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Abstract

We provide novel stylized facts about competition, bidding, entry and bidders across a wide spectrum of public procurement auctions using comprehensive and rich Finnish data. Competition for publicly procured contracts is relatively low with a median bidder count of two (three conditional on receiving any bids). Bidders typically are very heterogeneous in size, which likely limits competition further. Competition seems to work roughly as expected as on average (standardized) bids mainly decrease with the number of actual and potential bidders. Using information on registrations as a good proxy for potential bidders, we show that the ratio of actual to potential bidders increases with the number of actual bidders. We also show that being present in the contracting authority's municipality or province correlates positively with registering, entry (bidding) and winning, but other firm characteristics matter less. While attracting more competition by means of contract and auction rule design is a desirable policy goal and we show suggestive evidence that the use of scoring rule can be an entry barrier, increasing competition may be in practice difficult. Therefore, reservation prices may be a more useful policy tool to alleviate issues associated with the lack of competition.

Key words: Competition, Entry, Public Procurement

JEL classes: D44, H57, H76, L11

1 Introduction

In many countries, a large share of public sector purchases are implemented via public procurement (PP). For example, in the OECD countries PP is estimated to account for about 12% of GDP.[1] Adopting PP is often seen as addressing both issues related to the lack of incentives, inefficiencies and rent-seeking involved in in-house production by the public sector (e.g. Alchian & Demsetz 1972 and Niskanen 1971), and various market imperfections arising in private markets producing public goods. However, recently policy makers in the EU have been increasingly worried that PP does not work as it should due to a severe lack of competition. For example, according to the European Commission (2017), "Public procurement relies on open competition to deliver the best value for public money. This competitive process is either not present or it is losing intensity. Between 2006 and 2016, the number of tenders with only one bid has grown from 17% to 30%. The average number of offers per tender fell from five to three in the same period."

Despite the pressing policy need to understand the implications of this lack of competition, and the reasons for it, as well as the possible remedies, the existing evidence is very limited in scope. We seem to be missing a comprehensive picture regarding some of the very basic and fundamental questions about the anatomy of public procurement in any country. Does PP work by and large as intended? How extensive is the lack of competition and how does it vary across industries, procurer type, and the applied auction mechanisms? Does competition work as the auctioneer would like? How can one attract more potential bidders? What type of potential bidders bid and what type abstain, and can entry be influenced by the auction or contract design?

We leverage rich and wide data to provide comprehensive descriptive evidence on these questions in Finland. Finland is an interesting case for such an analysis as a standard auction mechanism (first-price sealed-bid) is in use, and the regulatory framework follows the standards adopted in the EU. Our data contain all types of public procurers (central, regional and local governments, and other types of public authorities conducting PP such as public universities, state church, municipal co-operations) and cover all industries, and throughout the country. We have information on the invitations to tender (ITT) and all the bids and registrations, which we argue to be a very good proxy for potential bidders, which allows for detailed analysis of

[1] Source: http://www.oecd.org/gov/public-procurement/ accessed on February 3, 2019.

entry choices. We also have detailed information on all the participating and potential bidders.

The reason for the lack of prior evidence is that most of the applications using PP data usually analyze special cases, i.e. they use data from a single type of services or goods, or a single type of contracting authority (henceforth we use the term procurer). In cases where more comprehensive data are available and used, often the auction mechanism is non-standard (see Ferraz et al. 2016 for Brazil and Lee 2017 for Korea), or the data are limited in other ways, such as lacking information on all the bids (e.g. Decarolis et al. 2018 for the US). The richest data (aside ours) concern Lithuania (Baltrunaite 2018) and Russia (Best et al. 2018 and Vitalijs 2017), but even in those, and in all the large data sets we are aware of, information on (or a good proxy for) potential bidders is missing. In Table 2, we provide more details of the literature and the available data. In addition to these data limitations, research questions are usually focused on specific topics rather than aimed at providing a descriptive overview of the data.

We make several key observations. First, there seems to be a serious lack of competition also in Finnish PP across industries and procurers, with a median number of actual bidders of only two. This means that for more than half of the auctions, there are either no bidders, a monopoly bidder or duopoly bidders. Even conditional on attracting at least one bidder, the level of competition is low with the median number of actual bidders being three. The issues associated with the lack of competition are likely further exacerbated by the large heterogeneity in size (turnover and employment) between the bidders that we observe. The lack of competition is an issue across all industries and different contracting authorities.

Second, we argue that the lack of competition is likely to be a problem for procuring goods and services as we show competition (both the number of actual and potential bidders) to have by and large the desired correlations with the standardized price measures (win margin, and difference between the expected and realized price). Increasing competition has only a minor influence after six or more bidders participate, but less than 10% of the invitations to tender have more than six bidders. This association between competition and prices is not as trivial as would intuitively seem despite standard auction theory (Bulow & Klemperer 1996, Klemperer 2000) arguing that attracting enough competition is crucial in making public procurement auctions work in getting high-quality goods and services at reasonable prices. The reason is that the "Common values effect" (Bulow et al. 1999, Hong & Shum 2002), the "Affiliation effect" (Pinkse & Tan 2005, Hubbard et al. 2012), and the "Entry effect" (Li & Zheng 2009)

may limit the benefits of competition or even reverse the relationship between prices and the number of bidders. We describe these mechanisms later and argue that they may explain why the association between competition and standardized prices is not always monotonic.

Third, our data offer a unique opportunity to understand the reasons behind the lack of competition, because we observe the universe of potential bidders. We show that the lack of competition arises both from the lack of potential bidders and from entry costs that prevent potential bidders from submitting bids. This indicates a need to both design the contracts in such a way that they appeal to more firms, and to design both the contracts and the bidding process so that it is simple to calculate production costs and submit bids. One possible avenue is a careful consideration of how to contract for quality as we show that the use of scoring auctions is associated with lower entry probabilities. However, given that auction rules overall do not correlate much with the number of bidders, and given that based on our analysis entry costs seem to be more about firms needing to calculate their production costs rather than about bid preparation costs, the auctioneer seems to have somewhat limited tools to attract more bidders. Moreover, the most important firm characteristic that predicts entry is firm location, and that is beyond the control of the procurer. Therefore, a more rigorous use of reservation prices should be implemented to limit the high prices that the lack of competition leads to (Myerson 1981, Gentry & Li 2014 and Vitalijs 2017).

Our analysis contributes to the recent surge of literature in policy-relevant PP questions. These topics include for example, corruption (Bandiera et al. 2009, Mironov & Zhuravskaya 2016), favoritism (Hyytinen et al. 2018), various political economy concerns (Boas et al. 2014, Baltrunaite 2018, Ruiz 2018, Gulzar et al. 2018), (incomplete) contracting on quality (Asker & Cantillon 2008, Asker & Cantillon 2010, Lewis & Bajari 2011, Lewis & Bajari 2014, Hart et al. 1997), litigation concerns (Coviello et al. 2018), fiscal policy goals (Balat 2017, Ferraz et al. 2016, Lee 2017), and the nature and amount of competition (Hong & Shum 2002, Li & Zheng 2009, Kang & Miller 2017). To our knowledge, we are the first to provide a comprehensive description of how competition and entry work in PP.

In the next Section, we describe how we constructed the data and describe them. In particular we analyze how representative they are. In Section 3, we analyze the extent and implications of competition. In Section 4, we analyze the role of entry in the lack of competition. Section 5 provides more information on the bidders, in particular on the nature of bidder asymmetry. We conclude in Section 6.

2 Institutional setting and data

2.1 Institutional setting

The Act on Public and Concession Contracts (1397/2016) in Finland is based on EU regulations and dictates that all purchases made by municipalities, government entities and state-owned enterprises need to follow a predetermined procurement procedure. The only exceptions are purchases that are under the government-set minimum threshold values. This threshold is 60 000 euro for most goods and services, 150 000 euro for construction works, and 400 000 euro for social and health care services.[2]

The procurement procedure is as follows. When a public entity decides to make a purchase that is over the threshold value, it must advertise the contract notice and the invitation to tender in a publicly run electronic notice board called Hilma. On Hilma, firms can opt to register free of charge for more information about the Invitation to Tender (henceforth ITT) from a source provided by the buyer. The ITT must include all information about the purchase, thus ensuring that complete information is available to all potential bidders. The invitation also sets the timeline for the procurement procedure and informs bidders about the allocation rule.

Two different allocation rules are used in public procurement.[3] The first chooses the lowest price from all the bidders who fulfill the minimum (quality) requirements. The second rule allocates the purchase to the "most economically advantageous bidder". In practice, this means using a scoring rule to evaluate quality criteria. In the majority of cases, the weight of the quality score is 50% or less, with the remaining weight being allocated to the price. All bids in our sample are submitted as sealed bids and the winning bidder pays the amount bid.[4]

2.2 Procurement data

We use data from public procurement auctions held in Finland between June 2010 - September 2017. Nowadays, the majority of Finnish public sector entities use electronic procurement

[2]Some of the threshold values were increased on 1.1.2017. The values from the previous period were 30 000 euro for most goods and services and 100 000 euro for social and health care services.

[3]There is also a third rule which allocates based on producer costs, but it is used in less than 0.1 percent of Finnish public procurement.

[4]In some recent and very rare cases an ascending electronic auction format has been used.

software provided by a single private firm Cloudia Oy to conduct their procurement auctions with Cloudia's market share being almost 90%. This expansion has been rapid as their software was introduced only in 2010. They benefited especially from a recent regulation stating that starting from January 2018 all public procurement must take place via electronic platforms. From 2010, a gradually increasing amount of municipalities and other public sector agents have started using their platform. This means that a large part of our data is from recent years.

