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PROCUREMENT PROCEDURE, COMPETITION AND FINAL UNIT PRICE: THE CASE OF COMMODITIES

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ABSTRACT. We show how institutional and procedural characteristics affect the final price in public procurement. In order to obtain comparable unit prices, our analysis examined public procurement of homogeneous goods only. We examined two Czech commodity markets: electricity and natural gas, which enabled us to use a private market price as a benchmark metric. The regression analysis is based on the standard ordinary least squares method. On a dataset of 277 tenders, we found that the final unit price of the procurement is sensitive to movements in both commodity market price and price estimated *ex ante* by the procurer. Moreover, we identified that the final price is reduced when the procurer uses an open procedure, an electronic auction, or attracts more competitors.

INTRODUCTION

Public procurement refers to the process of making purchases and investments from public resources, which consist of about 15 % of annual GDP in developed countries (OECD 2011). Public procurement has several very important institutional characteristics that differentiate it from private purchase processes and strongly affect its overall efficiency.

Despite the significance of the topic, the volume of empirical literature related to public procurement is relatively small. This is

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partly a result of poor data availability, and may also result from the wide variation of procured goods and services, which results in low levels of comparability between individual procurement results. We tried to overcome this obstacle by examining only a small subset of contracts, where subject of trade is well-defined, measurable, and has a solid price benchmark given by private markets; hence we focus on the procurement of electricity and natural gas. By examining those markets, we were able to compare the unit prices of particular tenders and identify the significant differences between procurement via an open procedure, where anyone can enter the competition, and those by a negotiated procedure with a number of pre-selected bidders. At the same time, we identified the effect of competition (the number of bidders) on the final unit price. Last but not least, we found a significant decrease in final unit price when procurement is carried out by electronic auction (in comparison to a standard sealed bid auction). Our analysis is, to the best of our knowledge, the first to employ empirical analysis using a private market price as a benchmark metric. Our results are relevant for both theoretical discussion and daily practice in public procurement. Moreover, as the legal framework we examined is common across the whole European Union, our results should be applicable (at least) Europe-wide.

The paper is organized as follows: we introduce the topic with a literature review. Our motivation for research and our methods are presented in next section. After that, we give an overview of our dataset with a data description where two public procurement markets (electricity and natural gas) are analysed. Then the results of our empirical study are presented and discussed. Finally, we conclude and offer some policy suggestions.

LITERATURE REVIEW

The roots of economic literature in the field of public procurement describe the process through auction theory. McAfee and McMillan (1987), Bulow and Roberts (1989) or Maskin and Riley (1999) attempted to describe optimal or sub-optimal strategies in procurement procedures, with several assumptions given. Laffont and Tirole (1993) and Che (1993) discussed an optimal procurement process in terms of maximizing the procurer's expected payoff, and showed that a scoring auction fulfils this requirement. However, Asker and Cantillon (2010) showed that scoring auctions are not necessarily optimal when the bidders' cost functions are multidimensional. Bulow and Klemperer (1996) discussed the pros and cons of competitive bidding (auctions) in comparison to negotiations, showing that under reasonable assumptions and interdependent signals auction processes maximize the expected revenues. Holt (1979) showed that the expected winning price in a competitive bidding decreases with the number of participants in the procedure. De Boer, van Dijkhuizen, and Telgen (2000) compared the expected benefit for additional bid with the related transaction costs and found an optimal amount of bidders for particular bid distribution. Heijboer and Telgen (2002) compared the total cost of a restricted procedure with an open procedure and showed that the optimal procedure is derived by the expected number of bidders, the distribution of their bids and the costs of evaluation. Since we also search for difference in outcomes between e-Auction and standard sealed bid auction, Milgrom and Weber (1982) provided us a theoretical foundation for such differences. Authors showed that, for interdependent values, the expected revenue from an English auction at least as big as the expected revenue from a first price sealed bid auction.

