CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Jiří Čep

Public Procurement Procedures and Their Effects: Evidence from the EU

Bachelor thesis

Prague 2019

Author: Jiří Čep

Supervisor: Mgr. Miroslav Palanský

Academic Year: 2018/2019

Bibliographic note

Jiří Čep. *Public Procurement Procedures and Their Effects: Evidence from the EU* Prague 2019. 70 pp. Bachelor thesis (Bc.) Charles University, Faculty of Social Sciences, Institute of Economic Studies. Thesis supervisor Mgr. Miroslav Palanský

Abstract

The goal of this thesis is to analyze the effect the choice of procurement procedure has on the price of public procurement. We achieve this by investigating the dataset on public procurement data in the EU by the Digiwhist project. In the presented model, we explain the variation in the difference of final and estimated price of procurement as a function of procurement procedure used and a set of auction characteristics such as the number of bidders, contract complexity, type of supply and others.

The results show that the open procedure is generally superior to its alternatives in terms of monetary savings. We also demonstrate that in the open procedure, the largest part of the cost reduction comes from the competition effect caused by the number of bidders present, whereas other procedures are not as sensitive to changes in the number of bidders. We find that the average number of bidders is significantly lower than the optimal number would be.

Abstrakt

Cílem této práce je analyzovat efekty výběru druhu zadávacího řízení na cenu veřejných zakázek. Toho jsme dosáhli s pomocí datasetu s informacemi o veřejných zakázkách na území EU poskytnutým projektem Digiwhist. V použitém modelu vysvětlujeme variaci v rozdílu konečné a odhadované ceny zakázky jako funkci použitého druhu zadávacího řízení a sady vlastností

řízení jako počtu uchazečů o zakázku, komplexity kontraktu, typu dodaného zboží/služeb a dalších.

Naše výsledky odhalují, že otevřené veřejné řízení je, co se peněžních úspor týče, obecně nejvýhodnější druh řízení. Také jsme prokázali, že během otevřeného řízení největší část snížení nákladů je díky větší konkurenci plynoucí z většího počtu přítomných uchazečů, zatímco ostatní druhy řízení na tomto do stejné míry závislá nejsou. Na závěr jsme spočítali, že průměrný počet uchazečů ve všech druzích řízení je značně menší než by byl počet optimální..

Keywords

public procurement, procurement procedures, open procedure, negotiated procedure, restricted procedure, cost of procurement

Klíčová slova

veřejné zakázky, druhy zadávacích řízení, otevřené řízení, jednací řízení, užší řízení, cena veřejných zakázek

Declaration of Authorship

I hereby proclaim that I wrote my bachelor thesis on my own under the leadership of my supervisor and that the references include all resources and literature I have used.

I grant a permission to reproduce and to distribute copies of this thesis document in whole or in part.

Prague, 30 July 2019

Signature

Acknowledgment

The author would like to express my gratitude to everyone who supported me during the writing of these thesis and a special thanks to my supervisor for helping me successfully writing this thesis.

This research has benefited from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 681228.

Contents

Introduction

At least 14% of GDP of all countries in the EU or 1.9 trillion EUR gets spent each year on public procurement. Therefore, having the right policies set up for conducting public procurement can mean significant savings for public authorities. One of the polices the public authorities get to decide on is the type of procurement procedure. There are several types of procurement procedures like open procedure, negotiated procedure with or without publication, restricted procedure or competitive dialog. Those differ in competitiveness, the openness of the process, entry barriers, time durations of the tendering process and other parameters. This aims plans to investigate the effects of these procedures in the European Union.

It achieves this by first assessing the formal rules for public procurement in the EU as written in Directive 2014/24/EU on public procurement and later conducting a regression analysis of data supplied by the Digiswhist project, an EU funded initiative focused on battling corruption in public procurement section by making the procurement data transparent and readily available. The used dataset was just recently made available to the public and thus this thesis is be one of the first to conduct any analysis of the data.

The main focus of this thesis is to study the monetary savings as a result of public procurement procedures used. Hence, the time dimension (savings measured in days) and the quality dimension were disregarded, mainly due to unavailability of the data. Furthermore, the effects of competition, transparency and bidder participation in auctions will be studied, as those measures are closely related to the type of procurement procedure used.

The results show us that there indeed is a statistically significant difference in final prices of auctions between different types of procurement procedures. We also concluded that the open procedure yields the most cost-effective results compared to the other procedures, with the increase in costs ranging from 1.8% in case of negotiated procedure with publication to 6.8% in case of competitive dialog.

Additionally, we studied the effect of a single additional bidder in different

procedures and the ideal amount of bidders. We reached a conclusion that open procedure, in addition to the largest overall effect on procurement cost reduction, is also the procedure with the greatest effect of a single bidder by a large margin. Also, a test for an optimal number of bidders in each procedure was conducted, from which we decided that the optimal number of bidders for open procedure is 20, while for negotiated procedure with publication and restricted procedure it is 10 and 18, respectively.

