement auction data. Research on cartels and collusion in public procurement has gained increased attention from economists, with one of the challenges being to identify cartel members with econometric methods; see, for example, Porter and Zona (1993), Bajari and Ye (2003), and Pesendorfer (1995; 2000).

We use data related to the asphalt cartel that was active in Sweden during the 1990s and consisted of all of the major firms in the industry. The cartel met on a yearly basis to allocate the coming year’s contracts, coordinate bidding, and share information regarding volumes and prices. The members used complementary bidding (submitted fake bids) in procurement auctions to maintain the appearance of a competitive environment.

Exploring the data, we find that it is difficult to visually observe an increase in costs using bid per square meter of asphalt. Therefore, it is more important to develop more sophisticated models to be able to test for collusive behavior.

We test for non-independent bidding between the convicted cartel members in procurement ranging from 1994 to 2009 using spatial econometric techniques, which is traditionally used in the geographical dimension. Taking advantage of the fact that the cartel used complementary bidding, we investigate whether the bids from cartel members appear to be influenced by other cartel members’ bids before and after the cartel.
Our model indicates non-independent bidding during the cartel, whereas the relevant parameter does not acquire significance in the non-cartel period. Therefore, we conclude that spatial econometrics applied to procurement auction data can be used to confirm non-independent bidding.

Although we cannot conclude which specification is preferred in our estimations, or measure how spatial econometric models perform relative to other econometric models developed to test for collusion, spatial econometrics seem to be relevant in testing for collusive behavior. This model’s main advantage is its relatively low data requirements.
References


Federal Acquisition Regulation. 2005. Issued by the General Services Administration, Department of Defense, National Aeronautics and Space Administration. (1) March.


Holm, J. 2011. *En analys av transaktionskostnaderna vid offentlig upphandling*. Report to the Swedish Public Procurement Committee. [In Swedish.]


SOU 2015:12. *Överprövning av upphandlingsmål m.m.* Swedish Government Report


Södertörn Doctoral Dissertations 2013-

För samtliga titlar i serien, sök i DiVA (sh.diva-portal.org)

A list of further titles in this series can be found by searching in DiVA (sh.diva-portal.org)

76. Tanya Jukkala, *Suicide in Russia: A macro-sociological study*, 2013
77. Maria Nyman, *Resandets gränser: svenska resenärers skildringar av Ryssland under 1700-talet*, 2013
82. Anna Kharkina, *From Kinship to Global Brand: the Discourse on Culture in Nordic Cooperation after World War II*, 2013
84. Oskar Henriksson, *Genetic connectivity of fish in the Western Indian Ocean*, 2013
94. Henriette Cederlöf, *Alien Places in Late Soviet Science Fiction: The "Unexpected Encounters" of Arkady and Boris Strugatsky as Novels and Films*, 2014
105. Katharina Wesolowski, *Maybe baby? Reproductive behaviour, fertility intentions, and family policies in post-communist countries, with a special focus on Ukraine*, 2015