A number of other research questions have been discussed in the empirical literature on public procurement. An analysis of cleaning contracts by Domberger, Hall, and Li (1995) suggested that while competitive bidding (an open procedure in European terminology) reduces the price of a contract, the procurer's ownership (private or public) has a negligible effect on the price (Domberger, Hall, and Li, 1995). Bandeira, Prat and Valletti (2009) analysed a wide range of goods purchased by public institutions and concluded that final prices correlate with procurer types: central administration pays more than semi-autonomous agencies (Bandeira, 2009). The role of competition in public procurement has often been empirically tested by examining the number of bidders participating in the procurement (Kuhlman & Johnson, 1983; Gomez-Lobo & Szymanski, 2001; Haile, 2001; De Silva, Jeitschko, & Kosmopoulou, 2005; Iimi, 2006; Onur, Kamil, & Ta, 2012). Most of those papers used a model introduced in Kuhlman and Johnson (1983), in which the explanatory variable is the final price, normalized as a portion of the price estimated *ex ante* by the procurer. Unfortunately, this methodology depends heavily on the quality of the estimated price, which we consider to be a weak point, since the creation of this variable is a rather vague process – at least in the Czech environment. The estimated price is often used for budgeting purposes, therefore procurers have a tendency to overestimate it in order to be sure that the budget they are allocated will cover their expenditures. Moreover, for larger and more complex projects, the level of contingency in *ex ante* estimation will be higher, leading to disturbances in the ratio those papers discuss. We attempted to deal with this issue by analysing a small subset of homogeneous goods and comparing their procurement outcomes with the goods' market price. Regardless of their model, it is worth noting that all the papers mentioned above concluded that a greater number of bidders lead to a lower final price in public procurement procedures.

METHODS

Our goal is to discuss and identify the impact of institutional characteristics on final procurement price. Quantitative research on public procurement frequently runs into trouble because of difficulties identifying an objective metric of success. Contract prices for provision of public goods typically connected with public procurement usually lack any benchmark against which they could be compared. To overcome this difficulty, we limited our research to markets where benchmarks for the resulting prices exist, specifically looking at procurement of natural gas and electricity. Here we can compare the unit price of public procurement contracts against the market price for these commodities, which should enable us to measure the effect of various institutional settings on the public procurement result. The market price serves as an indicator of the opportunity costs for the suppliers, as the majority of procurement suppliers operate on the commodity market as well – either as sellers or buyers. We use this to examine how chosen procurement settings and procedures affect price mark-up, and derive some conclusions regarding the most efficient procurement behaviour. Our findings have only limited relevance outside the particular markets we examine, and most notably, do not provide information on public procurement where the qualitative aspects of the goods offered play a significant role and the goal of the public procurement is not only to minimize the price of a well-defined goods or service. Price is, however, the single selection criterion in 60 % of all Czech public procurement procedures (own computation based on www.vestnikverejnychzaka zek.cz), and for these contracts our results have some significance.

Unfortunately, even the utilities markets were not as homogeneous as we would have wished. Although the base price for electricity is established on commodity exchange, the final price for consumers (or the procurer) depends on the properties of the electricity consumed (voltage level, length of contract, number of phases, assigned distribution rate, peak/off-peak off-take). Similarly, the final price of natural gas reflects not only price on the spot market but also the total off-take, daily reserves and timing of the off-take. Nonetheless, examining these details would be lengthy and not particularly interesting from the economic point of view. To control for these irregularities, we used the fact that procurers should account for the specific nature of their demand (such as off-take time patterns) when producing estimated prices, which we use as an explanatory variable.

Even when controlling for movements in the market price and for the estimated price, the characteristics of individual procurement procedures are expected to affect the final price. On the basis of the theoretical (e.g. Bulow & Klemperer, 1996), and empirical (e.g. Domberger, Hall, & Li, 1995) literature presented in the previous section, we expected our results to correspond to the type of procurement procedure used: the open procedure provides the most favorable environment for competition, making bidders cut their bids, pushing the final price as low as possible. By contrast, negotiated procedures restrict potential competition, allowing bidders to bid with mark-up, and thus raising the final price.

A similar logic is applicable in the case of the number of bidders: both theory (e.g., Holt, 1979; Bower, 1993; Bulow & Klemperer, 1996) and evidence (Kuhlman & Johnson, 1983); Onur, Kamil, & Ta, (2012) suggested that the advantages of increased competition outstrip the potential gains resulting from negotiations. Not only is the number of bidders affected by the type of procedure used, but the level of competition within the given procedure also affects the outcome – the more bidders involved in the bidding process, the lower the final price can be.

