Public Procurement of Homogeneous Goods: the Czech Republic Case Study

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Public Procurement of Homogeneous Goods: the Czech Republic Case Study

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Abstract:
The goal of this paper is to show how institutional and procedural characteristics affect the final price of the public procurement. In order to get comparable prices, only public procurement of homogeneous goods is analyzed. Presented model attempts to explain the variation in unit price as a function of price estimated by the contracting authority, market price and characteristic of procurement procedure – type of procedure, number of bidders and use of electronic auction.
We find that the final price in the electricity and natural gas public procurement is more sensitive to purchaser's estimate than to actual market price. At the same time, we identify that the final price is reduced by using open procedure, electronic auction or attracting more competitors.

Keywords: public procurement, homogeneous goods, energy markets

JEL: H57, D23, D73, C21

Introduction

Public procurement (PP) are processed purchases and investments from public sources which consist about 15 % of annual GDP in developed countries (OECD, 2011). PP has several very important institutional characteristics that differentiate them from private purchases and which highly affect their overall efficiency.

Despite the enormous importance of the topic, the volume of related economic literature is quite small. Besides poor data availability, the main problem with PP research possibly lays in variation of procured goods and services, resulting in low comparability of atomic procurement results. We try to overcome this obstacle by examining only a small subset of PP's, where subject of trade is well-defined, measurable and has solid price benchmarks coming from private markets. These are procurements of electric energy and natural gas.

The PP in the Czech Republic is an extraordinary case: the relative size of the PP market is the second largest of all OECD countries (OECD, 2011), whilst the country has weak both formal and informal institutions (Schwab, 2011). These two observations imply severe risk of inefficiency but also room for improvement. Recent studies and publications (e.g.: Pavel, 2009 or Nikolovová et. al., 2012) about PP in the Czech Republic describe the procurement system as a whole, pointing out its crucial pitfalls and shortcomings and giving a broad overview of basic information. While their approach is appropriate for initial research, their description of the market where all kind of goods and services are purchased leads to generalizations. We will move forward to more compact and unified market to deliver a more analytical and objective study. This paper will provide new results relevant for both theoretical discussion and daily practice of PP. Moreover, as the examined legal framework is present not only in the Czech Republic but across the whole European Union, our results should be applicable Europe-wide.

The work is organized as follows: first, we introduce the topic with a literature review. Then we present the motivation of our research together with hypothesis statement. Third, we show an overview of our dataset with a data description where two public procurement markets (electricity and natural gas) are analyzed. Finally, the results of our empirical study are presented, followed by hypotheses discussion and summarizing conclusion.

Literature review

The majority of PP literature describes the process through auction theory. Most papers, such as McAfee and McMillan (1987), Bulow and Roberts (1989) or Maskin and Riley (1999), attempt to set up the optimal or sup-optimal strategies in procurement game with several assumptions given. Laffont and Tirole (1987) and Che (1993) discuss an optimal procurement process in terms of maximizing expected payoff of contracting authority and show that scoring auction provides such property. However, Asker and Cantillon (2010) show that scoring auctions are not necessarily optimal when the bidders' cost functions are multidimensional. Bolow and Klemperer (1996) discuss the pros and cons of competitive bidding (auctions) in comparison to negotiations, showing that under reasonable assumptions and interdependent signals the auction processes do maximize the expected revenues.

The role of transaction costs in PP procedure was described by Smiley (1976), Bajari and Tadelis (2001) or in the Czech Republic by Pavel (2009). In terms of policy making in the Czech Republic is important the work of Reimarová (2011) who estimates the administrative or transaction costs of the procurement procedure and evaluates the differences between an in-house administration and an outsourced administration in terms of prices and efficiency.

Domberger, et. al. (1995) wrote one of the first papers that uses an econometric approach on PP. They collected data on about 61 cleaning contracts from public offices, schools and hospitals in Australia. Their results suggest that while competitive bidding reduced the price of PP, the effect of ownership of contracting authority (private versus public) on price was negligible (Domberger, 1995). Another paper by Bandeira, Prat and Valletti (2009), based on 6000 procurement from Italy, concluded that final prices correlate with types of contracting authority: the central administration pays more than semi-autonomous agencies (Bandeira, 2009). Contrary to previously mentioned theories and empirical evidence, Bajari, McMillan and Tadelis (2008) show on the dataset of private sector building contracts that auctions may not maximize expected revenues when projects are complex and contractual designs are incomplete (Bajari, 2008). Hattori (2010) shows that the amount of bidders in electricity PP in Japan is dependent on characteristics of the purchased good and geographical location.

In the Czech Republic, Pavel (2008) examines 202 tenders of infrastructure engineering works, concluding that final price (as a percentage of estimated price) is affected by the type of procedure and amount of applicants. The largest caveat of such approach lies in the dependent variable, which is after all determined by subjective estimate and/or strategic

consideration of contracting authority. In this paper we would like address the issue by using market price as more objective benchmark.