Our data contain over 18 000 ITTs with at least one bidder registration, 275 000 auctions and 705 000 bids.[5] Invitations to tender often contain several separate auctions for which bidders submit individual bids. For example, an invitation to tender may be about office stationery, and the individual auctions within it about paper, pens etc. Currently the latest full year in our data (2016) contains about 30% of all the ITTs for that year (in Hilma), totaling 5.3 billion euro in expected costs.[6] Procurers are not forced to disclose the expected cost, hence it is missing for approximately 25% of the invitations to tender. We are in the process of extending the data to include the most recent year (2018) with potentially even up to almost 90% of municipal public procurement auctions in Finland.

The industry classifications can be obtained from CPV classification codes.[7] Moreover, we have the procurer's written description of the invitation to tender as well as the details of each individual auction, which allows us to analyze procurement at a very detailed level. Furthermore, we can use information on the bidders (see next subsection) to infer the industry.

The Cloudia procurement data are generated in three steps. First, a procurer makes a decision to procure something and chooses how to conduct the procurement. At this stage most of the procurement process related data are created, including all the ITT-specific variables. These are the objects of the procurement, the engineer-estimated cost, the allocation rule (scoring vs. price only), and whether bidders are allowed to bid on a subset of auctions. We

[5]We omit ITTs with zero registrations as for them we cannot disentangle whether it is a mistake or some kind of a test in the Cloudia system. Therefore, the real extent of competition may be even lower than we document.

[6]We cross-reference our data with Hilma to ensure there are no pre- or post-announcements which are not meant for bidding or registrations. We also exclude all such announcements from the Hilma database when comparing the two sets of data.

[7]The common procurement vocabulary (CPV) establishes a single classification system for public procurement in the EU aimed at standardizing the references used by contracting authorities and entities to describe procurement contracts.

refer to this option of dividing the contract into separate lots as partial procurement.

In the second step, potential bidders opt-in to an invitation to tender by registering for the ITT in the Cloudia system via a link in Hilma. Based on our discussions with several civil servants who conduct public procurement and Cloudia employees, registration is a very good proxy for being a potential bidder. Registering requires only a very small (but non-zero) amount of effort, and allows bidders to access further information about the tender that is only available to registered firms. Registering firms then choose whether to actually bid in the auctions concerned. It is not possible to bid without registering. We have data on all the firms that have registered in an ITT and all the bids submitted in the auctions. We also observe auctions where no bids were submitted.

In the final step, the contracting authority awards a contract to one or several economic operators that have submitted a bid. We have the information on the chosen winner(s), which is important in the case of scoring auctions, where sometimes the lowest price doesn't win. So far, we do not have detailed information on what kind of scoring rule has been used or how the bids and quality characteristics are translated into scores. Possibly some of that information could be constructed from the database using text analysis methods.

2.3 Firm data

We merge the procurement data with detailed firm-level data and with Finnish Longitudinal Employer-Employee Data (FLEED) obtained from Statistics Finland. These data contain information on all the approximately 300 000 Finnish firms and their employees up to and including the year 2016.

The firm data contain all the information found in the firms' financial statements as well as information on the municipalities where the firm is registered for business. The latter allows us to analyze the importance of geographical presence in public procurement. All the firm data are collected by Statistics Finland on a yearly basis.

The FLEED also contains information on the firms' employees. We observe employees' levels of education, salaries and several other personal characteristics such as the municipality where the employee lives. We also observe employment and unemployment on a monthly basis. This information will be utilized in future work.

All the data are matched using the business identity codes that exist for all Finnish com-

panies. When identifying unregistered bidders from the same industries, we first look at the most common industry classification among the firms that have registered to an invitation to tender, and then match unregistered firms in the same industry as potential registers for that ITT.

2.4 Descriptive statistics

The most commonly procured goods and services in our data, as well as their cumulative expected costs, can be seen in Figure 1. In terms of the number of tenders, construction is the most common. There are also many different service and equipment categories with a lot of tenders. Social housing service contracts are extremely valuable even if there are not that many of them. Social and health care contracts are both valuable and numerous.

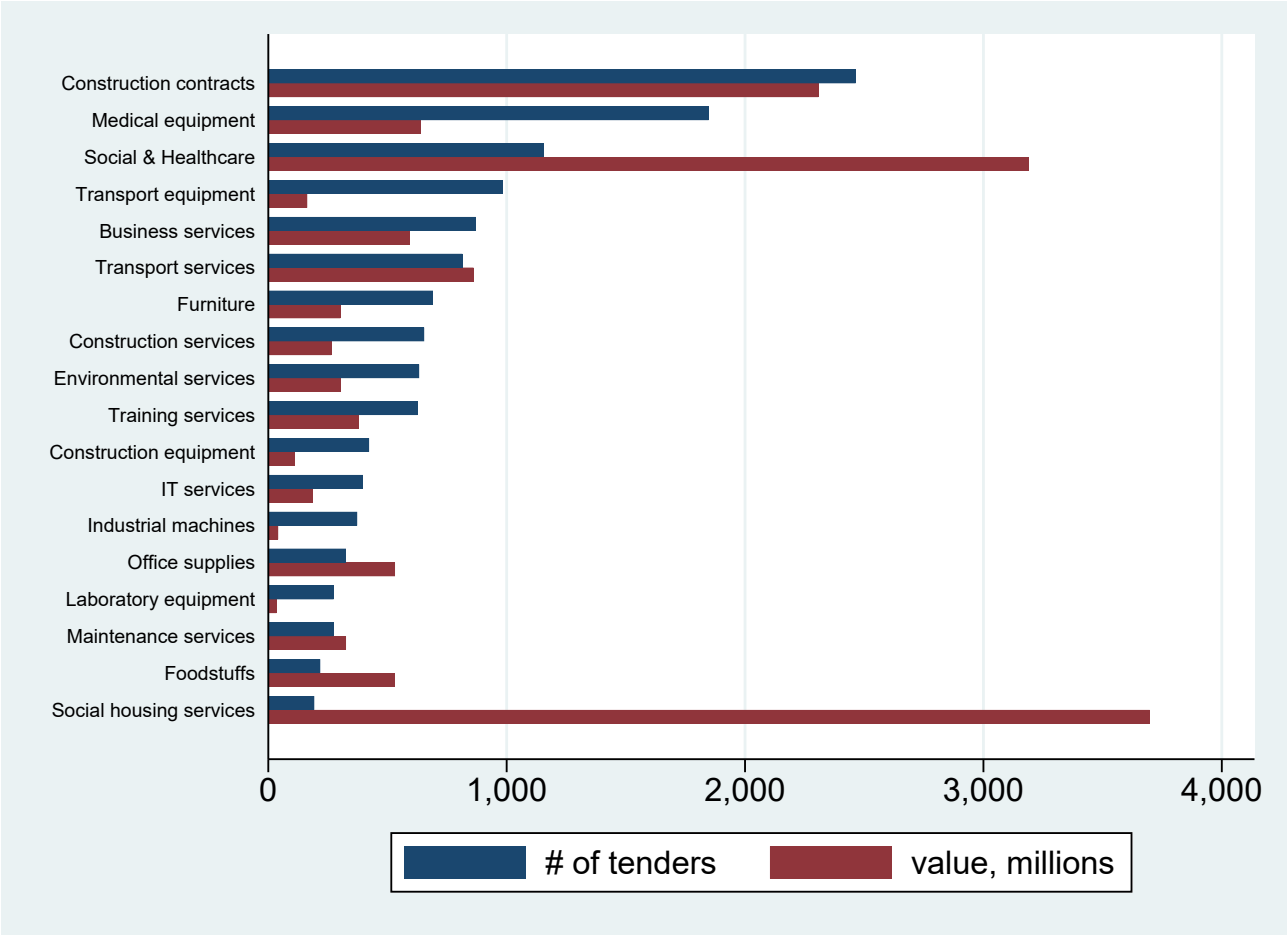

Figure 1: Number of invitations to tender and sum of their expected values.

Notes: Number of invitations to tender in our sample, presented for the commonly procuring industries. The sum of expected values is calculated using engineer estimates provided by the procurer. Engineer estimates are available for only 75% of the ITTs.

The descriptive statistics on the invitations to tender and the choices made by the procurer are presented in Table 1. The most costly tenders are in the social and health care sector where the median expected cost of procurement is 680 000 euro, about three times the amount in the construction sector, which ranks second at 230 000 euro. Social and health care ITTs have the highest share of partial procurement at 45%. Scoring is most common in the Goods category. Procurer size is measured as the expected value of tenders invited by the given procurer in the year 2016. The procurer size distributions do not vary much across the four industries. However, there are larger differences between procurer size when we compare various public sector branches to each other. Central government procurers are the largest, and municipalities and health care districts the smallest.

To understand how representative our data are of the entire Finnish public procurement scene, we complement and cross-reference our data with Hilma, which contains all Finnish public procurement, but lacks the detailed information that our data contain. In the left-hand graph in Figure 2, we show that the distribution of the count of ITTs across industries is fairly similar in Hilma and our sample. Depending on the industry, our sample covers 7 - 25% of all procurement in 2010 - 2017. Our data get richer in later years, roughly doubling the share of procurement covered by the year 2016 with the most representative industries reaching 50% coverage (see Table 13 in the Appendix). A comparison provided in the right-hand graph in Figure 2 shows that the representation of industries in the year 2016 is quite similar to earlier years, implying that the sample is representative across industries. The reason for this was explained to us by Cloudia, who state that typically they get all or most of the PP run by a municipality or other government body, or none at all. Thus the sample is representative across industries but some municipalities are missing completely from the data. Based on Table 14 in the Appendix, there is some selection based on the use of the scoring rule, but the data sets appear to be balanced on the expected cost of procurement.