The conclusions of this thesis are primarily important for all levels of contracting authorities of the EU. It provides them with additional insight into the effect the various procurement procedures can have, possibly resulting in considerable monetary savings. That being said, the general outline of the results is in line with the available literature on the topic. Palguta (2012) [31] and Soudek (2013) [36], arrive at the same conclusion - that open auctions are the most beneficial in terms of pure monetary savings. The general literature agrees that increased number of bidders has a positive effect on the project price and Bajari and Tadelis (2006) [39] state that the benefits of open procedure consist mainly of the number of (qualified) bidders. Therefore we can observe that our findings are also in accordance with existing literature.

The thesis is divided into three parts: theoretical part, empirical part, and results and discussion. In the theoretical part, we first define basic terms used in the text, later we take a closer look at the characteristics of different procurement procedures from a legal point of view and then we examine other procurement characteristics, f.e. the thresholds triggering EU-wide rules. Lastly, we take a look on the existing literature on the topic. In the empirical part, we first state our motivations for this thesis, then we assess the available data and scrutinize the variables and their expected effects and state the possible data limitations. Later we explain the methods used and investigate possible problems with the dataset. After that, we state our model and hypotheses. Lastly, we assess the assumptions for ordinary least squares estimation. In the last part, we interpret our models and later we

evaluate the previously stated hypotheses.

1 Theoretical background

1.1 Definitions of basic terms

Public procurement, as defined by the European Commission, is a process by which public authorities, such as government departments or local authorities, purchase work, goods or services from companies.

Contracting authorities means any government authorities or bodies governed by public law or associations formed by such authorities or public bodies which need to obtain either works, supplies or services via public procurement. For our purposes, we can divide contracting authorities into four groups:

- Central government authorities and their subsidiaries, such as ministries and national offices
- Local authorities, such as municipalities and regional offices
- Bodies governed by public law, such as schools or hospitals
- Profit-seeking firms, such as state-owned enterprises, utility companies or postal companies

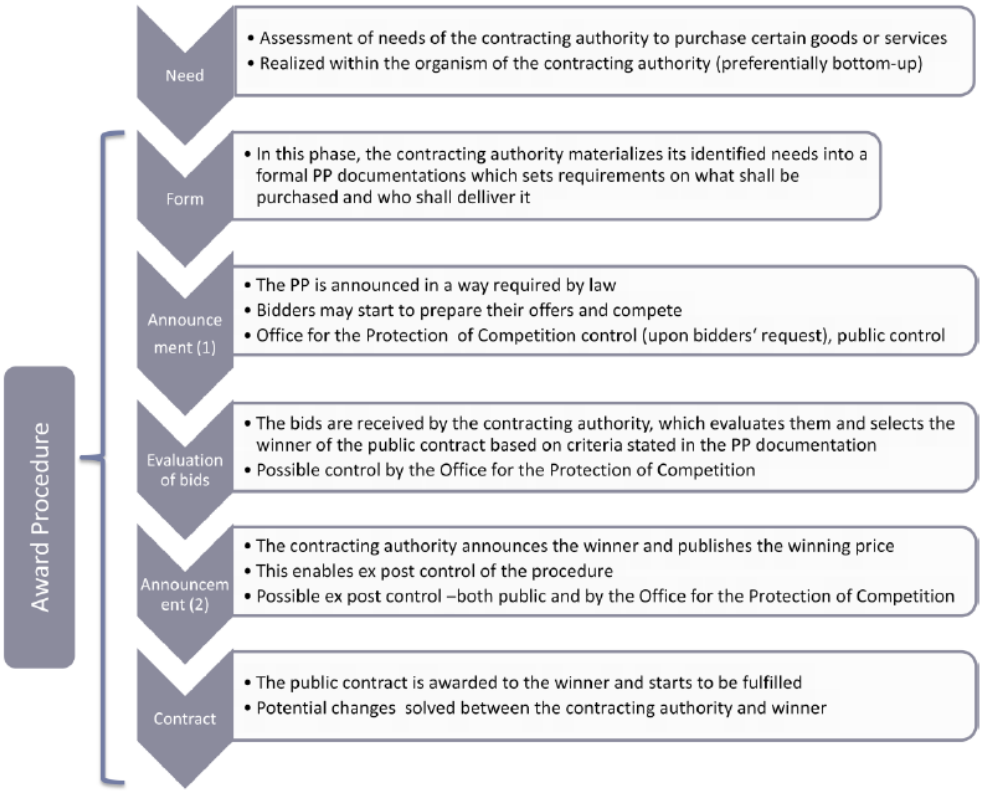
Supplier can be any entity who is able to supply the needed goods, services or works to the contracting authority. In case the supplier submits a request to participate in a procurement process, he becomes a **bidder**. Unlike the supplier, bidder is a part of a legal relationship and must comply with applicable law.

Public procurement procedure legal process the contracting authority follows when selecting a winning bidder. A variety of different public procurement procedures are available to public authorities, each offering a distinct combination of openness, transparency and different formal requirements, which in turn influence the essential characteristics of a public contract, such as the time frame, number of bidders and the characteristic central to this study, the final price of a contract. As procurement procedures play a paramount role in this thesis, we shall dedicate a separate

section to examine all relevant types of procedures.

Electronic auction or e-auction is a process that can be used simultaneously with most of the procurement procedures. It is usually conducted as a reverse auction, meaning, in this case, that the contracting authority puts up a request for a required good or service and sellers then place bids for the amount they are willing to be paid for the good or service. At the end of the auction, the seller with the lowest amount wins. It is used mainly when the final awarding mechanism is based mostly on price.