Motivation & hypotheses

We now attempt to discuss and identify the impact of institutional characteristics on the final price of the procurement. Quantitative research on public procurement usually runs into trouble because of difficulties with any objective metric of success. The provision of public goods typically connected with PP is difficult to measure as PP prices usually lack any benchmark against which they could be compared – in terms of both price and quality. To overcome such difficulty, we limit our research to markets where benchmark for resulting price exists, i.e. to markets with natural gas and electricity. Here we can compare the price of PP purchases against the spot market price of these commodities. Consequently, this should enable us to measure the effect of various institutional settings on PP result. The market price should serve as sort of lower-bound price benchmark, as majority of suppliers either obtains the energy on the commodity market, or sells it here and therefore any bidder would hardly offer lower price, than they would get on the market. We will use it to examine how chosen procedure and criteria affect the price mark-up, and derive some conclusion regarding efficient behavior. Apparently, our findings will have only limited relevance outside examined markets. Most notably, they do not provide information on PPs where qualitative aspects of offered goods play significant role and the goal of PP is thus different from minimizing price of well-defined good or service.[1]

However, unfortunately even utilities markets are not as homogeneous as we would wish. Although base price for electricity is established on commodity exchange, the final price for consumer (or in case of PP for the contracting authority) depends on the properties of consumed electricity (voltage level, length of contract, number of phases, distribution assigned rate, daily hour course taking of electricity). Similarly, the final price of gas reflects not only price on the spot market but also the total natural gas offtake, daily reserves and timing of the offtake. Nonetheless, examining these details would not only be tedious, but would also not be very interesting from the economic point of view. We will neglect such heterogeneity for two reasons:

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[1] The procurements using the price as a single criterion typically ammount to 50-60% of annual procurement volume in Czech republic (own calculation). This outlines maximum applicability scope of our results.

1. Since our sample of contracting agencies are government offices with arguably similar consumption patterns, the differences in price schemes should be only minor relative to overall price

2. Contracting authorities should account for specific nature of their demand such as offtake time patterns, when producing estimated price (please see the legal definition in appendix A), which we use as an explanatory variable. Simultaneously, the estimated price reflects the authority's willingness to pay – it signals the amount of disposable money that authority budgeted for the procurement.

Nevertheless, when controlling for movements in the market price as well as the estimated price, the characteristics of individual procurement procedure are expected to affect the final price. On the basis of theoretical (e.g.: Bolow and Klemperer, 1996) and empirical (e.g.: Domberger, 1995) literature presented in previous section, we are expecting corresponding results related to the type of procurement procedure (please see description in appendix A): within the open procedure is a most-favorable environment for competition, bidders must shed their bids, pushing the final price as low as possible. On the contrary, the negotiated procedure restricts competition, allowing bidders to bid with an additional mark-up and thus raising the final price. Formally we will test following hypothesis:

hypothesis H1: The final unit price of the procurement is affected by the type of the procurement procedure.

Similar logic is applicable in the case of number of bidders: theory (e.g.: Bower, 1993 or Bolow and Klemperer, 1996) suggests that gains of increased competition outstrip the potential gains resulting from negotiations. Whereas number of bidders is certainly affected by type of procedure, the competition within certain given procedure can have additional effect – the more bidders involved in bidding process, the lower final price can be reached:

hypothesis H2: The final unit price of the procurement is a decreasing function of a number of bidders interested in the procurement.

Currently, one of the most discussed tools in PP community is the electronic auction. The electronic auction allows bidders to repetitively adjust offered prices, therefore the competition ends only after no one is willing to bid a lower price. This implements the "English auction" features in a PP environment. According to the auction theory, 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 – means a basic open procedure (for details see Krishna 2010). Some current incidents in the Czech Republic[2] demonstrate that the cost cuts caused by an electronic auction might be tremendous. We believe in demonstration of statistically significant negative impact on the final price of procurement of homogeneous goods as well:

> *hypothesis H3: The usage of electronic auction reduces the final unit price of the procurement.*

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 contracting authorities. Their result suggests that the more autonomous the authority is, the greater the concern about unnecessary excess expenses and looking after the final price. The hypothesis is stated as follow:

> *hypothesis H4: The final unit price of the procurement is affected by the type of the contracting authority.*

A crucial issue concerning specificity that must be dealt with is the potential endogeneity bias resulting from the omitted variable problem. PP might be subject of a wasteful behavior, which might, through correlation with the explanatory variables, cause false significance. For the purpose of this paper there is no need to create a distinction between wasteful behavior as a result of corruption and wasteful behavior as a result of carelessness and lack of interest in the cost minimizing (as proposed in Bandeira, 2009). In general, the wasteful behavior might affect both procedural characteristics (estimated price, type of procedure, number of bidders) and the final price of the procurement. This, unfortunately, would lead to a negative bias of the ordinary least square estimators. To tackle this omitted variable problem, we decided to use a proxy plug-in solution[3]. As a proxy variable for this unobservable *"wasteful behavior"* we decided to use a *zIndex*, a composite index presented by Chvalskovská and Skuhrovec (2010) that rates contracting authorities according to quality and transparency of all their procurement competitions over given period of time. The index consists of ten individual ratios representing openness, competition or effective controlling processes in purchases of each contracting authority (see appendix B for individual composites of zIndex).

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[2] In the most famous current case the statutory city of Ostrava managed to decrease their mobile phone expenses from 22 mil CZK to 3 mil CZK (http://moravskoslezsky.denik.cz/zpravy_region/ostrava-usetri-miliony-za-volani20110810.html).
[3] See Wooldridge, J. M.: Introductory Econometrics, Fourth Edition, South-Western, 2009, page 307

In general, the zIndex measures good practice behavior in public expenditures. Those authorities who follow all "good practice" guidelines will reach a high level of zIndex. At the same time, the space for wasting public money will be (or, at least, should be) much lower than authorities without such good practices. Therefore the wasteful behavior should be minimized as well. The zIndex as a good practice measure seems to be a good proxy variable for omitted wasteful behavior that might occur in a PP dataset.