Table 1: Descriptive statistics on procurers and ITTs

Panel A					
		Size of procurer	Est. cost	Partial	Scoring
Construction	mean	129,032	808.89	0.14	0.23
	se(mean)	2,848	39.44	0.01	0.01
	median	54,260	245		
Goods	mean	151,579	616.02	0.31	0.57
	se(mean)	2,507	42.42	0.01	0.01
	median	64,532	100		
Services	mean	209,734	1,094.41	0.26	0.52
	se(mean)	3,582	71.87	0.01	0.01
	median	91,599	150		
Social & Health care	mean	176,624	5,223.49	0.45	0.38
	se(mean)	6,007	532.70	0.01	0.02
	median	68,493	680		
Panel B					
		Size of procurer	Est. cost	Partial	Scoring
Government	mean	281,999	3,073.00	0.18	0.61
	se(mean)	6,735	297.34	0.01	0.01
	median	283,572	220		
Health care districts	mean	76,910	736.85	0.32	0.66
	se(mean)	2,639	72.15	0.01	0.01
	median	37,980	120		
Joint municipalities	mean	147,395	1,967.80	0.34	0.42
	se(mean)	1,769	309.86	0.01	0.01
	median	200,552	150		
Municipalities	mean	149,961	1,160.15	0.25	0.43
	se(mean)	1,869	67.62	0	0.01
	median	51,985	160		

Notes: Descriptive statistics are categorized by industry in panel A and by procurer type in Panel B. Size of procurer is calculated by taking a sum of engineer estimates for all ITTs of a procurer in the latest full year (2016). Estimated cost is an engineer estimate announced by the procurer when posting an ITT. Estimated cost is available for approximately 70% of ITTs. Partial refers to share of ITTs that were split into smaller, separately awarded contracts. Scoring refers to share of ITTs which were awarded using a scoring rule. Both size and estimated costs are reported in thousands of euro. Unit is ITT.

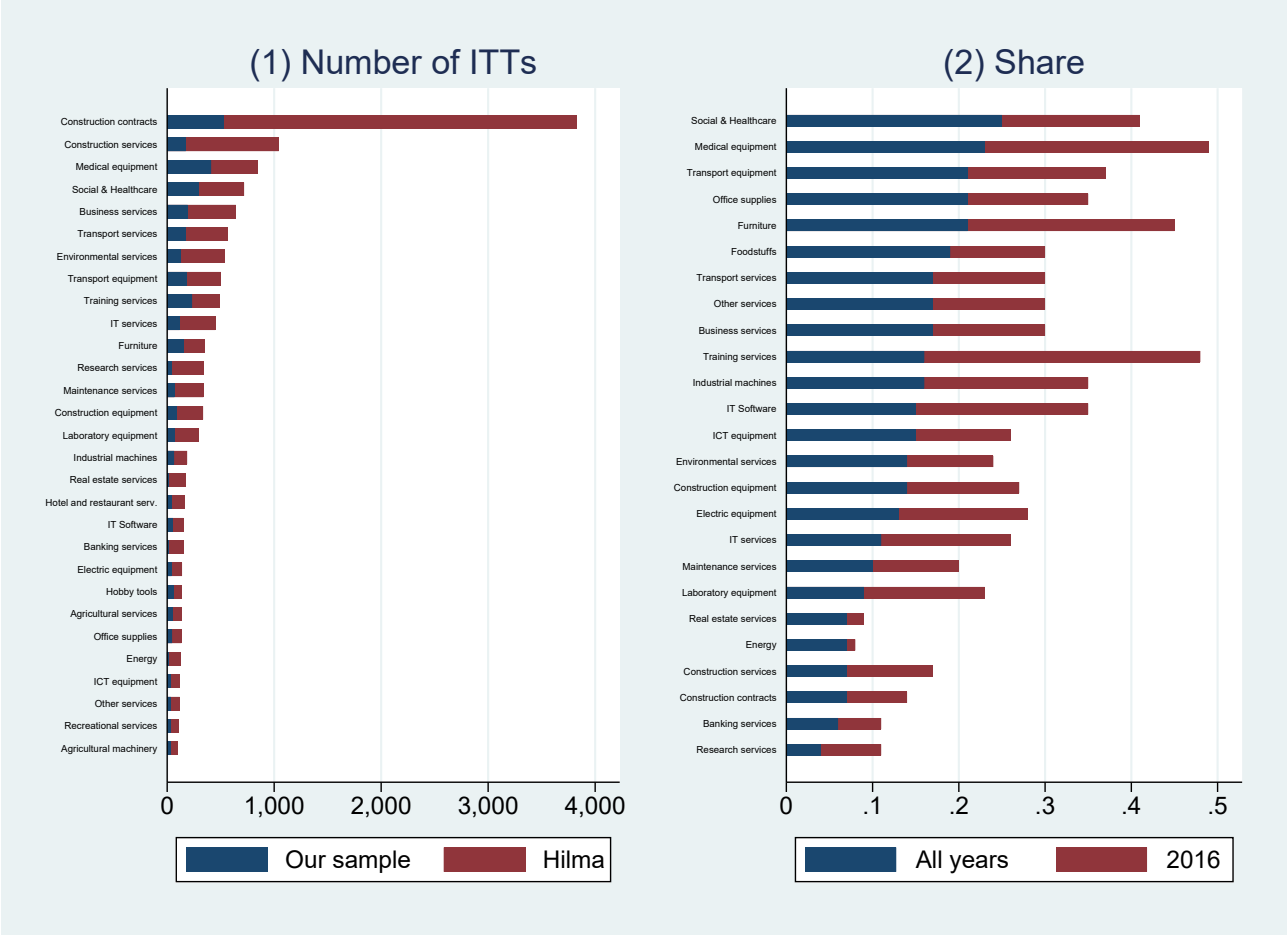

Figure 2: Comparison of our sample to Hilma database

Notes: Graph (1) presents the number of invitations to tender in our sample and the Hilma database in the year 2016. Graph (2) presents the share of our sample compared to all public procurement in Finland in the whole sample period and its most representative year (2016). Hilma contains information on all public procurement in Finland. Categories are based on the CPV classification.

2.5 Comparison with related studies

In Table 2, we survey recent studies using somewhat similar large public procurement databases as we do. We describe the country in question, the auction mechanisms applied, the industries and procurers that the data contain, and which bids the data have information on. We also document that none of these data have information on the number of potential bidders (N) or their characteristics. In addition to this limitation, these data sets have other limitations relative to our case to a varying degree. For some (but not all) parts, the analysis we provide cannot be replicated with these other existing comprehensive data sets, at least at the moment.

Table 2: Survey of public procurement datasets from related studies

Related papers	Country	Mechanism	Industry	Procurer	Bids	Registrations
Baltrunaite 2018	Lithuania	first price	all	whole public sector	all	no
Best et al. 2018, Vitalijs 2017	Russia	descending auction	all	whole public sector	all	no
Giuffrida & Rovigatti 2018, Decarolis et al. 2018, Liebman & Mahoney 2017	U.S.	several	all	federal	winning	no
Gugler et al. 2015	Austria	first price	construction	federal and regional	all	no
Coviello & Gagliarducci 2017	Italy	avg. bid mechanism	all	municipal	winning	no
Ferraz et al. 2016	Brazil	candle auction	all	federal	all	no
Baranek & Titl 2018, Palguta & Pertold 2017	Czech Republic	first price	all	national and regional	winning	no
Lee 2017, Schoenherr 2018	Korea	avg. bid mechanism	all	government	all	no
Straub 2018	Paraguay	several	all	whole public sector	winning	no
Lewis-Faupel et al. 2016	India, Indonesia	several	construction	states and provinces	winning	no

3 Competition

The key practical concern in the public procurement regime in Finland and elsewhere is whether there will be enough bidders in public procurement contract awards. Attracting enough competition also seems to be the central ingredient from both an academic and an intuitive perspective in making public procurement auctions work in getting high-quality goods and services at reasonable prices (Bulow & Klemperer 1996, Klemperer 2000). The first analysis in this section concerns the extent of competition in Finnish PP overall.

The second analysis in this section concerns how competition affects prices. The standard (auction theory) competition argument ("competition effect") predicts that an increase in competition, i.e. a higher number of actual bidders (denoted with n), leads to lower prices (and/or higher quality) in PP. This is because more aggressive bidding is needed to win with more intense competition. However, auction theory (and evidence) also argues that competition may sometimes have the opposite effect. In common-value PP auctions, the winner is the bidder who has estimated the production costs to be lowest (even if costs are the same for all bidders). Thus the winner may suffer from the winner's curse as the real production costs are higher than the winner thought. This underestimation becomes more severe as the number of bidders increases. Rational bidders account for this and bid less aggressively as competition increases. This is called the "Common values effect" (Bulow et al. 1999, Hong & Shum 2002). A similar winner's curse may arise in affiliated values auctions where the bidder with the lowest signal on the costs (i.e. the winner) also believes that the other bidders have very low signals, and thus assumes that a lower bid is needed to win that they would assume without the updating of their beliefs resulting from affiliation. A rational bidder who accounts for this bids less conservatively the more competition there is. This is called the "Affiliation effect" (Pinkse & Tan 2005, Hubbard et al. 2012). An "Entry effect" (Li & Zheng 2009) means that the higher the number of potential bidders (denoted with N), the less profitable it is to enter due to the more intense competition, and thus it does not make sense to pay the entry costs. Thus an increase in N may lead to a decrease in n. Due to these concerns, it is an empirical question whether competition has the desired effects. It may also be the case that the effects are nonlinear and the relationship may even reverse at some point. Moreover, the effects of competition are likely to vary case-by-case.

Estimating the effect of competition on prices is tricky, e.g. due to variables being omitted

and the selection of bidders via entry. In the auction literature, this is typically addressed with structural models (or experimental designs in the lab). However, the scope of our paper is descriptive. We try to address these issues to some extent through measurement and by providing different types of analyses for which the methodological issues differ.