Currently, one of the tools most intensely discussed in the public procurement community is electronic auction. Electronic auctions enable bidders to repeatedly adjust their offer prices, and the competition ends only when no bidder is willing to bid a lower price. This implements “English auction” features in the procurement environment. According to Milgrom and Weber (1982), in the model with interdependent values, the expected revenues from an English auction are at least as good as the expected revenue from a first price sealed bid auction (a standard open procedure; for details see Milgrom & Weber, 1982). When procuring commodities, we can expect strong interdependence between the submitted bids, because the opportunity cost (the market price) is the same for all the bidders. Therefore, implementing an electronic auction procedure for commodity procurement would be expected to lead to lower prices than those achieved through a standard sealed bid auction.

As a result of previous empirical evidence (Bandeira, 2009)) presented in the literature review, we will also test whether there are differences in final prices of tenders purchased by different types of procurers. The results presented in Bandeira (2009) suggest that more autonomous authorities are more concerned about unnecessary expenses and achieving a low final price.

DATA DESCRIPTION

We chose to examine electricity and natural gas markets based on several criteria. These included the availability of a sufficient number of public procurement observations, data on purchased quantities for unit price computation, the homogeneity of the goods for comparability, and the availability of market price time series.

The source of the dataset is the Czech national informational portal for public procurement (www.vestnikverejnychzakazek.cz), where every contract above the given threshold (see below) since the year 2006 is listed. All public procurers (municipalities, hospitals, central administrative bodies, etc.) are obliged to select their electricity and gas suppliers via public procurement procedures, if the *ex ante* estimated value of the contract is higher than CZK 2 million (€80,000). After preparing contract documentation and calculating the contract's estimated value, the procurer chooses a procurement procedure and announces a contract notice with a call for tender. In the case of open procedures (the most frequent procedure type in our dataset), competitive bidding then takes place. Alternatively, the procurer negotiates with a number of pre-selected bidders (negotiation procedures). Other types of procedures are unusual in Czech commodity procurement and are not examined here.

In order to be able to compare the final unit price in procurement with the market price, we used Power Exchange Central Europe (PXE.CZ) as a source of market price data. This company works as a commodity exchange for the Central Europe area, where commodities and related securities are traded. Since all of the commodity procurement contracts are forward-looking, meaning that the procurer and the winner of the tender sign a contract for deliveries of the given commodity over a specified period of future time (usually one or two years), we decided to use the one year forward price (base CAL) as a measure of the market price. These prices are lower than retail prices, however they are the key determinant of prices for both consumers and firms, hence well reflect the supplier's opportunity costs. In order to avoid the effects of day-to-day volatility on the market, we used monthly average prices, as presented in Power Exchange Central Europe's statistical reports.

The dataset covered procurement from 2008 till 2013. The total amount of purchased electricity was over GWh 6,200 and the summarized price of these tenders was over GWh 8.5 billion (over €340 million at CZK 25 per €). The gas dataset represented tenders purchasing 1 500 GWh of gas worth CZK 1.5 billion (€60 million). The average contract price was about CZK 37 million (€1.5 million). Detailed descriptive statistics are provided in Appendix A. Figure 1 and Figure 2 illustrate how the tenders and unit prices were scattered over time. The highest and most volatile unit price was the estimated price, in both electricity and gas procurement; the average market price was the lowest and least volatile. As can be seen on both figures, the estimated unit price was higher than the final unit price in most of the observations, indicating that the procurers consistently overestimated the cost of the procurement.

Table 1 shows the distribution of various institutional characteristics within the dataset. The dataset covered 225 open procurement procedures and 54 negotiated procurement procedures (with or without announcement). In 136 cases the procurer decided to use an electronic auction.