To conclude the motivation, the aim of this empirical study is to identify the impact of institutional and procedural characteristics on the final price of the procurement. For the purpose of statistical comparison the final price is normalized per unit of purchased commodity. Since we are not much interested in the actual level of the final price but rather in its relative changes caused by other variables, we decided to use a natural logarithmic form of the final unit price as a dependent variable. Similarly, both the estimated and the market prices are designed in the natural logarithmic form. During the statistical analysis, the interaction terms (e.g. *procedure*authority*) will be tested as well.

Data description

We had several criteria for choosing examined markets – a sufficient number of PP observations, availability of purchased quantities for unit price computation, homogeneity of good for comparability and availability of market prices time series. We found two commodities that fulfill those requirements:

   a) electricity
   b) natural gas

The source of the dataset is the Czech national informational portal for PP (www.isvzus.cz), where every large procurement since the year 2006 is listed. This database has some shortcomings resulting from weak enforcement of data quality. However, we were still able to get a set of 259 procurements that have all the necessary information. For additional discussion on data gathering technicalities and connected issues please refer to Soudek (2012). As we already mentioned, we are also comparing the final unit price with the market price. We decided to use the Czech electricity and gas market operator (OTE) as a source of the market price. This company provides comprehensive services to individual electricity and gas market players and creates monthly and yearly reports on both markets in the Czech Republic. Since OTE works as a kind of commodity exchange, the unit prices of the commodities are lower than retail prices. OTE price is however the key determinant of retail

prices, hence it can be used as a solid bottom-line benchmark. In order to avoid day-to-day volatility on the market, we decide to use the monthly weighted average prices presented in the OTE annual reports.

The dataset covers procurement from 2008[4] till 2011. The total amount of purchased electricity was over 7 000 GWh and summarized price of these tenders was over 10.5 bn CZK (over 420 mil. €). The gas dataset represents tenders purchasing 2 GWh of gas worth 1.6 bn CZK (64 mil. €). The table 1 presents the comparison of unit prices (final, estimated and market). The highest and most volatile is the estimated price in both electricity and gas procurement, which might be caused by the heterogeneity of our dataset. On the other hand, the average market price seems to be the smallest and least volatile (especially in the case of gas).

Table 1: Average unit prices

	Electricity CZK/kWh		Gas CZK/kWh	
Price	average	SD	average	SD
Final	1.7	0.42	0.74	0.45
Estimated	1.92	0.55	0.97	0.56
Market	1.16	0.14	0.52	0.12

On the following graphs is presented how the tenders are scattered over time.

Figure 1: Electricity tenders in time
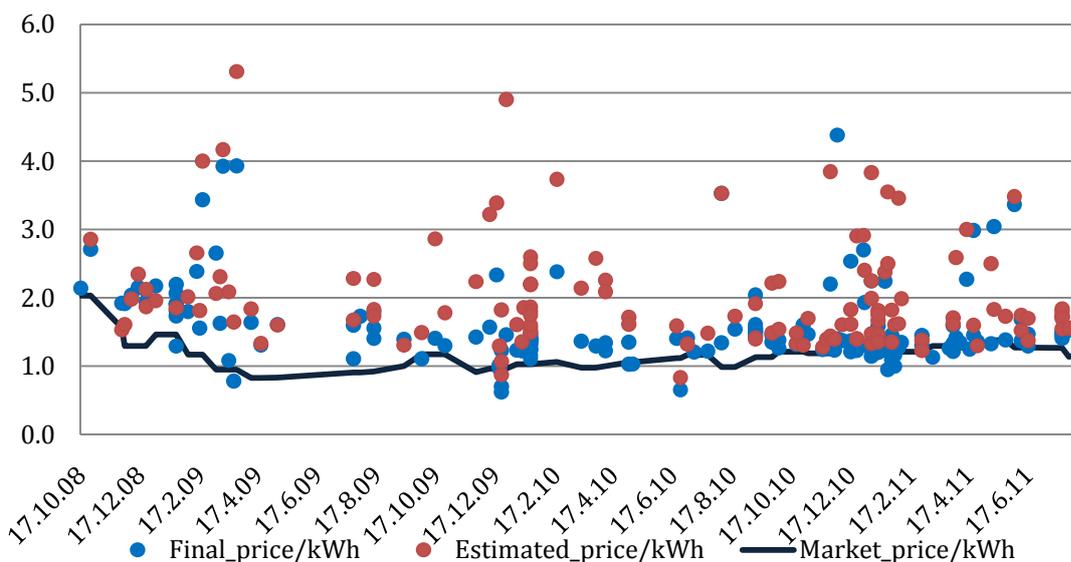
Source: own computation

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[4] Both markets have been liberalized only recently. Before 2008, they were almost fully monopolized, hence data are not relevant for our hypotheses, concerning competitive PP.