Figure 1: General process of public procurement



Source: Reimarová (2011) [35]

1.2 Closer examination of possible procurement types

On 24th February 2014, a new EU directive 2014/24/EU [14] was adopted. The member states of the EU had until 18 April 2016 to implement the aforementioned directive into their national legislation. There are several major

differences from the previous directive, 2004/18/EC [13] from 31 March 2004, which we will examine shortly. EU directives dating older than that are not of particular interest for the purposes of this study, since the available data spans from 2006 to 2018. The main goals of those changes were to: make small and medium enterprise participation in public contracts easier, make more provisions on grounds for exclusion and award criteria, improve safeguards against corruption, improve electronic procurement and make procurement procedures more flexible [16]. The procurement procedures this study shall be focusing on are as follows:

Among the most prevalent, there is the **Open Procurement Procedure** (or open auction). In open procedures, any interested economic operator in possession of the required certification is able to submit bids. The interested parties have at minimum 35 days to submit their bids, or 15 days if prior information notice was published or in case of urgency. Interestingly, the closed auction principles are used, meaning that until the opening of the bids, the bidders do not know of the other bidder's offers. The bids are later evaluated and a winner is selected based on a previously announced award mechanism.

The second of the procedure types, which are to be of main interest for this work is **Competitive Procedure with Negotiation** or in other words, the **Negotiated procedure with prior publication**, during which the contracting authority needs to publish a contract notice, for which any supplier can make a request to participate. In the procurement documents, contracting authorities need to provide a description of the characteristics required of the supplies, works or services to be procured and specify the contract award criteria. Said information is required to be sufficiently precise for the economic operators to decide whether to participate in the procedure further. The interested contractors then submit their offers and fill out the Pre-Qualification Questionnaires and based on those, the contracting authority will judge their qualifications and exclude from further process those who do not meet the required selection criteria are barred from further partici-

pating in the project - this is called the Pre-Qualification Phase. A minimum of three selected contractors will be invited to negotiate the specific features of the project, which may result in a new or revised tender. There are no regulations governing the actual conduct of these negotiations, however, the EU Treaty Principles of equal treatment, transparency, proportionality ,and non-discrimination apply. The time limit to receive requests to participate is 37 days from the publication of the contract notice, however, in case of urgency, can be reduced to 15 days, or 10 days in case the contract notice was sent electronically.

Moreover, a similar procedure to competitive procedure with negotiation may be used in certain cases - that is, if the open auction fails to attract a minimum amount of plausible bidders, the contract can be carried out by only a particular firm or in the case of extreme urgency. This procedure is called **Negotiated Procedure without Prior Publication**. Said procedure is indeed very similar to the Negotiated procedure with prior publication, except in this case, the procurement officer will directly approach one (or more) suppliers to negotiate the terms of the contract.

The next major procurement type of interest is the **Restricted procedure**. As in the open procedure, during restricted procedure any bidder may ask to participate in the bidding process, in this case, however, the same prequalification phase as in negotiated procedure with prior publication is used to thin the pool of contractors. In this case, the contracting authority has to select at least 5 candidates, who will subsequently submit their tenders. The time limit to request participation is 37 days from the publication of the contract notice and selected candidates then have 40 days to submit a tender. This can be reduced to 36 days if prior information notice was sent or even further in case of time pressure.

Numerous other procedure types are used in the European Union. For example the Competitive Dialogue, which is used when contracts are so complex that the contracting authorities find it hard to specify the contract details themselves and therefore discuss the tenders specifics directly with the

qualified bidders. **Innovation Partnership**, which is a new procedure in the 2014/24/EU directive, is used when there is a need for the development of an innovative product or service. The last but not least procedure is a **Design Contest**, during which the interested parties submit their project plans and a jury selects the most suitable one. Nevertheless, the last two types of procurement procedures are only marginally represented in the available dataset, therefore they are not of major concern for the purpose of this study.

1.3 Closer examination of other procurement characteristics

Another issue in need of discussion are the *Thresholds triggering the EU-wide rules*. In the case that the estimated tender value is below those monetary thresholds, the EU-wide rules do not apply and the tenders are carried out under national rules - those are called the *below-threshold procedures*. This means that, in some cases, contracts can be awarded in accordance with national laws, which might result in the contract awarded to firms outrightly, as it happens in a number of cases in the dataset (although most of them will be eliminated during the initial thinning). Therefore, we later use only above threshold projects in our analysis. Those thresholds as of April 2019 (the thresholds are being raised over time, presumably to cover for inflation) are, according to Directive 2014/24/EU [14], Article 4: EUR 5 548 000 for all works contracts for both central and sub-central government authorities, EUR 221 000 for public supply and services awarded by sub-central government authorities and design contests organized by them or for contracts on all defense products not listed in Annex III of Directive 2014/24 and EUR 144 000 for public supply and services awarded by central government authorities and design contests organized by them or for contracts on all defense products listed in Annex III of Directive 2014/24. A threshold of EUR 750 000 on services from the fields of social welfare, healthcare, administrative, education, postal and more. Finally, according to Directive 2014/25/EU [12] on procurement by entities operating in the

water, energy, transport and postal services sectors, in Article 15 it can be found that the thresholds are EUR 1 000 000/EUR 414 000 for all supply and service contracts from the relevant field listed/not listed in Annex XVII respectively.