FIGURE 1
Electricity Contract Unit Prices over Time (in € MWh)

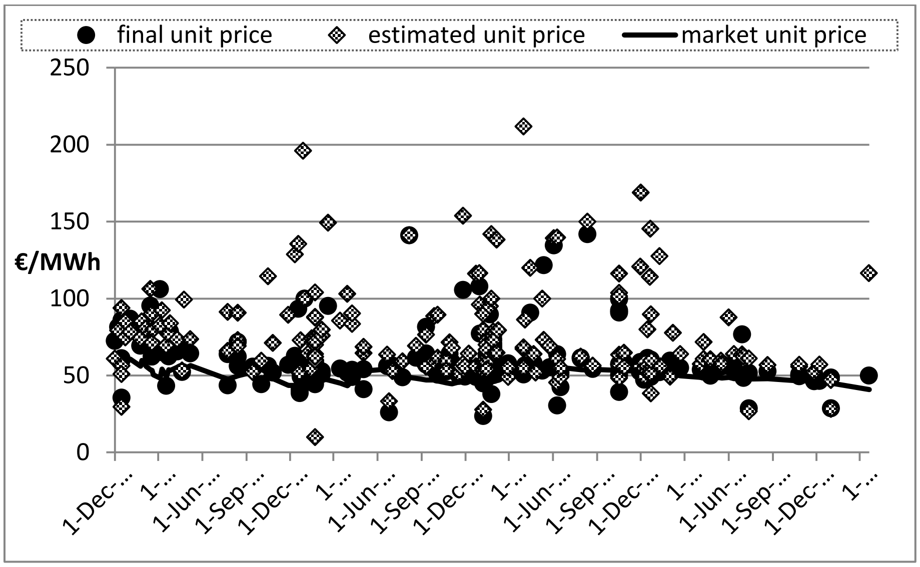

FIGURE 2
Gas Contract Unit Prices over Time (in € MNh)

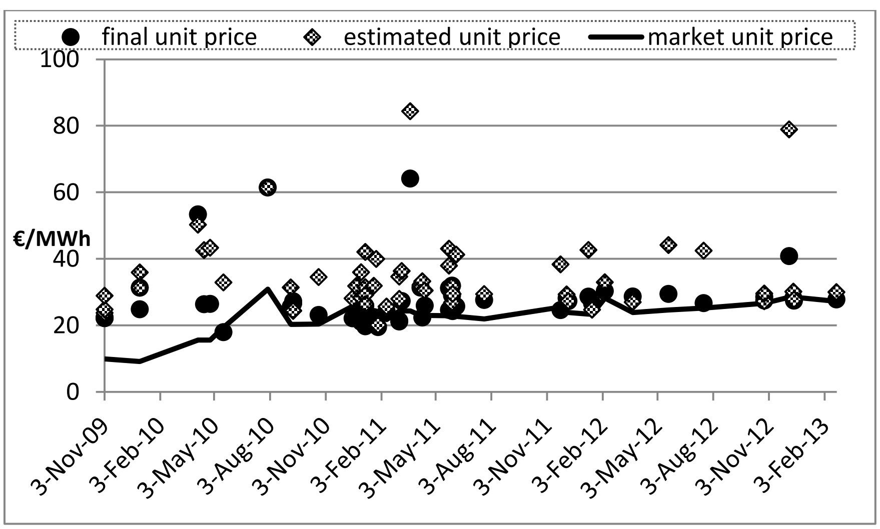

TABLE 1
Institutional Characteristics of Competitions in the Dataset

Commodity	Total contracts	Procedure		Format	
		Open	Negotiated	e-Auction	Sealed bid
Electricity	221	180	41	107	114
Gas	58	45	13	29	29

Table 2 presents the distribution of contracts in the dataset based on the type of procurer. The public authorities purchasing electricity and gas most frequently were regional authorities (including municipalities and regional authorities managing NUTS3 regions) and state-owned enterprises (e.g. Czech Railways, Czech Television and Czech Radio, and the Czech national postal service). The characteristics of both the competition and the procurer were used as dummies in our model.

TABLE 2
Types of Procurers in the Dataset

Commodity	Total Contracts	Type of procurer			
		State-Owned Enterprises	Public Bodies	Regional Authorities	Central State Authorities
Electricity	221	83	36	84	17
Gas	58	17	10	27	3

Annual electricity consumption in the Czech Republic is about 70 000 GWh (annual report of Czech Energy Regulatory Office; www.eru.cz), so our dataset covers less than two percent of the total electricity consumption in the reference period. This lends support to our model using the market price as its explanatory variable, because the procurement market represents a relatively small component of total electricity consumption, and therefore the procurement price can hardly be assumed to affect the overall market prices.

We have 13 electricity and 9 gas suppliers in our dataset, which can be considered sufficient for a relatively competitive structure.