Figure 2: Gas procurement in time

Market_price/kWh   ● Final_price/kWh   ● Estimated_price/kWh

Source: own computation

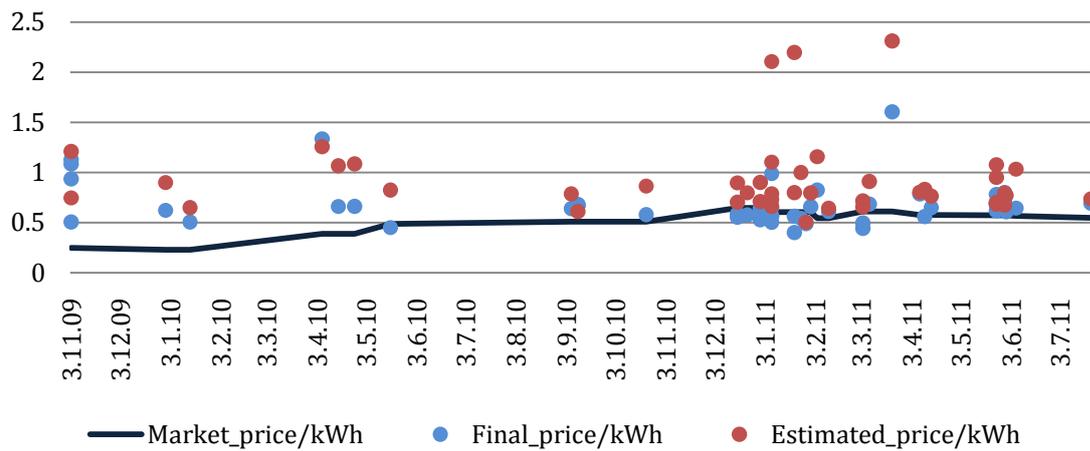As can be seen, the final prices are usually on or above the market price. Hypothetically, if all contracting authorities would be able to buy electricity at the market price, the public budget would save about 1.4 bn CZK (13 % off). Of course, we actually cannot say that this 1.4 bn CZK is the potential savings, but it indicates, that there is a space for possible cuts in electricity expenses. Another remarkable characteristic is, that in most of the observations the estimated unit price is above the final unit price, indicating that the contracting authorities are consistently overestimating the actual price of the procurement.

The following table shows the distribution of various institutional characteristics within the dataset. The dataset covers the 194 competitions that were using open procedure and the 65 tenders processed by negotiated procedures (with or without an announcement). Additionally, in 100 cases the contracting authority decided to use an electronic auction. The most frequent authorities of both electricity and natural gas procurement are public bodies and regional authorities.

Table 2: Contracting authorities of electricity tenders

	Total	Open procedure	Negotiated procedure	e-auction	Profit seeking firms	Public bodies	Regional auth.	Central state auth.
Electricity	206	157	49	76	14	61	77	54
Gas	53	37	16	24	10	17	24	2

Source: Our computation based on CAE

The supply side of market can be described as oligopoly. We have 13 electricity and 9 gas suppliers (please see the Appendix C for detailed table of suppliers) in our dataset. Three companies supply more than 77 % of the procurement volume in both cases. The Herfindahl

index measuring the market concentration equals to 0.25, which indicates high market concentration of suppliers in our dataset. The whole dataset of suppliers can be divided into three groups of similar companies in terms of their position and success on the market:

- The first group contains the big players on the market. In the case of electricity, four big players won 84 % of the total procurement volume, but only 35 % of the procurement cases. On the gas procurement market, three big suppliers cover 79 % of the volume, but 51 % of competitions. Those companies are highly successful when bidding for the largest contract, but they are usually not winning the smaller ones'[5].

- The second group encompasses small successful firms who supply lots of low-volume PP. The companies supply a relatively small share of the procured volume: 8 % of electricity and 6% of gas, but were able to win over 36 % of all electricity and 22 % of all gas PP cases in our dataset.

- The last group, called occasional suppliers, covers remaining suppliers who won only a few tenders. Together they supply 8 % of the electricity volume (15 % of gas volume) and 28 % of electricity PP cases (26 % of gas PP cases).

Potential differences in prices with respect to different types of suppliers might suggest some interesting features of examined procurement markets. Lower average prices of PP won by the big suppliers would suggest that suppliers are able to exploit some economies of scale. On the other hand, higher average prices might indicate that those big companies abuse their dominant positions[6]. At the same time, the group of small, successful firms should have (ceteris paribus) lower prices on average, as winning a procurement means offering the lowest price. Therefore if those companies win often, they should bid prices lower than others. Based on the discussion above, we decided to assess the fifth hypothesis:

> *Hypothesis H5: The final unit price of the procurement is affected by the type of the supplier.*

The important determinant of the outcomes from the procurement procedure is the number of bidders. The number of bidders varies around four (with SD of 1.7), which is similar to the average of the number of bidders in the whole PP market within EU (PWC, 2011). The

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[5] Since we do not have the information about bidders but only about winner of the procurement, we cannot say, whether the big companies are not winning the smaller procurement because they are not bidding in those procurement or whether they are bidding too high.
[6] Without sufficient track record, a company may not be able to compete in large PP's. Therefore competition in those might be limited to big players.

average amounts of bidders for gas is 3.3 (SD 1.6). So both the electricity and gas PP do not stand out in this characteristic. The comparison of the number of bidders with the amount of players on the whole electricity market is remarkable. As we discussed above, there are only 13 (9 in the case of gas) winners of PP and at least 4 bidders in the tendering procedure in more than 60 % of the cases. Therefore, the players must meet and compete with one another on a daily basis. At the same time, more than half of procurements have number of bidders higher than amount of big players on the market, therefore the small players are bidding in these PP as well. The outcome of such a competition might be a trend of decreasing the margins over the average market price in time. As we said already, both markets have been liberalized only recently, so the market is in consolidation period. Therefore we expect that final price will decrease over time, regardless of movements on the market. Thus we decide to assess the sixth hypothesis:

Hypothesis H6: The final unit price is decreasing over time.