After the bids from the firms are submitted, one of the two possible award mechanism is used. In the 2014/24/EU Directive [14] (Article 67), it was established that if the contractor is complying with obligations in the field of environmental, social and labor law, national law, collective agreements and by the international environmental and the social and labour law provisions, only the most economically advantaged tender (MEAT), while in the previous Directive 2004/18/EU [13] (Article 46), both the lowest price award criteria and MEAT was possible. In the former, the contracting authorities simply select the bid with the highest rebate with respect to the estimated contract value, whereas in the latter, the municipalities take a cost-effectiveness approach and select the winning bid based on multiple criteria, including but not limited to: quality, accessibility, organization, qualification and experience of staff assigned to performing the contract, after-sales service and technical assistance or delivery conditions such as delivery date, delivery process and delivery period.

Another important distinction is between fixed price and cost-plus (or cost reimbursement) contracts. While the former, according to which the final payment to the contractor does not depend on the amount of resources used or material expended, is more straightforward to use, the latter, featuring the mechanic of the contractor getting paid their expenses plus additional payment, which will result in their final profit, allows for more flexibility during the project. Unfortunately, we were not able to use the last two contract characteristics in our analysis due to the unavailability of data. We had no access to data on whether fixed price or cost-plus mechanism was used and more than 98% of data in our final dataset lacked information on award mechanism used. Nevertheless, we feel that both of these variables can have an impact on project efficiency.

1.4 Literature review

As was already mentioned in section 1.1, we recognize 4 tiers or contracting authorities, from the most to the least central. The contracting authority is also the agent with the most decisive power, because, as described for example by Laffont and Martimort (2009) [27], they are a subject to the principal-agent problem, wherein the agent (contracting authority, in this case) is able to make decisions and take actions on behalf of the principal (usually the state) and where the agent serves his own best interest, as opposed to the best interest of the principal. Hlaváček (1987) described such agent as Homo as assecurans [21], an entity having no profit motive and being only interested in keeping their job. In this thesis we use the type of contracting authority as a control variable.

One of the first to conduct research into the effect of competition increase on the cost of public procurement were Domberger, Hall and Ah Lik Li (1995) [11], who, based on a dataset of 61 cleaning contracts from school and public offices in Australia, arrived at the conclusion that increased competition (an increase in the number of bidders) does significantly lower contract price while at the same time keeping the same quality of service.

Goldberg (1977) states that "competitive bidding is seen to be a heterogeneous class of devices for transmitting information between organizations. As such it is both a substitute and complement for alternative devices such as negotiated contracts". [18]

Several studies, among them one of Klemperer (2004) [25] suggest the optimality of open auction outcomes, more precisely, they show the efficiency of auctions, since, under revenue equivalence theorem assumptions, the auctioned object (or contract, in our case) is allocated to the bidder with the highest value. According to Bulow and Klemperer (1996) however, "a single extra bidder *(in case of an open procedure)* more than makes up for any diminution in negotiating power" [6]. Therefore, the contracting authorities tend to be better off by spending resources to seek out more potential contractors rather than spending those resources to conduct negotiations with

one less contractor. Many other authors measure a different positive impact of the increase in auction participants on the final tender price. For example, Pavel (2009) [32] observes an average 4.4% of estimated price savings per every additional applicant on a dataset of construction works in the Czech Republic. Amaral et. al. (2013) [1] state that with an increase in the expected number of bidders, the price of the winning bid falls. On the other hand, Kuhlman and Johnson (1983) [26] discover that the actual, rather than the potential number of participants has an effect on the final price and they quantified that each new bidder reduces the average final price by 2% on the dataset of US highway construction works.

At the same time, multiple authors find the effect of more competition uncertain. For example, both Hong and Shum (2002) [23] and De Silva et. al. [9] bring up a concept of two adverse effects. A "competition effect", which causes a decrease in procurement costs through increase in the number of bidders and the "winner's curse" or the "entry effect", due to which, because of higher expected competition and therefore lower anticipated profit margins, the actual number of bidders might decrease in consequence of increasing the expected number of bidders if the entry effect offsets the competition effect. In accordance with that, Onur and Tas (2018) [30] estimate the number of bidders where procurement costs still decrease to be six to eight. We later use a similar method to study the optimal number of bidders in various procurement procedures, only based on EU data, rather than Turkish. We, however, arrive to a much higher optimal bidder number.

According to Holmes (1995) [22], the two main objectives tender procedures aim to achieve are public accountability and the ability to obtain the best value for money. Since the auction mechanism is set to make the bidders act competitively, then under ideal conditions (a large enough number of bidders, no bidder collusion) the first objective is usually achieved [20]. The second objective is of great importance in the public sector and luckily the general public perceives the open procedure as the fairest and most transparent, the qualities that help to fight corruption and political

favoritism.