First, we use $\frac{\text{Runner-up bid}-\text{lowest bid}}{\text{Runner-up bid}}$ = Win margin (available for all auctions with n>1) as one key measure. The second measure is Expected price ("engineer estimate") - Realized price[8]. These scalings partially address the omitted variables issues (contract heterogeneity) by differencing across bidders within the same auction, but may involve some other issues such as the win margin and n having a mechanical relationship.[9] We correlate these measures with n and N (potential bidders). Using both n and N partially addresses the selection issue. However, e.g. collusion may still be an issue. For example, if bidders submit phony bids, then the observed n is upward-biased from the real level of competition. N and n are also somewhat limited in information content if bidders are very asymmetric.

First, we analyze the extent of competition. In the left half of the Table 3, we describe the data at the ITT level and report the share of ITTs that have a given number of distinct actual bidders (unique actual bidder identities across all the auctions within the ITT), distinct actual bidders conditional on there being at least one, and registrations for the ITT. In the right half of Table 3, we describe the data at the auction level. We report the shares of ITTs within a given bracket as the average number of bidders across the auctions within the ITT, both unconditionally and conditionally on there being at least one actual bidder. The difference between the ITT level and the auction level is potentially relevant as one ITT can contain many auctions in which different bidders participate.

As reported in Table 3, 31% of ITTs have no actual bidders (first row of column 2). This is mainly due to the lack of entry of potential bidders as only 5.7% of ITTs have no potential bidders (first row of column 4). 15.6% of tenders have only one actual bidder (row 2, column 2) and 14.2% only two (row 3, column 2). Less than 10% of ITTs have more than 6 bidders. A similar picture emerges when we look at the actual auction level within the ITTs, where the

[8]Expected price is available for about 75% of ITTs, whereas realized price is available only for about 3% of ITTs. The reason is that where bids are in unit prices we do not often observe the respective quantities of those units. Overall, this measure is thus available only for 3% of ITTs.

[9]The more draws are taken from a continuous distribution, the smaller the expected difference between the smallest and the second smallest value gets.

Table 3: Shares of ITTs with a given number of actual or potential bidders

ITT level				Auction level		
count	bidders (n)	bidders (n>0)	registrations (N)	count bracket	bids	bids (n>0)
0	30.66%		5.64%	0 - 0.99	35.85%	7.43%
1	15.50%	22.37%	9.43%	1 - 1.99	17.01%	24.54%
2	14.27%	20.56%	9.26%	2 - 2.99	15.25%	22.01%
3	11.31%	16.30%	10.71%	3 - 3.99	11.36%	16.40%
4	8.17%	11.79%	10.18%	4 - 4.99	7.07%	10.20%
5	5.28%	7.62%	8.95%	5 - 5.99	4.40%	6.34%
6	3.70%	5.34%	7.47%	6 - 6.99	2.78%	4.01%
7	2.37%	3.42%	6.26%	7 - 7.99	1.80%	2.60%
8	1.81%	2.61%	5.23%	8 - 8.99	1.16%	1.67%
9	1.35%	1.94%	4.20%	9 - 9.99	0.74%	1.07%
10+	5.58%	8.04%	22.68%	10 -	2.58%	3.72%
obs	19467	13491	19467	obs	19467	13491

Notes: The left side of the table presents the shares of invitations to tender with the distinct number of actual bidders and registrations (potential bidders) respectively at the ITT level. Bidders are calculated as the number of distinct actual bidders in an ITT who have submitted at least one bid. The shares of ITTs are reported separately for ITTs with at least one bidder. The right half of the table presents the shares of ITTs at the auction level with average numbers of distinct bids per auction in an ITT. These bids are calculated first for each auction with the ITT, then averaged over the ITT, and then categorized into brackets. There are some ITTs where the average number of bids is lower than one even though the number of bidders is one or more, because there can be auctions where a bidder has not bid.

real competition takes place (rows 6 and 7 in Table 3).

Levels of competition seem to be low across all industries and procurers as shown in Table 4. The median of distinct actual bidders per auction is only two across all industries. The median is also two across other procurers than government where it is only one. It is interesting that municipalities can attract on average (or median) at least as much competition, and often more, than any of the other (bigger) administrative units based on all the five competition measures in Table 4. This indirectly and tentatively implies that small rural municipalities may not be the key concern in terms of lack of competition, but perhaps rather overly large and cumbersome contracts.

Table 4: Mean and median distinct bidders, avg. bids in auctions, registrations and win margin

Panel A		bidders	bidders n>0	bids	bids n>0	registrations	win margin
Construction	mean	3.32	5.21	2.73	4.28	7.89	0.32
	median	2	4	2	3.81	6	0.15
	obs	3,541	2,256	3,541	2,256	3,541	1,942
Goods	mean	2.59	3.55	1.93	2.65	6.34	0.38
	median	2	3	1.60	2	5	0.21
	obs	6,413	4,665	6,413	4,665	6,413	3,542
Services	mean	3.31	4.95	2.41	3.61	8.69	0.51
	median	2	3	1.67	3	6	0.28
	obs	4,955	3,305	4,955	3,305	4,955	2,714
Social and health care	mean	5.61	8.07	3.34	4.81	11.32	0.41
	median	2	3	1.40	2.50	6	0.17
	obs	1,349	938	1,349	938	1,349	742
Panel B		bidders	bidders n>0	bids	bids n>0	registrations	win margin
Government	mean	2.94	5.06	1.90	3.27	9.25	0.42
	median	1	3	1	2	4	0.17
	obs	2,021	1,175	2,021	1,175	2,021	824
Health care districts	mean	2.59	3.85	1.85	2.76	5.94	0.39
	median	2	3	1	2	4	0.21
	obs	1,969	1,323	1,969	1,323	1,969	987
Joint municipalities	mean	2.84	4.41	1.95	3.03	7.58	0.44
	median	2	3	1.20	2.40	5	0.23
	obs	2,133	1,374	2,133	1,374	2,133	1,124
Municipalities	mean	3.21	4.44	2.43	3.37	7.35	0.42
	median	2	3	1.93	2.66	5	0.21
	obs	13,344	9,619	13,344	9,619	13,344	7,438

Notes: Panel A presents statistics by industry and panel B presents them by procurer. Registrations (potential bidders) depict the number of distinct firms registered for an ITT. Bidders are calculated as the number of distinct actual bidders in an ITT who have submitted at least one bid. Bids and win margin are calculated first for each auction, then averaged for the ITT, and then for the industry. Bidder and bid statistics are also calculated for the whole sample as well as separately for ITTs with at least one bidder. The unit of observation is ITT.

Second, we analyze the correlation between our standardized price measures and the level of competition. The pattern of results shown in Figure 3 (see also Table 15 in the appendix) and Table 5 suggests that by and large competition is desirable for procurers as it decreases

the win margin. However, the relationship between win margin and n and N is not monotonic. This is consistent with case studies (structural econometrics of single industries) showing non-monotonicity due to the common values effect, the affiliation effect or the entry effect. Moreover, the relationship is nonlinear as the relationship flattens after about six actual bidders. This nonlinearity is further confirmed in Table 6, where the quadratic relationship between win margin and n (*bids*) is very robust to adding various control variables and fixed effects. This implies that six actual bidders seem to be "enough" competition to achieve about as narrow win margins as feasible.

Table 7 shows that the difference between the expected and realized price also gets larger (expected prices are overestimated more) as the number of bidders increases, providing further support that higher levels of competition are desirable. Therefore, it seems that the vast majority of Finnish PP would benefit from more actual (and potential) bidders.

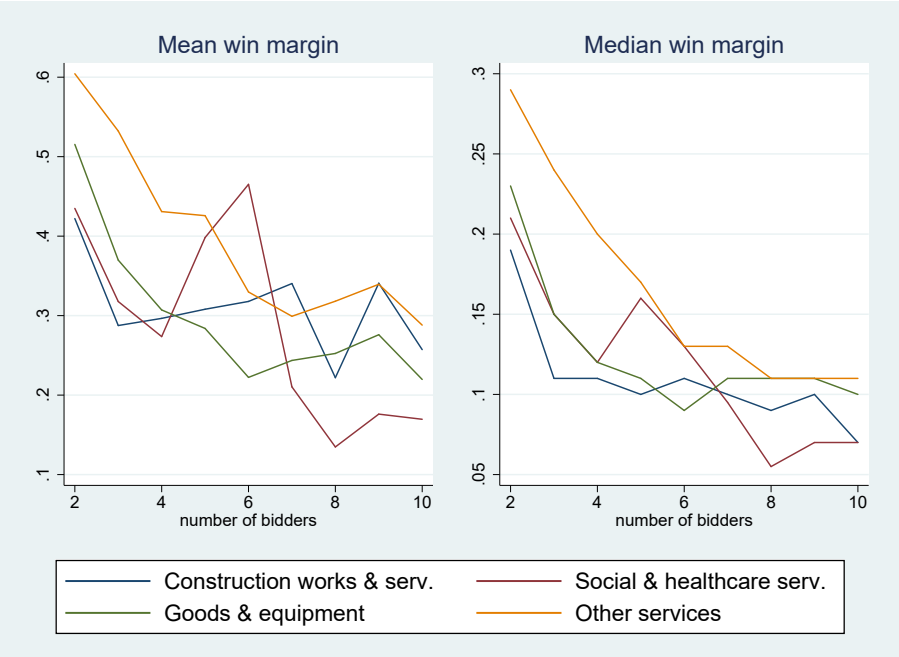

Figure 3: Mean and median win margins

Notes: Win margins are graphed as a function of the number of bidders. Graphs are presented by industry. Number of bidders is right-censored at 10.