Results and discussion

The results consist of two regressions, each for a given commodity. The regression analysis is based on the standard ordinary least square (OLS) method. The fulfillment of assumptions for the OLS method is discussed in detail in Appendix D. In both cases, the Breusch-Pagan test rejects the hypothesis of the homoskedastic residuals. Therefore, robust standard errors must be used in order to be able to use t-statistics and F-statistics for assessment of statistical significance. Moreover, the Shapiro – Wilkinson tests imply that the residuals of the models are not normally distributed (see appendix D). This might indicate that some nonlinear unbiased estimators might have a smaller variance. However, for the sake of simplicity, we prefer OLS as it already provides reasonably robust results.

The empirical analysis of electricity procurement is based on 206 observations (53 in the case of gas). Despite the minor methodological issues described above, the results appear to be relatively strong. The coefficient of determination (R-squared) for electricity dataset indicates that 63 % of the variation in the log (final price/kWh) is explained by variations in explanatory variables. The expectations about the significant differences in prices with respect of various kinds of contracting authorities were not confirmed (please see appendix D for the table of results including dummies for contracting authorities). On the other hand, all three important procedural characteristics seem to be significant determinants of the final price of the procurement, as can be seen in the Table 3.

Table 3: Electricity & gas procurement results; dependent variable: log(final price/kWh)

Explanatory variable	Electricity		Gas	
	OLS ß	Robust SE	OLS ß	Robust SE
log (estimated price/kWh)	0.64	(0.07) ***	0.41	(0.07)***
log (market price/kWh)	0.56	(0.11) ***	0.07	(0.12)
Open procedure	-0.07	(0.02)***	0.11	(0.13)
electronic auction	-0.06	(0.03)**	-0.17	(0.09)*
number of bidders	-0.012	(0.006)*	-0.04	(0.01)**
Big 4 suppliers	0.04	(0.04)	0.05	(0.08)
small successful suppliers	0.11	(0.03)***	0.16	(0.07)*
zIndex	0.05	(0.14)	0.3	(0.48)
Time	-0.00011	(0.00005)**	0.0006	(0.00035)
Constant	0.03	(0.1)**	0.2	(0.15)*
R-squared	0.63		0.71	
F- test	26.82		14.7	

Source: own computation based on CAE, note: robust standard errors applied, dropped dummies are negotiated procedure and occasional suppliers

The Ramsey reset test indicates that no quadratic form is missing in the model (see appendix D). Additionally, any interaction term was not found statistically significant. Thus, we dare to say that the causalities have linear character. The simple conclusion is, that the procedural characteristics do significantly affect the final price of the electricity PP. Results for gas are weaker; however there is still a statistically significant link between some PP features and the final price. The similarity of results for both markets also suggests that the findings may be in some sense general and have relevance also in other PP markets.

In both cases, the results indicate that the final price elasticity, with respect to the estimated price, tends to be higher than such elasticity with respect to the market price. In other words, the price expectation[7] of contracting authority does predict final price better than actual market price at the time, when bids are placed. The resulting market elasticity below one suggests high rigidity in the PP market. As the PP procedure usually takes several weeks to process and the contracts are signed for at least one-year, deliveries and the adjustments cannot be as flexible as the commodity market.

As we discussed above in the motivation, the estimated price captures the heterogeneity of the subject of PP, which creates differences in both estimated and final prices[8]. The core reason

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[7] The expected price is typically calculated 40-60 days prior to bidding process. Arguably it uses past prices of given authority as the most relevant input.
[8] If the heterogeneity had significant effect, there would be be a positive endogeneity bias in estimated price parameter.

for analyzing homogeneous goods was to eliminate such effect. However, such heterogeneity of the purchased goods should not explain the statistical differences in the procedural characteristics as there is no reason to believe that there is a correlation between differences in purchased good and differences in procedures.

Another explanation of higher estimated price elasticity might be that first price sealed bid auctions do not create a sufficiently strong competition environment. Potential suppliers are bidding on the basis of the willingness to pay of the contracting authority (equals to estimated price) rather than on the basis of the opportunity costs on the commodity market. However, such ineffectiveness in competition decreases in the case of an electronic auction or in where higher amounts of suppliers are competing for the PP.

The coefficient for the zIndex is insignificant in the model. This good practice indicator is designed as a proxy for wasteful behavior of contracting authority. The insignificance of the coefficient suggests that this good practice indicator does not provide any new information in the model, as the most important decisions (e-auction, procedure type, estimated price) are already explicitly present in the model.

The discussion of our empirical verification of such hypotheses follows:

> ***hypothesis H1: The final unit price of the procurement is affected by the type of the procurement procedure.***

A significant decrease in final until price, 7% on average, is present in the electricity dataset, when the open procedure is applied. Therefore, we cannot reject the hypothesis H1. Such a drop in final price is caused by the fact that open procedure provides a competitive environment, lowering the final price of PP. Any other type of procedure that restricts the competition causes a statistically significant increase in final price of electricity PP. In the case of gas, the insignificant results may be caused by poor datasets.