The main type of public works where the open procurement procedure fails to bring better results than the other procedure types are highly complex contracts. As Goldberg (1997) states: *"in its simplest manifestation it (competitive bidding) is a price-searching device, but as the complexity of the transaction increases, the relative significance of the price term will diminish. Competitive bidding for the provision of complex goods and services ... will look very different from a simple price-search model. The properties and the relative efficacy of competitive bidding mechanisms will depend crucially on the subject matter of the bidding competition".* [18] The author claims that, in the case of complex projects, the ability to discuss the potential obstacles of the project is crucial, given the difficulty to specify all contract elements prior the tender process. Due to the nature of open procurement procedure, this is impossible, whereas the negotiated procedure allows such practices. Baldi and Botasso (2016) [5] study this further and arrive to the conclusion that *"On average, a rise in the project complexity index from the 25th to the 75th percentile of its distribution increases the probability of procuring the project with a negotiated procedure by about 6%-8%".*

On the other hand, open auctions suffer from several problems, one of them being the relative inaccessibility of the process for small and medium firms, as pointed out by MacManus (1991). The author also states that *"Several small firms also complained that the mere costs of researching voluminous specs and 'regs' put them at a disadvantage and discouraged them from bidding on government jobs".* [28]

Furthermore, open procurement procedure is especially susceptible to adverse selection risk. Bajari and Tadelis (2001) doubt that the procurement problem is "one of ex-ante asymmetric information coupled with moral hazard", as it is described in most of the economic literature of the time, rather they believe the problem is largely "one of ex-post adaptations and adverse selection". [4] Their model also describes a link between cost-plus contracts and increased project complexity. Also Spulber (1990) shows the advantage

that the most opportunistic bidders can gain by offering unrealistically low prices. [37]

In his their recent work, Bajari et. al (2009) [2], among other things, point out that, compared to open auctions, restricted actions and the negotiated procedure tends to select more reputable contractors.

Another problem open auctions can be **collusion rings** among contractors or so-called bid-rigging. *"Bid rigging (or collusive tendering) occurs when businesses that would otherwise be expected to compete, secretly conspire to raise prices or lower the quality of goods or services for purchasers who wish to acquire products or services through a bidding process."* [29].

OECD recognizes four types of bid-rigging - cover bidding, bid suppression, bid rotation, and market allocation, however, all of them aim to create a semblance of competition where there actually is not one. The bidders submit overpriced bids, do not bid at all, withdraw their bids and in turn expect the other firms to do the same.

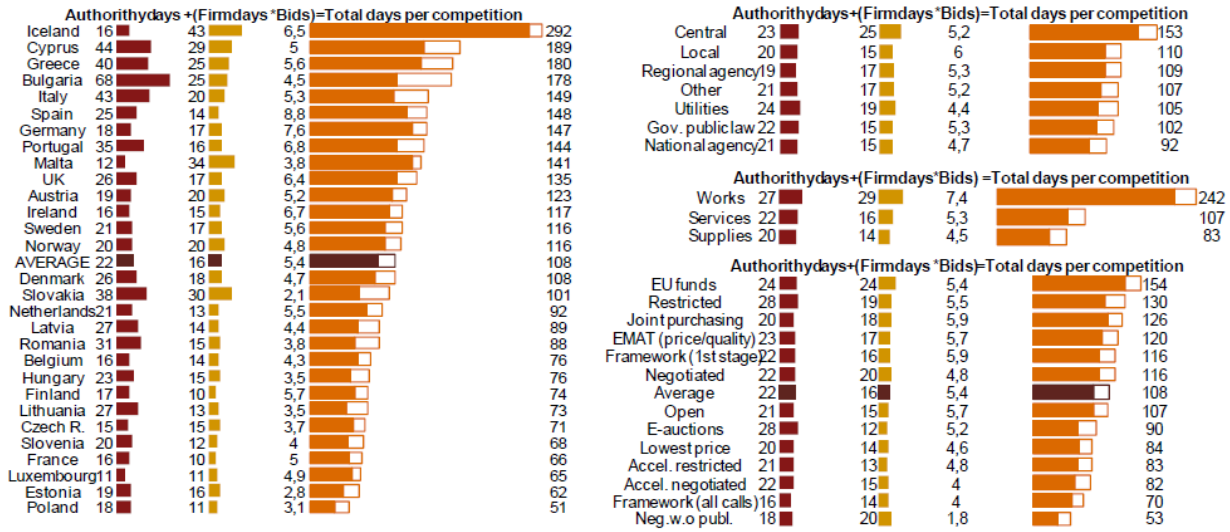
Multiple empirical works have proven the presence of collusion in bidding, for example, Conley and Decarolis (2016) [17] find that no less than 30% of average bid auctions are affected by coordinated groups on the sample of 802 average bid auctions in Italy in the years 2005-2010 or Pesendorfer (2000)[34], who analyses the functioning of bidding cartels on the case of first-price auctions of school milk contracts in Texas and Florida during the 1980's.

Another issue are the transaction costs in procurement. Transaction costs can be described as any costs of the contract, which at the same time are not the costs of an actual contract. Moreover, they can be divided into ex-ante costs (pre-award), costs incurred during the very award, ex-ante costs (post-award), and litigation and complaint (if those apply). Those costs are further composed the search and information costs, bargaining costs and policing and enforcement as stated by Dahlman (1979) [8] and are considerable on both sides of the contract. However, since as Pavel (2009) [32] states, the costs of the bidder are usually included in the final price of the contract, we

shall focus on the transaction costs on the side of the contracting authority.