Table 5: Win margin for number of bidders (n) and registrations (N)

count	win margin by n			win margin by N		
	obs	mean	median	obs	mean	median
2	33,936	0.84	0.25	3,766	0.74	0.20
		(3.34)			(2.89)	
3	32,937	0.55	0.17	6,613	0.53	0.18
		(2.11)			(1.87)	
4	22,510	0.50	0.13	8,753	0.66	0.15
		(2.90)			(3.05)	
5	14,530	0.51	0.12	9,847	0.48	0.18
		(2.72)			(1.44)	
6	8,698	0.29	0.09	10,676	0.52	0.18
		(1.17)			(1.74)	
7	5,528	0.30	0.10	9,659	0.51	0.16
		(1.60)			(2.20)	
8	3,569	0.34	0.10	12,666	0.49	0.12
		(1.65)			(2.16)	
9	2,575	0.33	0.09	8,050	0.57	0.16
		(1.60)			(2.58)	
10+	9,443	0.30	0.07	61,041	0.53	0.14
		(1.69)			(2.71)	

Notes: Win margin is calculated as the percentage difference between the lowest and the second lowest bid. Number of registered firms in an auction is extrapolated using the number of registered bidders in an ITT. Standard deviation reported in parenthesis below mean. The unit of observation is auction.

Table 6: Quantile regressions on win margin

	(1)	(2)	(3)	(4)
Bids	-0.0120***	-0.0104***	-0.0123***	-0.0124***
	(0.000285)	(0.000335)	(0.000402)	(0.000403)
$Bids^2$	0.000156***	0.0000778***	0.0000887***	0.0000889***
	(0.00000266)	(0.00000283)	(0.00000322)	(0.00000322)
Scoring		0	-0.00588**	-0.00787***
		(0.00177)	(0.00213)	(0.00229)
Partial bids allowed		-0.0192***	0.000900	-0.00127
		(0.00175)	(0.00223)	(0.00226)
Healthcare district				-0.0102
				(0.00735)
Joint municipalities				-0.00118
				(0.00683)
Municipalities				0.0138*
				(0.00624)
Constant	0.205***	0.210***	0.146***	0.136***
	(0.00139)	(0.00196)	(0.00709)	(0.0130)
Observations	138588	114240	110050	110050
Industry FE	No	No	Yes	Yes
Month FE	No	No	No	Yes
Year FE	No	No	No	Yes

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Quantile regression is used to combat excessive outliers in the data. 2-digit CPV classification is used for industry fixed effects. Government is used as the baseline procurer. Standard errors clustered at industry level. The unit of observation is auction.

Table 7: Mean and median percentage difference in estimated and realized costs

	Cost difference by bids			Cost difference by registrations		
bids	obs	mean	median	obs	mean	median
1	153	0.24	0.18	82	0.22	0.20
		(0.21)			(0.18)	
2	134	0.29	0.22	85	0.28	0.23
		(0.24)			(0.22)	
3	69	0.34	0.27	83	0.28	0.20
		(0.24)			(0.24)	
4	37	0.36	0.34	54	0.25	0.17
		(0.29)			(0.23)	
5+	50	0.48	0.51	139	0.41	0.36
		(0.27)			(0.28)	

Notes: Differences are presented only for procurement in the goods category where the quantities procured are known. Realized cost is calculated using data on bids and the amounts procured. Due to scarcity in data the sample size is small. Standard deviations are reported in parentheses below the mean. The unit of observation is ITT.

4 Entry

In this section, we turn to analyzing entry decisions. The main goal is to analyze why the levels of competition are so low. What are the possible obstacles to attracting more potential bidders and getting potential bidders to actually bid? The key policy design questions are whether more competition can be attracted by means of contract design or by decreasing entry costs.

We analyze entry by looking at how n and N relate to each other. In particular, we analyze n/N. This measures the share of actual bidders among the potential bidders. We correlate this measure with n. We also study whether this correlation varies across industries or whether we can predict it in other ways. Theoretically, the analysis will also potentially help to understand whether entry should be seriously accounted for when modeling PP and designing policy.

First, in Table 8, we give the means and medians of the potential and actual bidders at the ITT level, as well as actual bids per auction within an ITT conditional on whether the auction mechanism is scoring or not, and partial or not. Both of these are design features that the procurer could feasibly adjust in many cases. The use of a scoring auction is correlated with slightly less competition based on all measures, but the differences are small. For the partial or not comparison, the relevant measure is actual bids per auction in the middle column as the other measures differ due to mechanical reason that in partial ITTs there are always more auctions. Partial ITTs attract slightly more bids per auction on average, but nonetheless have higher win margins. While both these correlations are suggestive of auction rules possibly influencing the amount of competition, we should not base policy implications on such simple correlations.

Second, in Table 9 we analyze entry patterns by regressing n (at both the ITT and auction level), N and n/N on the ITT characteristics of using scoring and partial mechanisms, and ITT size in estimated value while controlling for industry, region and year fixed effects. The observed auction characteristics seem not to be very successful overall in predicting competition and entry. Partial mechanism is a significant predictor only for the ITT level n and N, but that is likely just mechanical, whereas it is not significant at its relevant column of auction level n. Scoring is not a statistically significant predictor of any outcome. ITT size shows some interesting patterns. Larger contracts have more potential bidders, but they bid less often as ITT size negatively predicts n/N. The resulting actual number of bidders remains roughly unaffected. However, the size effects are fairly small in magnitude as the unit is in million

Table 8: Differences in competition for ITTs with and without scoring rule and ITTs with and without partial procurement

		bidders	bidders n>0	bids	bids n>0	registrations	win margin
No scoring	mean	3.33	4.72	2.49	3.53	7.93	0.40
	median	2	3	2	3	6	0.21
	obs	9,269	6,543	9,269	6,543	9,269	5,295
Scoring	mean	2.88	4.40	2.09	3.21	7.14	0.41
	median	2	3	1	2.18	5	0.21
	obs	7,170	4,679	7,170	4,679	7,170	3,599
No partial	mean	2.27	3.34	2.13	3.14	5.66	0.42
	median	2	3	1	2	4	0.20
	obs	14,356	9,738	14,356	9,738	14,356	7,316
Partial	mean	5.35	7.28	2.64	3.60	12.40	0.43
	median	3	4	1.71	2.57	8	0.24
	obs	5,111	3,753	5,111	3,753	5,111	3,057

Notes: Scoring refers to ITTs which were awarded using a scoring rule. Partial refers to ITTs that were split into smaller, separately awarded contracts. Bids and win margins are calculated first for each auction, then averaged for the ITT. Bidder and bid statistics are also calculated and presented separately for ITTs with at least one bidder. The unit of observation is ITT.

euro and typically the contracts are much smaller (median estimated value is 0.157 million euro), implying that adjusting size is of limited practical relevance for affecting competition. Overall, these results suggest that the contract or auction design can be of only limited help in increasing competition. However, we look at a fairly limited set of contract characteristics as we have no information on e.g. quality requirements. Moreover, this analysis does not yet account for bidder characteristics. Nonetheless, a more fruitful avenue may be to alleviate the issues related to the lack of competition rather than trying to affect competition levels directly. Reservation prices offer a standard solution to limiting the adverse price effects resulting from a lack of competition.

In Figure 4, we report 95% confidence intervals for the mean and median of n/N for each n. In the information acquisition model of Levin & Smith (1994), bidders have to pay an entry cost to acquire information about their production costs. This results in mixed strategy equilibrium, where the entry probabilities decrease as N increases. This is because entry is profitable in expectation only for a limited number of actual bidders and this number is independent of N,

Table 9: OLS regressions on number of registered firms (N), number of bidders (n) and share of bidders to registered firms (n/N)

Dependent variable	N		n (ITT)		n (auction)	n/N	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Scoring	0.701	0.554	-0.213	-0.182	-0.2226	-0.00267	-0.00398
	(0.416)	(0.391)	(0.275)	(0.275)	(0.1442)	(0.00883)	(0.00955)
Partial bids allowed	6.429***	5.854***	2.890***	2.830***	0.272	-0.0219	-0.0154
	(0.970)	(0.931)	(0.560)	(0.582)	(0.150)	(0.0202)	(0.0202)
Estimated value		0.730*		0.125			-0.00253*
		(0.340)		(0.118)			(0.00124)
Estimated value^2		-0.00154		-0.0000153			-0.00000774*
		(0.000852)		(0.000266)			(0.00000327)
Constant	10.97**	6.283***	3.115**	1.580*	4.789	0.440***	0.475***
	(3.485)	(1.212)	(1.140)	(0.596)	(1.324)	(0.0264)	(0.0326)
Observations	13708	11750	13708	11750	86591	10157	8798
R^2	0.20	0.27	0.10	0.12	0.11	0.08	0.09
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Regressions were run on the number of bidders (n) for the ITT and auction level respectively. 2-digit CPV classification is used for industry fixed effects. Municipalities are used for area fixed effects. For joint municipalities and health care districts, region is used instead. Estimated value is available for 70% of ITTs. Estimated value is in million euro. Standard errors are clustered at the industry level. The unit of observation is ITT except for regression (5) where the unit is auction.

and rather depends on the entry costs and expected profits (that depend on n). Therefore, n is independent of N, and thus n/N increases in n. Moreover, the relation increases more steeply for smaller compared to large values of n. This is exactly what we see in Figure 4. The mixed strategy equilibrium also implies that some or even fairly many auctions may have zero or only one bidder, even if there would have been more potential entrants for whom it would have been ex-post profitable to enter. This is also consistent with our data even though this is indirect evidence as we do not observe profitability.