> ***hypothesis H2: The final unit price of the procurement is a decreasing function of a number of bidders interested in the procurement.***

> The electricity tenders are significantly sensitive to number of bidders: every additional bidder decreases the final price in average by 1 %. The gas tenders are even more sensitive, their price drops on average by 4 % with an additional bidder. Consequently, we cannot reject the hypothesis H2. The number of bidders has a positive effect on the competition

thus negative effect on the final price. Even though we tested for a potential quadratic form of relationship, the causality seems to be linear. Although we can hardly assume that the same effect would be caused by, for example, a 20th bidder. Nonetheless, within the plausible range, the relationship seems to be straightforward.

hypothesis H3: The usage of electronic auction reduces the final price of the procurement.

With usage of the electronic auction, the final unit price of the electricity PP falls in average by 6 %. On average, the gas PP using electronic auctions are 17 % cheaper. We cannot reject the hypothesis H3. The enormous difference between the electricity and gas electronic auction is again probably caused by poor dataset of gas PP. However, such dramatic falls in prices are caused by the ability of the electronic auction to allow bidders to adjust offered prices, therefore ending the competition only after no one is willing to bid a lower price. On the basis of these findings, utilizing the electronic auctions as frequent as possible seems to be very useful.

hypothesis H4: The final unit price of the procurement is affected by the type of the contracting authority.

We didn't find any statistically significant differences in the final unit price with respect to the different types of contracting authorities. Therefore we reject the hypothesis H4. The expected difference in prices, as presented in Bandeira (2009), were not confirmed (see table 5 in appendix D). National authorities purchase examined commodities with same prices as public bodies, regional authorities or state owned enterprises. Our expectations about different attitudes toward excessive spending with respect to different autonomies of institutions were not confirmed. Our explanation for this occurrence is that the commodity PP are usually a price driven bidding competition with not much space for discretion of different types of contracting authorities.

hypothesis H5: The final unit price of the procurement is affected by the type of the supplier.

We found statistically significant higher prices when small successful suppliers win the PP. We cannot reject the hypothesis H5. The higher prices are in contrast to our expectations. Since we do not find any characteristics that would distinguish the PP won by those firms from the rest, our explanation is that those firms are extremely successful in their bidding

strategies. The four or three big suppliers, who supply about 80 % of total volume of the commodities, do not sell them with some significant excess markup.

Hypothesis H6: The final unit price is decreasing over time.

In the case of electricity, the final price of PP decreases in time (as you can see in table 3), suggesting that the competitiveness on the market is increasing in time. We cannot reject the hypothesis H6. The results are consistent with our expectation that, as time goes by, the winners' mark-ups are falling.

Conclusion

The procedural characteristics affect the final price of PP significantly. Contracting authorities can reach a lower price of the PP by bringing a more competitive environment into the procedure. This might be achieved by using an open procedure that allows everyone to bid for the procurement. The contracting authority cannot choose a number of bidders in the PP, but it might easily encourage or discourage potential bidders by qualification criteria or other barriers to entry. The most effective device seems to be an electronic auction, which might strengthen the competition allowing the bidders adjust their bids. For PP of homogeneous goods, the additional administrative costs of e-auction are negligible (as estimated by Reimarová (2011) or PWC (2011)), but the potential savings are remarkable. Therefore it would be cost-effective to use the open procedure and the electronic auction as often as possible and encouraging as many extra suppliers as possible.

Our results are consistent with the academic literature (e.g. Bower (1993) or Bulow and Klemperer (1996)) and at the same time, they would be hardly a surprise for PP practitioners, to whom straightforward effect of the electronic auction or the open procedure is anecdotally known. Thus question arises – why do they stick with negotiated procedures, which objectively waste public money? Answer is open to further research, and may consist of their special requirements, corruption or plain rigidity.

The PP of homogeneous goods is a relatively small but still remarkable part of public purchases. At the same time, the unique features of PP of homogeneous goods allow us to identify relationships between the institutional setting of the procurement and its final price. Those relationships have been suspected by practitioners and theorists and the main contribution of this paper is its estimation of those relationships and the proof that the more competitive environment of PP is formed, the less will the procurement cost.

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Appendix

Appendix A – elements of legal framework

The Czech legislature, namely Act no. 137/2006 Coll. On Public Contracts (the PP Act), is generally the transcription of European directives (2004/17/EC & 2004/18/EC). These directives set up a common institutional framework and the basic terms for all EU countries. The following part of the appendix describes the most important term that needs to specify in order to understand presented discussion in the paper.

Contracting Authority is any public office which has to use the PP procedures when it wants to purchase any goods or services. **Bidder** is anyone who offers the delivery of goods or services in the PP procedure. The winning bidder signs a contract with the contracting authority and becomes a **supplier** of desired products.