Three large companies supply about 30 % of the contracts (by number), which means market concentration is relatively low. However, if we look at the contracts by volume, it is a different story: those three companies supply more than 77 % of the total procurement volume in both markets. We used the Herfindahl index (the sum of the companies' squared shares on the total market volume) as a standard indicator for market concentration. The index value of 0.25 confirmed that the commodity procurement market is very concentrated in volume terms: the dominant players on the market supplied the largest tenders and the rest of the market participants competed for the smaller contracts.

A crucial determinant of the outcomes from the procurement procedure was the number of bidders, which varied around 4.4 (with a standard deviation of 1.96), and was similar to the average number of bidders in the public procurement market across all products in the EU (European Commission (2011)). The average number of bidders for gas was 3.6 (with a standard deviation of 1.5). Neither electricity nor gas contracts stood out in terms of bidder numbers. However, the number of bidders was remarkably high in comparison with the number of players on the whole electricity market. As we discussed above, there were only 13 distinct winners of public procurement contracts in electricity (9 for gas) and yet in more than 60 % of cases, at least 4 bidders participated in the tendering procedure. This indicates that the companies present on the procurement market must meet and compete with one another on a daily basis. To conclude, both gas and electricity procurement markets had very similar characteristics, and we expect similar outcomes from our econometric analysis.

RESULTS AND DISCUSSION

Our results consist of two regressions, each for a given commodity. For the purpose of statistical comparison the final price was normalized per unit of purchased commodity. Since we were not particularly interested in the actual level of the final price but rather in its relative changes caused by other variables, we used a natural logarithmic form of the final unit price as a dependent variable. Similarly, both the estimated prices and the market prices were given in the natural logarithmic form. The procedural characteristics (open procedure, electronic auction and type of procurer) were in the form of dummy variables in the model. The regression analysis was based on the standard ordinary least squares (OLS) method with a backward selection process. The OLS assumptions were tested and discussed in appendix B. The empirical analysis of electricity procurement was based on 220 observations; that of gas procurement was based on 57 observations. The coefficient of determination indicates that more than 50 % of the variation in the log (final price/kWh) can be explained by variations in the explanatory variables. All three important procedural characteristics seem to be significant determinants of the final price of the commodity procurement, as can be seen in Tables 3 & 4.

TABLE 3
Electricity Procurement Regression Results: Dependent Variable log(final price/kWh)

Explanatory variables	**OLS ß**	**Robust SE**	**OLS ß**	**Robust SE**
Log(market price/kWh)	*1.07*	*(0.25)******	*1.03*	*(0.19) ******
Log(estimated price/kWh)	*0.44*	*(0.10)******	*0.43*	*(0.09) ******
Open procedure	*-0.21*	*(0.10)***	*-0.07*	*(0.04)**
Electronic auction	*-0.16*	*(0.04)******	*-0.12*	*(0.03)******
Number of bidders	*-0.05*	*(0.02)***	*-0.015*	*(0.008)**
Log (quantity)	*-0.01*	*(0.01)*		
Time	$1*10^{-5}$	$(5*10^{-5})$		
State owned enterprises	*-0.04*	*(0.05)*		
Public bodies	*-0.02*	*(0.05)*		
Central state bodies	*-0.03*	*(0.07)*		
*Cross effect open procedure*bidders*	*0.04*	*(0.03)*		
Constant	*0.39*	*(0.25)*	*-0.1*	*(0.07)*
R^2	***0.58***		***0.54***	

Note: open procedure, electronic auction and types of procurer are dummy variables; negotiated procedure and regional authority are dropped dummies; * indicates p-value< 0.001, ** indicates p-value< 0.01, *** indicates p-value< 0.05.