Riemarová (2011) [35], in her study on Czech procurement data notes that transaction costs can vary. According to her, those can range from 1 000 EUR to 20 000 EUR based on the type of procurement procedure, the number of bidders, the contract value and last but not least, whether the project administration was made in-house or it was outsourced, calculated with man-days used times the average wage. Pwc (2011) [38], in their report for the European Commission, have calculated the procurement costs in various states of the EU, as well as costs by both the type of contracting authority and the type of procurement procedure.

Figure 2: Costs of public procurement



Source: PwC: Public procurement in Europe. Cost and effectiveness, 2011

As we can see from the above figure, the costs of procurement expressed in man-days, the average number of bids vary significantly in the European Union. More importantly, we can observe great differences in the costs of procurement procedures, with the costs of negotiated without publication being by far the lowest, mainly because of the extremely low amount of average bids compared to the other procedures and restricted procedure being the most expensive, particularly due to the high time demands on both the contracting authority and the firms. The study has also found out that contracts from the "works" category to be by far the most expensive,

compared to the two other types.

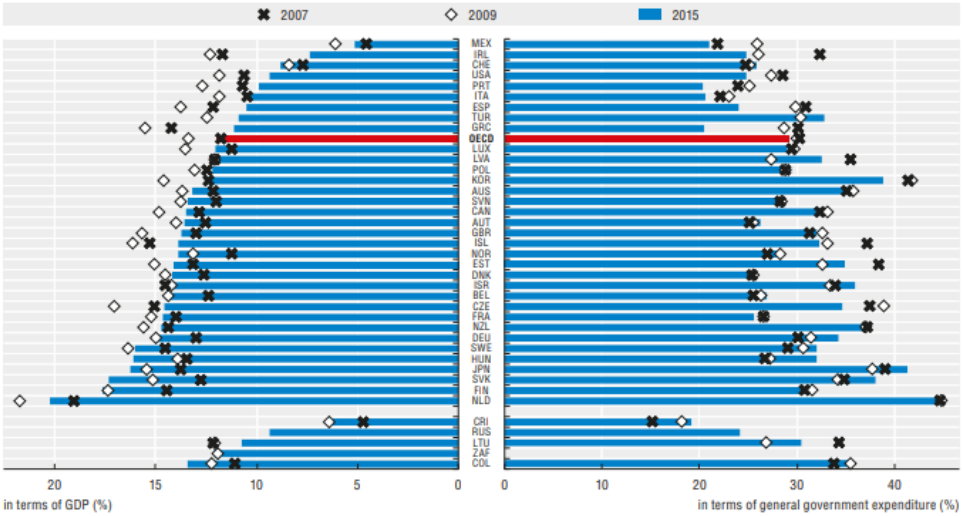
Studies with a goal similar to our thesis have been conducted by multiple authors (Pavel (2009) [32], Palguta et. al. (2012) [31], Amaral et. al. (2013) [1]), however, they are usually not focused entirely on the effect of procurement procedures and are mostly focused on a smaller geographical area, usually only one country.

2 Empirical part

2.1 Motivation

According to European Commission factsheet, the volume of GDP spent every year on public procurement reaches 12% in the OECD countries and is as high as 14% in the EU [15]. That amounts up to EUR 1.9 trillion in the EU. Those numbers are an estimate from 2017 and they do not account for spending by utility companies. Former estimates including utility procurement are around 19% of EU GDP, i.e. roughly EUR 2.3 trillion.

Figure 3: Government public procurement spending in the OECD



Source: OECD: Guidelines for Fighting Bid Rigging in Public Procurement, 2009

Based on said facts and the above graph, we can conclude that public procurement spending is an important part of government expenditure and therefore it is crucial to maximize the effectiveness of the institutional framework.

In the past, research into public procurement was not a mainstream economics topic, possibly because the data used to be hard to access, whereas the public authorities were not transparent with their suppliers and were reluctant to show the public how they spend their tax money. In recent years

though, the public has started pushing for more transparent government and thus, public procurement data slowly become more readily available.

2.2 Data description

For our used dataset, we have selected a list of public procurement contracts downloaded from *www.opentender.eu*, one of the portals under the Digiwhist project. Digiwhist (The Digital Whistleblower) is an EU funded project of six research institutes of different European universities with the aim to empower the general public to combat public sector corruption. This is to be done by doing research into government contracts, providing information to the public and last but not least, by making the data on public procurement contracts accessible.

The digiwhist project has downloaded the raw procurement data from various national registers of 25 countries of the EU. Since the EU lacks a unified central database of public procurement data, the data was in multiple forms: web pages, FTP servers, or JSON or CSV data dumps. The data was later formatted, structured and cleaned to form out initial dataset. Because different countries have different reporting standards and also because some data does not get reported due to the bureaucratic process, a large portion of data contains missing variables.

The data available is from the years 2009-2020 (with information about planned future contracts as well), we, however, found it suitable to use only data from years 2009-2018 due to a large portion of contracts from years 2019 and 2020 being not finalized. The year 2009 is the year the dataset starts due to a change in EU legislative, which made public procurement data more available to the public.