Award procedure is a legal process of selection the supplier of PP. Both Czech and European legislature propose a variety of procedures, different in terms of openness, formalities or transparency. General process of decision making can be illustrated as follows:

Figure 3: General concept of public procurement process
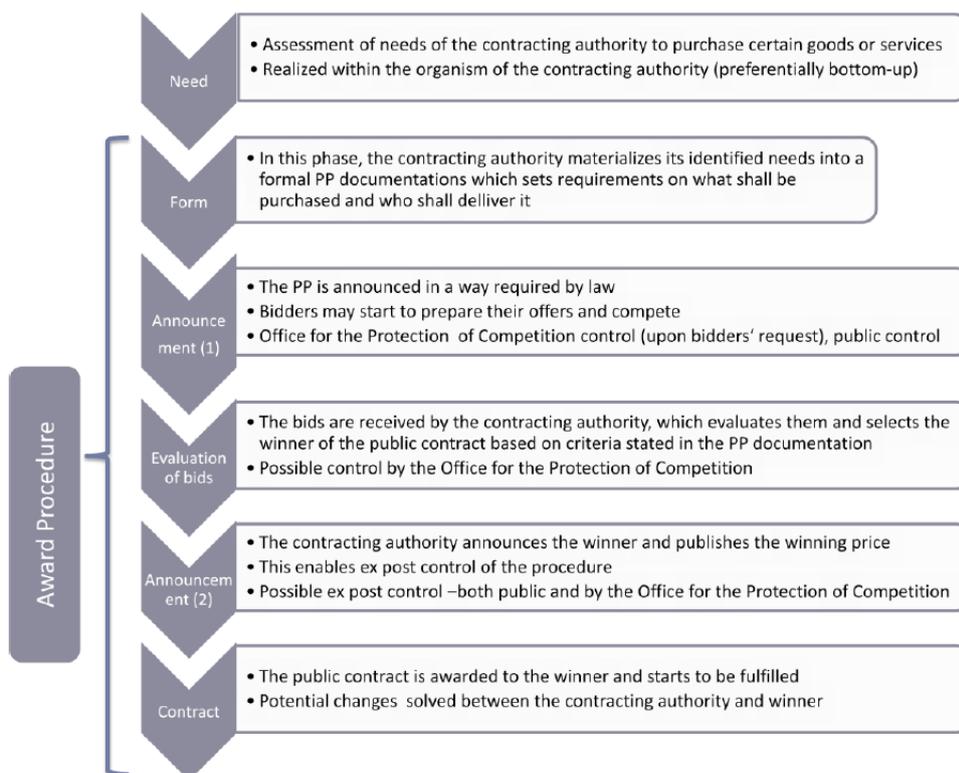
Source: Reimarová (2011)

As we said before, the most substantial institutional characteristic is an award procedure. Type of award procedure determines the openness and transparency of the process as well as time dimension and the number of bidders. For the purpose of this paper there are two most relevant basic types of award procedures:

- **Open procedure** allows everyone to bid in the tender. Contracting authority announce the intention to award a procurement on the internet and ask unlimited amount of potential suppliers who may bid for procurement after they show the fulfillment of qualification criteria.
- **Negotiated procedure** is the procedure whereby the contracting authority consults and negotiates the terms of contract with one or more of bidders. The use of this procedure is limited; contracting authority can use it only in some special cases, specified by the law. This procedure may or may not be published. The procedure is usually used when the previous open procedure was canceled or when the contracting authority needs to discuss with the suppliers before it specifies the subject of PP. However this procedure might be abused to restrict the competition, because it allows the contracting authority to award only those bidders who were asked for the bid in the tender.

Estimated price shall be understood as an amount of financial liability estimated by the contracting entity and ensuing from the performance of the public contract. The contracting entity shall calculate the estimated value on the basis of data and information on contracts of equal or equivalent subject-matter; where such information is not available, the contracting entity shall establish the estimated value based on data and information obtained by means of market research of required performance, or, if appropriate, on the basis of data and information gained in another suitable manner.

Electronic auction is a repetitive process of recessive auction that enables the bidders to cut down their offered prices in order to win the procurement. The auction ends in the moment where no one is willing to sell the goods for lower price. Electronic auction can be used within any type of the procedure, it is used only as a price setting device.

Contracting authorities

There can be identified four basic groups of the contracting authorities:

- **State authorities** such as ministries or national offices

- **Regional authorities** such as municipalities and regional offices

- **Bodies governed by public law** (public bodies) such as schools and hospitals

- **Profit seeking firms** such as state owned enterprises ("SOE") and utilities - entities operating in the water, energy, transport and postal services sectors

Each of these categories might have different attitude to excessive expenditures and wasting of sources. Such a different attitude is made by the different connection to the state budget, the "softness" of its own budget - the possibility of being bought out or other sorts of financial help from the state budget in the case of financial difficulties.