TABLE 4
Gas Procurement Regression Results
Dependent Variable: log(final price/kWh)

Explanatory variables:	**OLS ß**	**Robust SE**	**OLS ß**	**Robust SE**
Log(market price/kWh)	*0.20*	*(0.10)***	*0.15*	*(0.09)**
Log(estimated price/kWh)	*0.56*	*(0.11)****	*0.41*	*(0.11)****
Open procedure	*0.29*	*(0.19)*	*0.08*	*(0.06)*
Electronic auction	*-0.08*	*(0.07)*	*-0.15*	*(0.06)***
Number of bidders	*0.01*	*(0.05)*	*-0.03*	*(0.01)**
Log (quantity)	*-0.02*	*(0.02)*		
Time	$-1*10^{-5}$	$(1*10^{-4})$		
State owned enterprises	*0.14*	*(0.07)*		
Public bodies	*0.07*	*(0.08)*		
Central state bodies	*0.00*	*(0.14)*		
Cross effect open procedure*bidders	*-0.06*	*(0.05)*		
Constant	*0.12*	*(0.45)*	*-0.11*	*(0.08)*
R^2	***0.66***		***0.52***	

Note: open procedure, electronic auction and types of procurer are dummy variables; negotiated procedure and regional authority are dropped dummies; * indicates p-value< 0.001, ** indicates p-value< 0.01, *** indicates p-value< 0.05

The F-test supports exclusion of insignificant variables such as log(quantity), time, and type of procurer ((for electricity: $F(5, 209) = 0.68$, Prob > F = 0.64 and for gas: $F(5, 46) = 0.53$, Prob > F = 0.75). Additionally, no interaction term was found to be statistically significant. In other words, it appears that the causalities are such as can be identified by the reduced form of the model.

The simple conclusion is that procedural characteristics do significantly affect the final price of electricity contracts. The results for gas are weaker, but there is a visible link between some public procurement features and final procurement price. The similarity of these results for both markets also suggests that the findings may be in some sense general and have relevance in other procurement markets with similar characteristics. Let us now discuss the results of particular coefficients, case by case:

a) The beta coefficient of log(market price/kwh) can be interpreted as an elasticity: the coefficient of one for electricity means that market price movements will be fully transferred into the final price of electricity procurement contracts. In other words, bidders reflect market price changes fully in their opportunity costs when submitting bids. For gas, the resulting elasticity is much smaller, but this result is probably caused by the small dataset and low variance in the gas market price.

b) Using similar logic, the coefficient of log(estimated price/kwh) indicates that in both markets changes in the estimated price are reflected in the final price by 40 %. The positive sign in the coefficient indicates that a higher initial estimate will lead to a higher final price. However, as we discussed in section 3, the estimated price captures the heterogeneity of the subject of the contract (such as timing of energy use), which necessarily affect both estimated and final prices. The core reason for analyzing commodities (which are considered to be homogeneous) was to minimize this effect. Even so, this heterogeneity should not explain statistical differences in the procedural characteristics, as there is no reason to believe that differences in the goods purchased correlate with differences in procedure. More than 90 % of the tenders in our dataset are evaluated solely on the basis of price with no other evaluation criteria. This indicates that the procedure type (open vs. negotiated), format (e-auction vs. sealed bid) and level of competition (number of bidders) are determined exogenously. Secondly, the coefficient of 0.4 indicates relative inelasticity in the final price with respect to the estimated price; this means that bidders only partially reflect changes in estimated prices when submitting their bids. They are able to identify contingencies or buffers in the procurer's *ex ante* estimations, and adjust their bid accordingly.

c) Open procedures are seen to cause a significant decrease in final unit price, by 7 % on average, in the electricity dataset (in comparison to negotiated procedures). This is thanks to the open procedure providing a more competitive environment by allowing for more potential bidders. A negotiated procedure restricts the competition and causes a statistically significant increase in the final price of the electricity contract. For gas, the insignificant results, may be caused by the poor dataset. The dramatic change in this coefficient for electricity between the initial and reduced forms of the model (from -0.21 to -0.07) is given by the positive but insignificant coefficient of the cross effect of open procedure and number of bidders (see below for a discussion of this cross effect).

d) Electricity tenders are significantly sensitive to the number of bidders: every additional bidder decreases the final price by 1 % on average. Gas tenders are even more sensitive, and their price drops by 3 % on average with each additional bidder. The number of bidders has a positive effect on competition and hence this negative effect on the final price. We tested for a potential quadratic form of relationship, but, although we cannot assume that the same effect would be caused by, for example, a 20th bidder, nonetheless within the plausible range the relationship here seems to be linear. This result and the previous result for open procedures can be viewed as the respective impacts of potential competition (open procedure) and real competition (number of bidders). Whereas the former provides motivation for lower bids and reduces the risk of collusion, the latter is a consequence of having more offers on the table from which the procurer can choose the cheapest. As we saw in the case of open procedure results, there is a substantial change in the coefficient for number of bidders between the initial and reduced form of the model (from -0.05 to -0.01); this is once again given by the positive but insignificant coefficient for the cross effect of open procedure and number of bidders.