Our dataset has initially contained 20 851 010 entries about contracts and lots from contracts from all of the countries of the European Union and occasional EU territory or non-EU state. Because those states do not usually use the same rules on procurement as does the EU, data from non-members or nondirect members were dropped. This change has left us with 19 821

187 observations.

In the models, we shall use the percentage difference between the final and estimated prices as a dependent variable, which was created as follows:

$$\frac{(final\_tender\_price - estimated\_tender\_price) * 100}{estimated\_tender\_price} \tag{1}$$

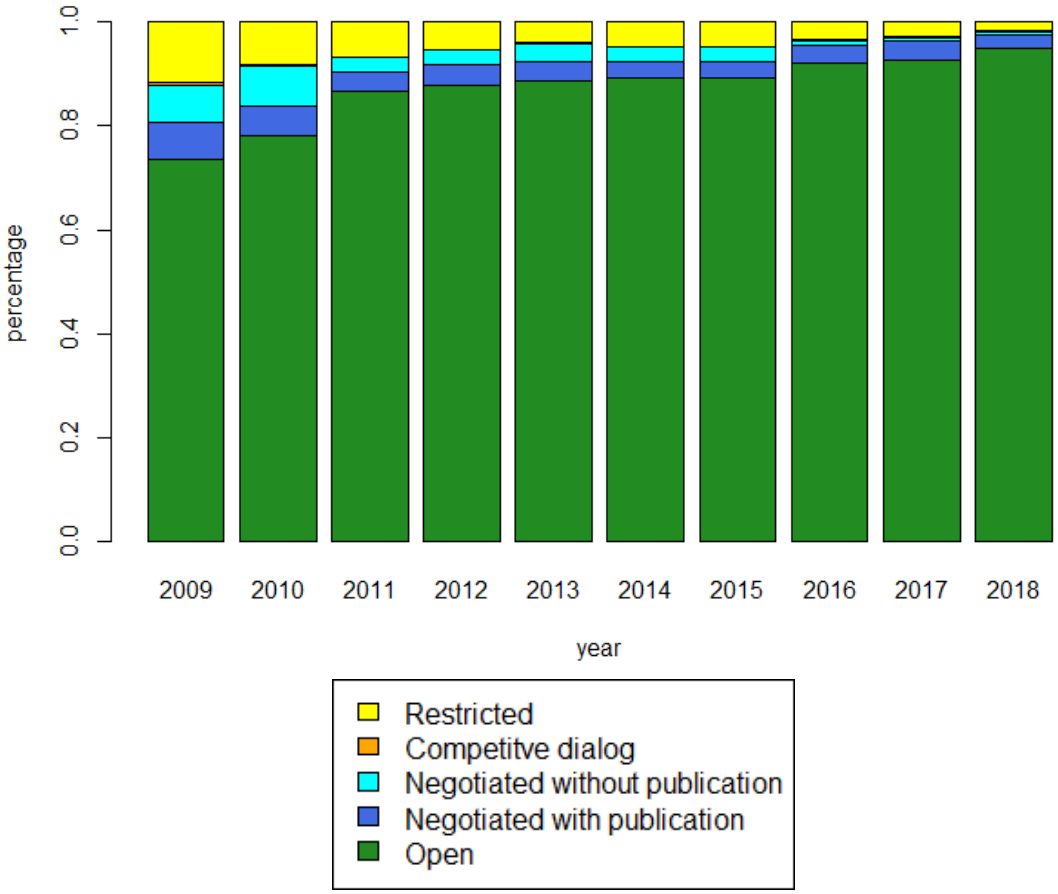
Aforementioned dependent variable describes the difference in the final and estimated prices in percent. The variable being a ratio of the difference between the final and estimated costs helps us to normalize the winning bids (the actual value of the bid does not have an impact on the dependent variable) and also allows us to simply access the proximity of winning bid to the estimated one. Multiple studies use the same or similar dependent variables, for example, Palguta et. al. (2012) [31] use the exact same variable as is used in this study and Pavel (2009) [32] and Grega and Němec (2015) [19] used a ratio of final and estimated price as his dependent variable, an approach reasonably similar to our variable definition. Silva et. al (2008) [10] and Bajari and Ye (2003) [3] use a variable called "relative bid", which is the ratio of bids and the engineer's estimates (estimated costs).

The mean of the dependent variable - after removing any dependent variable outliers (see Methodology) from the data - is -13.356, which would suggest a presence of the competition effect. This is in accordance with our expectations since Conley and Decariolois (2016) [17] state that the estimated contract cost *"is the maximum (the contracting authority) is willing to pay"*. On the case of Italian auction between the years 2000 and 2010, the authors arrive at the conclusion that the average winning bid is 13.4% lower than the estimated cost, which is incidentally the same as our observation. Ishii (2009) [24] reaches a similar conclusion, reporting that the ratio of winning to estimated bid is between 0.8 and 0.95 (based on road construction contracts in Japan).