Appendix B – components of zIndex

Openness:
1. PP share on total spending on purchases - punishes avoidance of PP (through portioning), or extending contracts beyond their limits.
2. PP openness - rates according to openness of legal regimes used for PP
3. Elementary violations of transparency - punishes failure to announce PPs or their price

Competition:
1. Winner's concentration - punishes repetitive PP awarding to one or few suppliers
2. Bidder count - measures average number of firms competing for PP
3. Deadlines - punishes setting unrealistically close deadlines for placing bids

Accountability:
1. Legal violations - measures number of erroneous PPs detected by regulatory office
2. Supplier rating - a supplier transparency measure composed of several sub-indicators
3. Data quality - counts mistakes in crucial published data (mainly company identification, preventing traceability)
4. Information provision - measures time and quality of an institution's response to information inquiries

Source: Zindex.cz

Appendix C – PP Suppliers in dataset

Table 4: Electricity suppliers

Supplier	Total value of PP (CZK)	Total share	Amount of tenders
ČEZ Prodej, s.r.o.	4 385 554 898	41%	19
United Energy Trading, a. s.	2 445 139 040	23%	24
E.ON Energie a.s.	1 382 817 052	13%	15
Pražská energetika a.s.	768 806 388	7%	15
Lumius, spol. s.r.o.	611 974 852	6%	41
CENTROPOL ENERGY a. s.	234 716 403	2%	34
7 other suppliers	803 179 880	8%	58
Total	10 632 188 514	100%	206

Source: Our computation based on CAE

Table 5: Gas procurement suppliers

Supplier	Total value of PP (CZK)	Total share	Amount of tenders
Pražská plynárenská a.s.	645 553 356	38%	10
ČEZ Prodej, s.r.o.	355 192 334	21%	2
Pragoplyn, a.s.	328 415 670	20%	15
VEMEX s.r.o.	116 732 124	7%	1
Lumius, spol. s.r.o.	104 494 697	6%	12
4 other suppliers	130 769 623	8%	13
Total	1 681 157 804	100%	53

Source: own construction based on CAE

Appendix D – OLS assumptions

OLS must satisfy classical linear model assumptions to provide the best unbiased estimator.

At first, the model must be linear in parameters – that's determined by the model described in *Motivation & hypotheses*. In similar way the randomness of data sample was discussed already in Data description. To repeat the conclusion: the dataset covers all public contracts within given type of the commodity minus those incomplete observations. Since we do not find any reason why the incomplete observations should be correlated with final unit price, we dare to say that the dataset is a random subsample of the initial procurement sample.

First tested assumption is the homoskedasticity of residuals (same variance given any value of the explanatory variable). As can be seen in the table below, the Breusch-Pagan test rejects the hypothesis of homoskedastic residuals in both cases.

Table 1: Breusch – Pagan test, H0: constant variance of residuals

	Electricity	Gas
χ^2	53.29	16.42
$P > \chi^2$	0	0

However, heteroskedastic residuals do not cause any bias in the estimations. Nothing but the robust standard errors need to be applied in order to be able to use a t-statistics for assessment of statistical significance.

Next tested assumption is normality of residuals in the model. As can be seen in table below, the Shapiro – Wilk test rejects the hypothesis of normally distributed residuals in both cases.

Table 2: Shapiro - wilk test, H0: normal distribution of residuals

	Electricity	Gas
z	4.39	2.98
P > z	0	0

There might exist some nonlinear unbiased estimators which will have a smaller variance. However, since the goal of this paper is to test hypothesis state above, the simple OLS method is sufficient for that purpose. The dataset is sufficiently large enough to conclude that the OLS estimators satisfy asymptotic normality and using the t- and F- statistics is possible for testing the hypotheses[9].

Another assumption that needs to be tested is the absence of the multicollinearity. We use variance inflation factor (VIF) as an indicator of the potential multicolinearity and it does not indicates such threat.

Table 3: Variance inflation factor

	Electricity	Gas
Mean VIF	1.33	1.22

At last but not least a correct model specification needs to be tested. As can be seen in table 4, squares of the fitted values are insignificant, suggesting, that no squared of explanatory variables are missing and therefore the relationships seem to be linear.

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[9] For further discussion on this topic see Wooldridge, J. M.: Introductory Econometrics, Fourth Edition, South-Western, 2009, page 173

Table 4: Squares identification: (fitted of log(final unit price))²

	Electricity	Gas
t	1.07	-1.24
P > t	0.287	0.222

Classical linear model assumptions were tested; the eventual issues were discussed and resolved. Therefore the OLS estimators can be applied for our empirical study.

The following table shows our results including insignificant variables.

Table 5: Electricity & gas procurement results – including contracting authorities; dependent variable: log(final price/kWh), 259 observations

Explanatory variable	Electricity OLS ß	Electricity Robust SE	Gas OLS ß	Gas Robust SE
log (estimated price/kWh)	0.66	(0.07) ***	0.42	(0.06)***
log (market price/kWh)	0.55	(0.11) ***	0.21	(0.23)
Open procedure	-0.09	(0.03)***	0.11	(0.13)
electronic auction	-0.08	(0.03)**	-0.24	(0.13)*
number of bidders	-0.013	(0.007)*	-0.04	(0.017)**
Big 4 suppliers	0.06	(0.04)	0.1	(0.07)
small successful suppliers	0.13	(0.04)***	0.24	(0.08)*
zIndex	0.09	(0.14)	-0.5	(0.36)
Time	-0.00013	(0.00005)**	0.0003	(0.0004)
SOE	-0.06	0.04	-0.05	0.12
Public bodies	-0.09	0.05	-0.12	0.09
National auth.	-0.11	0.07	0.23	0.15
Constant	0.09	(0.11)	-0.8	(0.35)**
R-squared	0.64		0.71	
F- test	23.20		14.7	

Source: own computation based on CAE, note: robust standard errors applied, dropped dummies are negotiated procedure, occasional suppliers and regional authorities

The joint F-test for contracting authorities induces us to reject hypothesis H4 (p=0.26 for electricity, p=0.19 for natural gas).

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