In contrast, the bid preparation costs model of Samuelson (1985) is less consistent with the evidence. In this model, bidders know their production costs, but have to pay a bid preparation cost or entry fee to enter. All bidders with production costs below a certain threshold enter. The threshold depends on the entry costs and expected profits (which depend on n). As N increases, more bidders have valuations below the threshold, and thus n increases. This means that unlike in the Levin & Smith (1994) model, n is not independent of N, but rather they

are positively correlated. This would lead to a relatively constant relationship between n/N in n. However, in this situation, the entry threshold in production costs may be adjusted with N if N is common knowledge, because that may influence the expected profits of entry via n. This mechanism could possibly also lead to an increasing n/N in n, and thus, makes it complicated to infer the entry paradigm based solely on the relationship between n/N in n. However, the key difference with an information acquisition model is that here entry is selective as only bidders with the lowest costs enter. This implies that bidder characteristics should be predictive in the margin where potential bidders decide to submit a bid. We study this below in reduced form. A more rigorous structural test of the entry paradigm using this idea is provided by Marmer et al. (2013), but implementing that is beyond the descriptive scope of our paper and is more suitable to case studies.

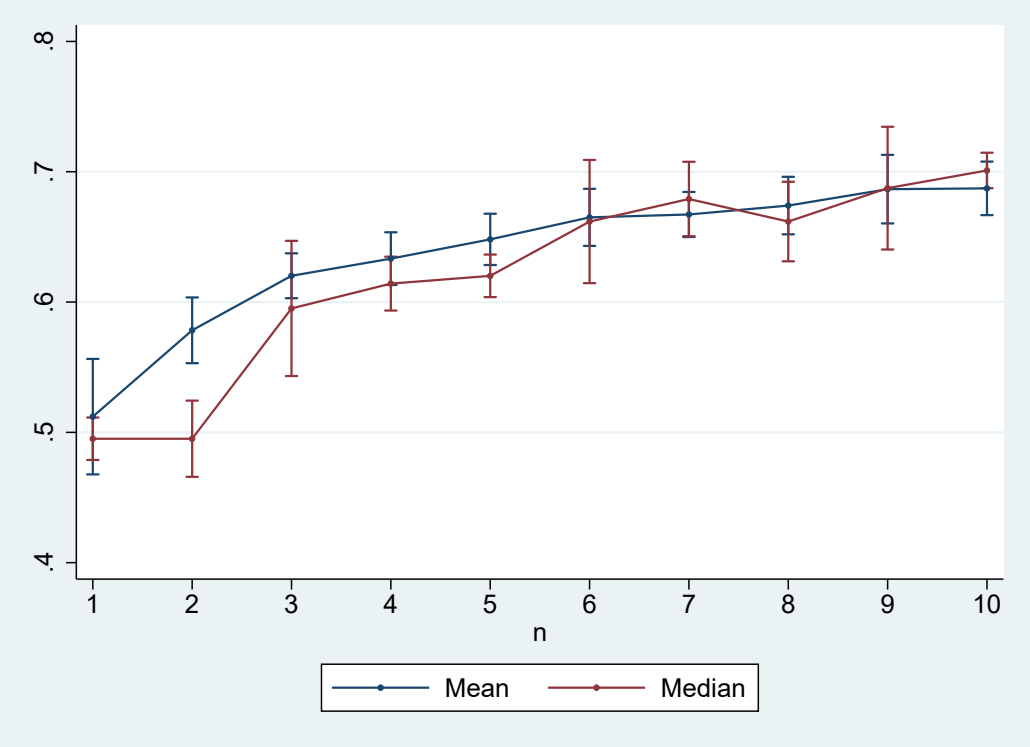

Figure 4: 95 % confidence intervals of mean and median n/N by n

Notes: Means and medians are obtained by regressing n/N on dummies for different n. We control for industry, municipality and time fixed effects as well as the procurement method. Standard errors are clustered at the 2-digit CPV category level.

This analysis can also be informative for understanding what assumptions we should make about the theoretical relationship $n = f(N)$, when N is unobserved. This is important for informing theoretical models and conducting structural auction econometrics, because the equilibrium behavior that identifies those models is typically based on the often unobserved N

(rather than the often observed n), or the expectation of N. In structural models, the researcher needs to assume the relationship $N = g(n)$, i.e. how to use the observed information to impute the unobserved. Typical practical solutions include assuming $N = n$, $N = max(n_i)$, where i denotes an auction and the researcher observes many auctions with the same set of potential bidders, N equals the sum of unique bidder identities across a range of similar auctions, or $N = n + e$, where e is random. We also study whether the relationship between n and N varies across industries?

Entry is an important feature as there are systematically many more potential than actual bidders in our data. The relationship between n/N and n seems to vary somewhat across industries (Figure 5). While the patterns in the data are not detailed enough to warrant strong conclusions, they are the least at odds with the practical assumption that N equals the sum of unique bidders identities across a range of similar observed auctions. This is because the increasing relationship between n/N and n, and the rough consistency of the data with the information acquisition model with mixed strategy entry, implies that for a fixed N across many auctions, one would observe varying n with different identities of actual bidders across the auctions.

We also analyze whether bidder characteristics can predict entry at various stages. Here we first identify for each auction the most common 3-digit industry code among the potential bidders. We use this to pick from the FLEED data (see Section 2) all the firms that have that code as their main industry. We treat this sample as all the firms that are relevant (could have registered but did not necessarily register) for the given ITT. Thus, for each auction, we can describe the characteristics of all the relevant firms, potential bidders, actual bidders and the winners. In Table 10, we report the median turnover, number of employees and profit margin of the unregistered (but relevant) firms, potential (registered) bidders, actual bidders and the winners. In Table 11, we present the share of firms in these four categories that are registered for business in the location of the contract either at the municipality or the province level.

Based on Tables 10 and 11, most selection seems to take place at the registering stage rather than at the entry (into bidding) stage when it comes to firm size and profitability, which is also more in line with the information acquisition model than the entry fee model. However, the locality of the firm correlates with the selection at both the registering and bidding stages, and also with winning (other than in the social and health care sector). This pattern can be rationalized by local firms having both lower information acquisition and production costs.

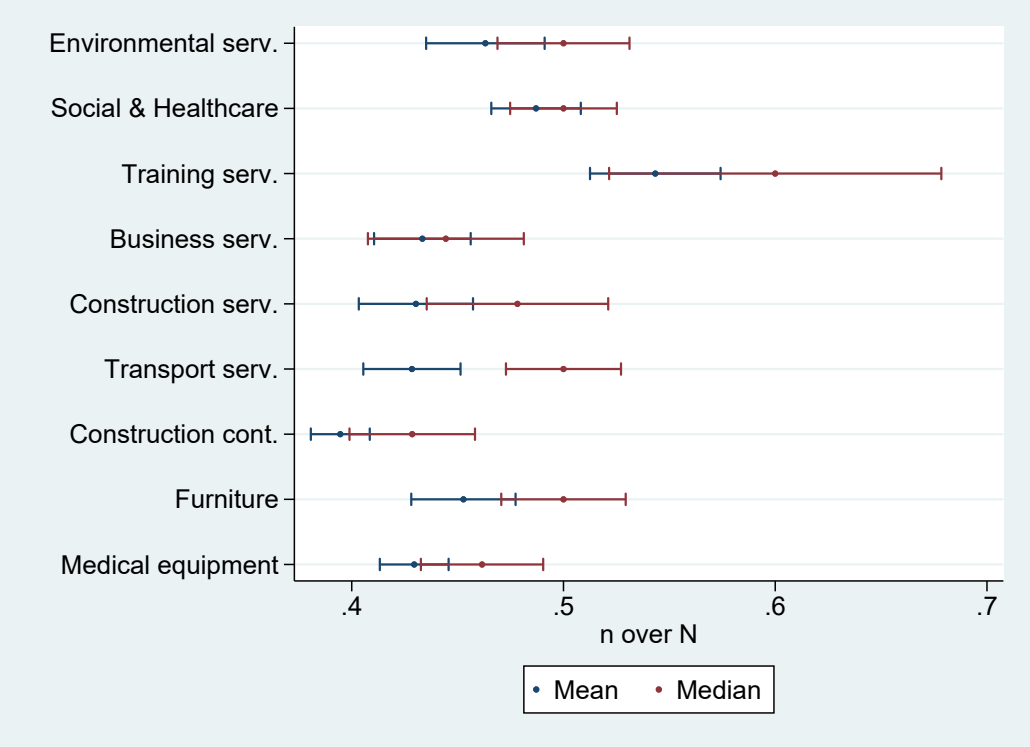

Figure 5: 95 % confidence intervals of mean and median n/N by industry

Notes: Means and medians are obtained by regressing n/N on industry dummies. We control for municipality and time fixed effects as well as the procurement method. Standard errors are clustered at the 2-digit CPV category level.

However, it seems unlikely that bid preparation costs (entry fees) vary based on locality.

Based on Table 12, the results are similar when the firm characteristics are analyzed simultaneously in the entry decision (bidding conditional on registering) regression. Locality correlates strongly with entry. Previous experience in bidding is also a strong predictor. Other firm characteristics have less predictive power. Another interesting result is that the use of scoring auctions seems to correlate with less entry (as long as fixed effects are included). This indicates that careful consideration between minimum quality requirements (or other tools such as sanctions) and scoring as alternative ways to attract quality could be in order.

Table 10: Median bidder turnover, employees and profit margin by industry

	median	unregistered	registered	bid	won
Construction	turnover	446	5,012	6,682	10,278
	employees	2.00	16.79	21.16	30.00
	profit margin	0.03	0.02	0.02	0.02
Goods	turnover	200	938	1,605	1,039
	employees	1.96	7.73	14.40	9.10
	profit margin	0.09	0.04	0.03	0.04
Social and healthcare	turnover	214	1,829	1,093	1,562
	employees	1.38	18.40	12.10	17.00
	profit margin	0.15	0.03	0.03	0.03
Other services	turnover	257	2,136	3,950	3,069
	employees	2.08	12.37	21.87	19.12
	profit margin	0.06	0.03	0.02	0.02

Notes: Median bidder turnover (in thousands of euro), employees and profit margin are presented for unregistered, registered, bidding and winning firms. Columns are mutually exclusive at the ITT level, meaning that a firm can only belong to one column for each ITT it has participated in. For partial tenders, a firm that has won is counted only in the "won" column while a firm that has bid but hasn't won is counted in the "bid" column. Observations are at the ITT level. Unregistered firms are gathered from the Statistics Finland database and matched to the respective ITTs using industry classifications. Firms with turnover below 100 000 euro are excluded from the unregistered firm pool. Observations are at the ITT level.