e) When electronic auction is used, the final unit price falls on average by 12 % for electricity and 15 % for gas. These dramatic price drops are caused by the electronic auction enabling bidders to adjust their price bids until no one is willing to bid a lower price. This is an extremely important feature because it creates direct and real-time competition pressures on bidders (in comparison to the standard sealed bid auction, in which bidders place their bids on the basis of their expectations about the number of co-bidders and the strength of the price competition). In other words, this result confirms the theoretical conclusion presented by Milgrom and Weber (1982). On the basis of these findings, it would seem advisable to implement electronic auctions as frequently as possible to improve procurement efficiency.

A number of the insignificant results are also interesting and worthy of comment:

- First, we did not find any statistically significant differences in the final unit price with respect to the different types of procurers. The differences we had expected were not confirmed (the F-Test for electricity: $F(3, 209) = 0.40$, $Prob > F = 0.75$ and for the gas: $F(3, 46) = 0.66$, $Prob > F = 0.58$). This means that according to our data, national authorities purchase gas and electricity at the same prices as public bodies, regional authorities, and state-owned enterprises. There is no evidence of different attitudes toward excessive spending, based on the different autonomies of these categories of institutions. Our explanation for this result is that commodity tenders are usually price-driven bidding competitions and there is not much room in such procedures for procurer discretion.
- Second, we did not find any economies or diseconomies of scale on the procurement market: the quantity of the commodity contracted does not affect the final unit price. When procuring commodities, there is no benefit from enlarging the procured volume, for example by merging demands or prolonging the contract. The procedural characteristics of the procurement seem to be more important than the contract volume in determining the final unit price.
- Surprisingly, the effect of the number of bidders is not significantly different in open procedures than in negotiated procedures. Czech commodity procurers often enter into negotiations with several bidders - the average number of bidders in negotiated procurement procedures is 3.65 (st. dev. 1.57), and this is only slightly lower than the average 4.3 bidders (st. dev. 1.95) in open procedures. This indicates that in both procedures the competition forces are similarly structured, and have a similar effect on prices.

CONCLUSION

Our analysis has demonstrated that procedural characteristics significantly affect the final price of public procurement contracts.

Procurers can obtain lower prices for their procurement by bringing a more competitive environment into the procedure. This can be achieved by using an open procedure, which enables anyone to bid for the procurement. The procurer cannot determine the number of bidders in the procurement, but can encourage or discourage potential bidders by setting qualification criteria or other barriers to entry. The most effective device for reducing the final price seems to be an electronic auction, which strengthens competition by allowing the bidders to adjust their bids. For the procurement of homogeneous goods, the additional administrative costs of e-auctions are negligible (as estimated by Reimarová, Chvalkovská, and Skuhrovec (2011) or the European Commission (2011)), but the potential savings of this type of procedure are remarkable. It would therefore be cost-effective to implement an open procedure administered through an electronic auction as often as possible, and to encourage as many suppliers as possible to place bids.

Our results are consistent with the academic literature by (e.g. Holt (1979), Bulow and Klemperer (1996) or Milgrom and Weber (1982)), and will be unsurprising for public procurement practitioners, to whom the substantial effects of electronic auctions and open procedures are well known anecdotally. The question therefore arises as to why many procurers continue to run negotiated procedures, which objectively waste public money? This question requires further research, and its answer may lie in procurers' special requirements, corruption, or resistance to change. Moreover, the role of the *ex ante* estimated price would be a very interesting topic for further research, as its relationship with other characteristics and its impact on the final winning bid have been relatively little studied in public procurement literature.

The public procurement of commodities makes up a relatively small yet remarkable part of public purchases. At the same time, the unique features of commodity contracts enable us to identify relationships between the institutional settings of the procurement procedure and the final price of the contract. Those relationships have been suspected by practitioners and theorists, and this paper provides empirical proof of their existence, confirming that the more competitive a procurement environment is formed, the less the procurement will cost.