Table 11: Bidders' presence in procurer's municipality and province

	presence in	unregistered	registered	bid	won
Construction	municipality	0.02	0.13	0.18	0.21
	province	0.10	0.26	0.34	0.37
Goods	municipality	0.03	0.20	0.31	0.35
	province	0.12	0.40	0.52	0.55
Social and healthcare	municipality	0.03	0.24	0.36	0.22
	province	0.13	0.47	0.60	0.48
Other services	municipality	0.02	0.23	0.30	0.40
	province	0.12	0.53	0.62	0.69

Notes: Share of firms present in procurer's municipality and province for unregistered, registered, bidding and winning firms. Columns are mutually exclusive at the ITT level, meaning that a firm can only belong to one column for each ITT it has participated in. A firm that has won is counted only in the "won" column while a firm that has bid but hasn't won is counted in the "bid" column. For joint municipalities a bidder is counted as present in a municipality if it is present in any of the procurers' municipalities. For health care districts bidders' presence is counted only at the province level. Unregistered firms are gathered from a Statistics Finland database and matched to respective ITTs using industry classifications. Firms with turnover below 100 000 euro are excluded from the unregistered firm pool. Observations are at the ITT level.

Table 12: Logit and LPM regressions on bidding conditional on registration

	Logit		LPM	
Dep. var.: Bid conditional on registration	(1)	(2)	(3)	(4)
Bid in previous year	0.851***	0.739***	0.191***	0.159***
	(0.0698)	(0.0505)	(0.0113)	(0.00851)
Bid in previous year (same region and industry)	0.234***	0.255***	0.0578***	0.0611***
	(0.0379)	(0.0421)	(0.00963)	(0.0100)
Registered in previous year	-0.824***	-0.720***	-0.184***	-0.154***
	(0.0828)	(0.0606)	(0.0208)	(0.0138)
Present in same municipality	0.254***	0.256***	0.0615***	0.0603***
	(0.0406)	(0.0420)	(0.00988)	(0.00966)
Present in same province	0.180**	0.187***	0.0430**	0.0443***
	(0.0559)	(0.0486)	(0.0135)	(0.0112)
Backlog	0.0000197	0.0000159	0.00000451	0.00000417
	0.0000182	0.0000151	0.00000439	0.00000371
Backlog/Turnover	-0.0000403**	-0.0000144	-0.00000931**	-0.00000378
	(0.0000139)	(0.0000149)	(0.00000300)	(0.00000345)
Turnover	0.000112	0.000131	0.0000269	0.0000286
	(0.000197)	(0.000262)	(0.0000422e)	(0.0000541)
Turnover^2	-0.000000874	-0.00000104	-0.000000199	-0.000000222
	(0.000000997)	(0.00000118)	(0.000000183)	(0.000000210)
Tender value/Turnover	0.00000349	0.00000662	-0.000000552***	-0.000000362
	(0.0000118)	(0.00000961)	(0.00000538)	(0.000000209)
$(\text{Tender value/Turnover})^2$	-0.0000000000071	-0.00000000000941	-0.0000000000000152***	-0.0000000000000706
	(0.0000000000107)	(0.00000000000887)	(0.0000000000000299)	(0.000000000000114)
Employees	0.00398	0.00421	0.000940	0.000979
	(0.00211)	(0.00263)	(0.000484)	(0.000581)
Scoring	-0.173	-0.287**	-0.0409	-0.0655**
	(0.0957)	(0.0931)	(0.0228)	(0.0206)
Partial	0.222	0.171	0.0512*	0.0387
	(0.118)	(0.102)	(0.0243)	(0.0215)
Tender value	-0.0219	-0.0185	-0.00373	-0.00296
	(0.0273)	(0.0266)	(0.00221)	(0.00186)
Tender value^2	0.000112	0.0000875	0.00001211*	0.0000101*
	(0.000328)	(0.0000290)	(0.00000561)	(0.00000467)
Constant	-0.232	0.142	0.441***	0.528***
	(0.143)	(0.243)	(0.0335)	(0.0529)
Observations	67517	67457	67517	67470
Industry FE	No	Yes	No	Yes
Region FE	No	Yes	No	Yes
Year FE	No	Yes	No	Yes

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Specifications (1) - (2) use a logit and (3) - (4) use a linear probability model. Dependent variable is a dummy indicating whether a firm has bid in any auction in an ITT conditional on registering for the given ITT. Backlog, turnover and tender values are in million euro. Employees are in 100s. Backlog is calculated taking the sum of the values of tenders awarded to the firm in our data during one year prior to the observed ITT. Standard errors are clustered at the industry level. Observations are registered firm - ITT pairs.

5 Bidder asymmetry

Large asymmetries in productions costs between bidders also lead to less intense competition. Large asymmetries can work both as entry barriers (extensive margin) and also lead to less intense competition between the actual bidders (intensive margin).

In this section, we study to what extent bidders differ from each other in general and within auctions based on their observed characteristics. Of course, production costs are not observed. In Figure 6, we report the distribution of bidders by employee count to understand the overall heterogeneity in size. In Figure 7, we report the bidder distribution over within-ITT heterogeneity, measured as the maximum firm size divided by the mean firm size in employees within-ITT. We find that in general there is large heterogeneity in size between bidders, also within each auction. This should be accounted for when modeling public procurement auctions and conducting empirical analysis with public procurement data.

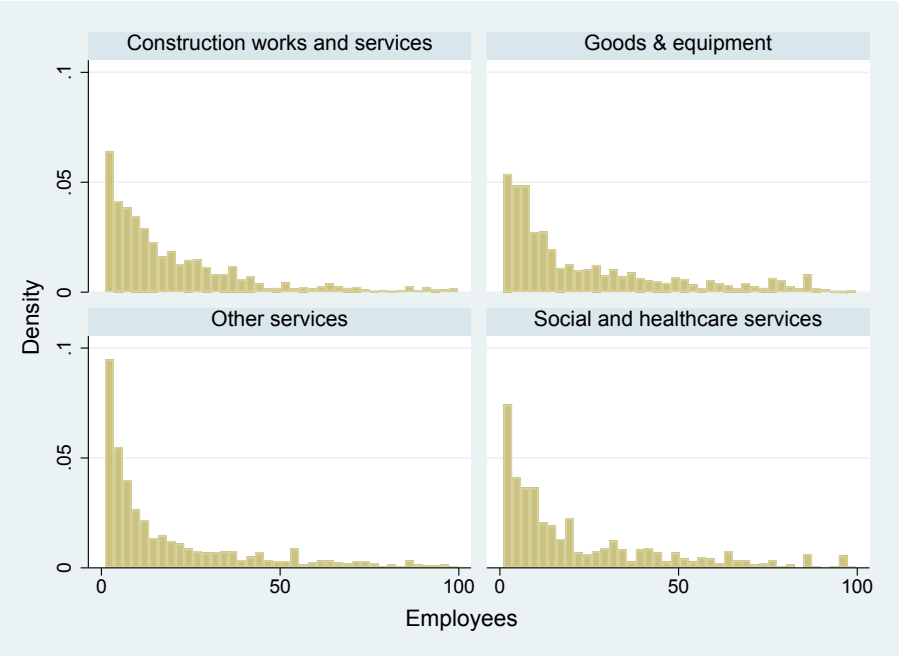

Figure 6: Distribution of bidders' employee count, by industry.

Notes: Bidders' employee counts are recorded as an average over the year the ITT took place. The unit of observation is bidder - ITT pair.

For the entry patterns, we saw that many small firms do not even register for auctions, and the analysis in this section shows that substantial asymmetries remain even after that selection. This suggests that perhaps the contract design should be tailored to attract more small firms. Also auction rules that favour smaller firms could intensify competition enough to offset the resulting inefficiencies. It also seems, based on Figure 8, that in general individual tenders are

not very important for bidders (but there is a long tail with very important tenders). One could therefore ask whether the bidding process is too cumbersome in that respect?

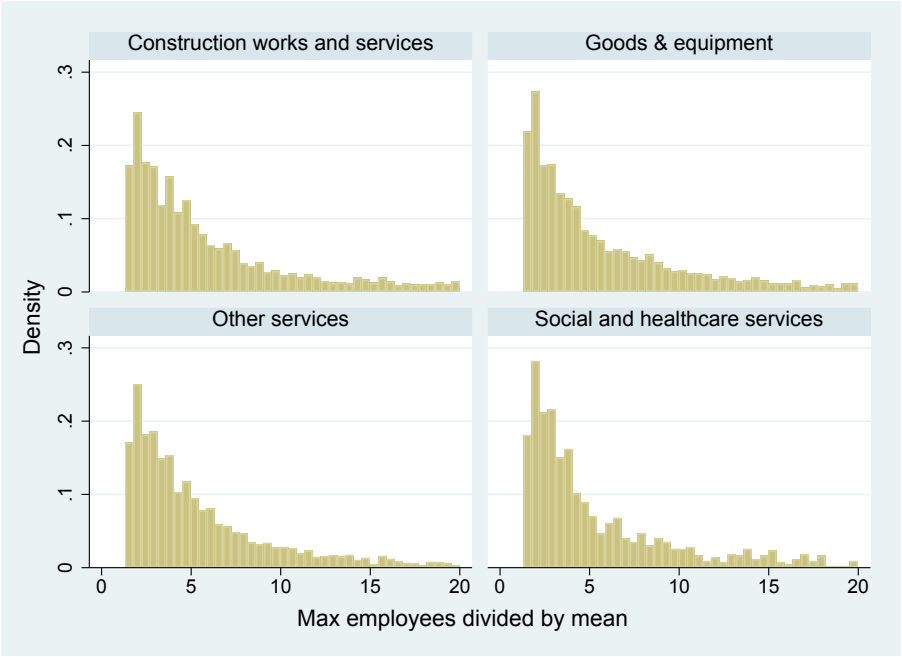

Figure 7: Distribution of bidder heterogeneity in employees

Notes: Bidder heterogeneity is calculated as maximum bidder employee count divided by mean bidder employee count for each invitation to tender. Bidders' employee counts are recorded as an average over the year the ITT took place. Distributions are truncated at 20. The unit of observation is bidder - ITT pair.

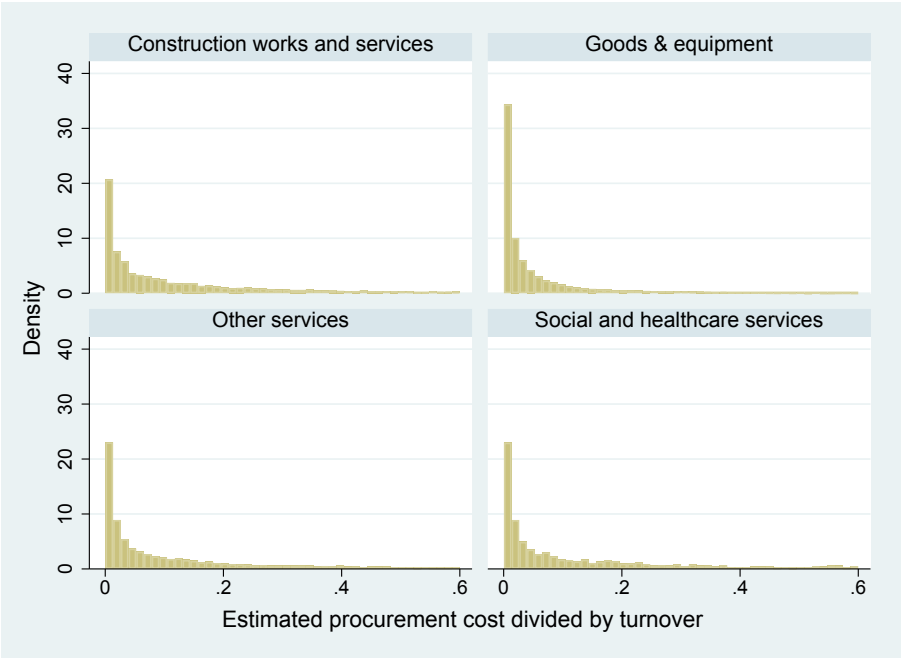

Figure 8: Distribution of procurement's significance to bidders.

Notes: A procurement's significance is calculated as the shares of the estimated procurement costs divided by bidder turnover. This is calculated for each bidder within each invitation to tender.

6 Conclusions

We use unique, comprehensive and rich data on Finnish public procurement to provide a set of stylized facts, some of which the previous literature has not been able to provide. First, we document a serious lack of competition in Finnish PP in general across all industries and procurers. This concern seems not to be limited to Finland as similar observations have been made elsewhere. For example, in Sweden more than half of public procurement contracts received between zero and three bids (Swedish Competition Authority 2017). Similar patterns are observed in Russian (Vitalijs 2017) and Lithuanian data (Baltrunaite 2018), and in the EU in general (European Commission 2017).

Second, the lack of competition is a problem as competition seems to have the desired price implications. Third, the lack of competition results both from potential entrants not actually bidding, but sometimes also from a lack of potential entrants. As such this calls for the contract design to make contracts more attractive and to decrease entry costs. It seems that the use of scoring auctions correlates with less entry, indicating one potential auction rule based remedy, at least if there are other feasible ways to contract for quality. Moreover, a careful scrutiny of optimal reservation prices to limit the adverse effects of competition is needed in any case. However, another consideration is that perhaps not all auctioneers want to engage in attracting more competition, but rather have their favoured producers. In some cases such discretion may be warranted and efficient, but can also be motivated by favoritism or corruption. We leave analysis of procurer motivations for further research.

Finally, the entry patterns in the data seem more consistent with information acquisition models of entry than bid preparation costs models, further implying that making bidding easier may not substantially increase competition. However, if the auctioneer can make it simpler for potential bidders to calculate their production costs, it could be possible to facilitate more competition.

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Online appendix

Table 13: Invitations to tender in our sample and Hilma database

	Whole sample			Year 2016		
CPV classification	Hilma	Our sample	Share	Hilma	Our sample	Share
Construction contracts	30887	2254	.07	3823	527	.14
Construction services	8931	623	.07	1043	174	.17
Medical equipment	7728	1802	.23	845	411	.49
Social & Health care	5067	1247	.25	719	296	.41
Transport services	4755	797	.17	567	172	.30
Business services	4635	794	.17	643	191	.30
Environmental services	4194	602	.14	534	128	.24
Transport equipment	4113	847	.21	503	184	.37
Training services	3833	595	.16	488	233	.48
Research services	3575	147	.04	344	39	.11
IT services	3420	388	.11	449	116	.26
Furniture	3142	661	.21	346	155	.45
Construction equipment	2908	400	.14	336	92	.27
Laboratory equipment	2686	254	.09	291	68	.23
Maintenance services	2649	258	.10	338	67	.20
Industrial machines	2103	332	.16	187	65	.35
Office supplies	1479	304	.21	132	46	.35
Real estate services	1433	106	.07	173	16	.09
Electric equipment	1379	185	.13	139	39	.28
IT Software	1245	185	.15	153	54	.35
ICT equipment	1202	175	.15	120	31	.26
Banking services	1193	77	.06	151	16	.11
Energy	1148	82	.07	129	10	.08
Other services	1111	187	.17	117	35	.30
Foodstuffs	1049	204	.19	99	30	.30
Agricultural machinery	911	125	.14	101	29	.29
Hotel and restaurant serv.	903	146	.16	159	42	.26
Hobby tools	867	194	.22	136	62	.46
Agricultural services	842	202	.24	136	49	.36
Clothes	713	172	.24	80	38	.47
Printed matter	677	117	.17	50	21	.42
Argicultural products	638	129	.20	77	33	.43

Notes: Statistics are presented for our whole sample spanning years 2010 - 2017 as well as for year 2016, which is the latest full year in the sample. Hilma database contains all invitations to tender published by Finnish public sector. Hilma database might contain duplicates, so the shares shown are a lower bound. Categories with over 100 observations in our sample are shown. Social & Health care services include social housing services.

Table 14: Cross-reference of our sample and Hilma database

	Estimated cost		Scoring	
CPV classification	**Our sample**	**Hilma**	**Our sample**	**Hilma**
Agricultural machinery	87	77	.54	.4
Agricultural services	4407	3729	.38	.2
Argicultural products	391	195	.33	.28
Aux. transport services	838	258	.49	.38
Banking services	1277	598	.43	.37
Business services	945	697	.6	.38
Chemical product	482	90	.15	.17
Clothes	343	139	.52	.31
Construction contracts	1007	888	.13	.12
Construction equipment	326	165	.37	.3
Construction services	509	296	.56	.24
Electric equipment	253	126	.51	.32
Energy	4611	1729	.15	.18
Environmental services	786	314	.4	.21
Foodstuffs	3411	659	.55	.18
Furniture	561	303	.5	.39
Government services	438	134	.75	.27
Hobby tools	319	160	.51	.28
Hotel and restaurant serv.	2222	644	.65	.27
ICT equipment	788	343	.48	.37
IT Software	717	246	.65	.32
IT services	714	268	.72	.29
Industrial machinery	139	91	.51	.42
Installation services	194	128	.36	.42
Laboratory equipment	145	115	.61	.48
Leather and textiles	315	94	.47	.46
Maintenance services	1497	1019	.41	.25
Medical equipment	484	183	.73	.51
Mining	787	131	.19	.11
Mining machinery	203	100	.48	.3
Office supplies	2469	705	.44	.35
Other services	863	447	.52	.28
Postal services	1383	856	.41	.56
Printed matter	2465	455	.36	.13
Public utilities	758	373	.66	.6
Real estate services	366	182	.34	.32
Recreational services	302	161	.65	.29
Research services	199	171	.72	.41
Security services	1251	954	.55	.48
Social & Health care serv.	3179	2814	.37	.35
Social housing serv.	22135	18215	.42	.42
Training services	615	552	.83	.14
Transport equipment	209	137	.54	.44
Transport services	1528	578	.28	.21
Total	1301	863	.47	.3

Notes: Cross-reference of Hilma database and our sample using information on usage of scoring rule and the posted estimated value of tender.

Table 15: Median win margin by industry

bidders	Construction		Goods & Equipment		Other services		Social & Healthcare	
	obs	median	obs	median	obs	median	obs	median
2	4,818	0.20	17,062	0.25	6,827	0.31	1,321	0.23
3	4,766	0.12	16,633	0.16	6,733	0.25	1,202	0.14
4	4,411	0.11	10,870	0.12	4,771	0.20	605	0.12
5	1,824	0.10	7,310	0.11	3,976	0.18	359	0.11
6	1,749	0.08	3,537	0.08	1,964	0.13	173	0.16
7	1,020	0.09	2,511	0.10	1,264	0.13	125	0.08
8	912	0.09	1,097	0.10	1,096	0.11	124	0.08
9	657	0.08	714	0.11	685	0.10	119	0.04
10+	1,591	0.04	1,991	0.04	4,104	0.10	866	0.06

Notes: Win margin is calculated as a percentage difference between the lowest and the second lowest bid. The unit of observation is auction.