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APPENDIX A
Descriptive Statistics of the Dataset

TABLE A-1
Descriptive Statistics of 221 Electricity Contracts

Variable:	Mean	Std. Dev.	Min	Max
Final contract price ['000 CZK]	40,100	208,000	27	2,570,000
Contract quantity [MWh]	28,300	151,000	20	1,810,000
Final price [CZK/kWh]	1.65	0.86	0.95	7.91
Estimated price [CZK/kWh]	2.00	0.98	0.25	7.07
Market price [CZK/kWh]	1.26	0.10	1.02	1.54
Number of bidders	4.36	1.96	1.00	11.00
Electronic auction	0.48	0.50	0.00	1.00
Open procedure	0.81	0.39	0.00	1.00
Log (final price/kWh)	0.43	0.33	-0.05	2.07
Log (market price/kWh)	0.61	0.39	-1.39	1.96
Log (estimated price/kWh)	0.23	0.08	0.02	0.43
Cross product procedure* bidders	3.65	2.52	0.00	11.00

TABLE A-2
Descriptive Statistics of 58 Gas Contracts

Variables	Mean	Std. Dev.	Min	Max
Final contract price ['000 CZK]	27,200	50,300	547	238,000
Contract quantity [MWh]	43,400	83,500	802	429,000
Final price [CZK/kWh]	0.71	0.25	0.45	1.67
Estimated price [CZK/kWh]	0.89	0.35	0.50	2.31
Market price [CZK/kWh]	0.58	0.17	0.23	1.17
Number of bidders	3.52	1.49	1.00	7.00
Electronic auction	0.50	0.50	0.00	1.00
Open procedure	0.78	0.42	0.00	1.00
Log (final price/kWh)	-0.39	0.27	-0.80	0.52
Log (market price/kWh)	-0.17	0.30	-0.69	0.84
Log (estimated price/kWh)	-0.59	0.32	-1.48	0.16
Cross product procedure*bidders	2.81	2.01	0.00	7.00

APPENDIX B
OLS Assumptions

OLS must satisfy classical linear model assumptions in order to provide the best unbiased estimator. The linearity of parameters is incorporated in the model as specified in Section 3 – methods. The randomness of our sample is not in question, since we use the full population of available data for our analysis. A zero conditional mean of residuals should not be an issue, as we do not see any possible threat of indigeneity in our model. The first assumption to be tested is the absence of multi-collinearity. We use the variance inflation factor (VIF) as an indicator of potential multi-collinearity and the result indicates there is no threat in this case (Table B.1).

TABLE B.1
Variance Inflation Factor

	Electricity	Gas
Mean VIF	1.33	1.22

Next we test the homoscedasticity of residuals (the same variance given any value of the explanatory variable). As can be seen in Table B.2 below, the Breusch-Pagan test rejects the hypothesis of homoscedastic residuals in both cases.

TABLE B.2
Breusch – Pagan Test, H0: Constant Variance of Residuals

	Electricity	Gas
χ^2	87.75	9.3
$P > \chi^2$	0	0

However, heteroscedastic residuals do not cause any bias in the estimations. Robust standard errors need to be applied in order to be able to use t-statistics for the assessment of statistical significance.

The final assumption we test is the normality of the residuals in the model. As can be seen in Table B.3 below, the Shapiro – Wilk test rejects the hypothesis of normally distributed residuals in both cases.

TABLE B.3

Shapiro - Wilk Test, H0: Normal Distribution Of Residuals

	Electricity	Gas
z	4.39	2.98
P > z	0	0

Despite the non-normality of residuals, the dataset is sufficiently large to conclude that the OLS estimators satisfy asymptotic normality and that use of the t- and F- statistics for testing the hypotheses is possible. Some nonlinear unbiased estimators may have a smaller variance, however, the goal of this paper is to test the hypotheses stated above, and the simple OLS method is shown to be sufficient for that purpose.

Moreover, a correct model specification was tested. As can be seen in Table B.4, the squares of the fitted values are insignificant, which suggests that no squares of the explanatory variables are missing, and that the relationships seem to be linear.

TABLE B.4

Squares Identification: (Fitted Value of log(final unit price))^2

	Electricity	Gas
t	1.07	-1.24
P > t	0.287	0.222