First and also the most important variable for us is the procurement procedure used. Since several types of procurement procedures were represented by only a marginal amount of contracts, we have decided to account only for restricted, open, negotiated with and without publication and competitive

dialog procedures. Since one of the categories was named just "NEGOTIATED" without further indication whether contract notice was published or not and the values of other variables were reasonably close to the values of "NEGOTIATED_WITH_PUBLICATION" category, it was decided to merge these two categories into one. This is also more likely the case since the negotiated with publication can be considered a more default type of contract, so during the bureaucratic process, the "with publication" part might seem unnecessary to report. We have decided to create dummy variables for each of those variables, with open procedure being selected as the base group, since it is by far the most used procedure, as we can see from Figure 4:

Figure 4: Development of procedure usage over time



Source: Own calculation in R

From figure 4 we can also observe an increase in the overall use of open

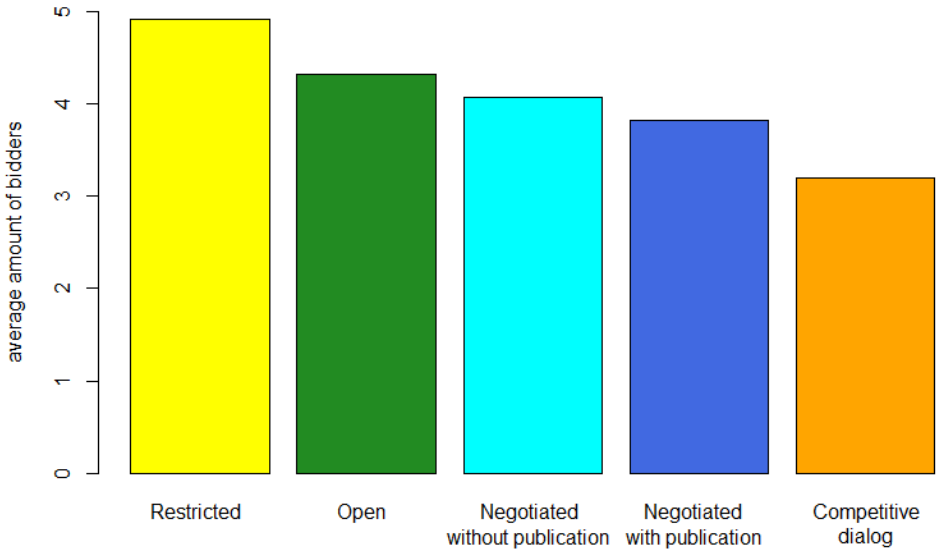
procedure over time, mostly at the expense of restricted procedure, the use of which fell from 12% in 2009 to 2% in 2018. At the same time, the usage of negotiated procedure remains roughly the same over the observed period. Despite the transaction costs of procedures conducted with open procurement procedure being higher than for example in negotiated procedure without publication (see Figure 2), it is expected that the competition effect from having more bidders on average than other procedures will manage to still drive price lower, compared to all other considered procedure types. The negotiated procedure with publication is close to the open procedure in terms of cost, but the cost for businesses is about 30 percent higher, which will make the procedure significantly more expensive in case of a high number of bidders, which, as Figure 5 shows, is close to our case, as negotiated procedure has a similar average number of bidders as the open procedure. We can, therefore, expect the negotiated procedure to be more costly than open procedure, at least in terms of transaction costs. The restricted procedure is similar in terms of costs incurred to businesses, but has a more costly process on the side of contracting authority, so the costs may be even higher than negotiated. Finally, negotiated procedure without publication is, in terms of transactions costs, the least expensive procedure, however, this is mainly due to the low bidder participation, which in turn increases the final price. On the other hand, as Chong et. al. (2010) [7] note, the bidders in this procedure have the longest contractual experience and therefore can be expected to perform better. In their study on Czech procurement environment, Palguta et. al. (2012) [31] reach a similar conclusion, in open auction, final price tends to be 12.6% cheaper than estimated, 9.19% for negotiated with publication, 1.33% for negotiated without publication and for restricted procedures, the final price tends to be 0.3% greater than estimated price. To sum up, we expect the sign of all said dummy variable estimates to be positive, and therefore more costly than the open procedure.

To help us specify the regression, apart from the variable of our primary interest - the type of procedure, we have selected seven other parameters

to be used as control variables. Those include number of bids, type of procurement procedure, type of the contracting authority, type of supplied product, EU region the contract originated from, number of words in the description of the contract and dummy variables of whether EU funds were used for the contract and whether electronic auction was used. We will now explain the variables and state our expectations on the effects they will have.

The first variable except procedure type that we expect for will account for the greatest difference and maintain the most stable significant effect is the number of bidders. The mean of this variable is 5.176, while the median is 3.0, suggesting extreme numbers in the highest part of data. This is indeed the case since the maximum is 999, a number that, in our opinion, is most likely an error. Moreover, the minimum value was 0, suggesting further flaws in data. Therefore, we have decided to further filter our data by removing any observations with the value of the bid equal to 0 or higher than 50, which was selected as the subjective plausible maximum of bidders a single lot can realistically have. This way, we have disqualified another 4308 observations (just under 1% of the remaining from our final dataset, see Methodology). After this, bidder mean amount is 4.326 and median is without change. However, as we can see in Figure 5, the average numbers of bidders are still slightly off our expectations - that the open procedure would have the highest amount of bidders. Here, restricted procedure marginally surpasses it. Also the negotiated procedure without negotiation has on average more bidders than anticipated, more than twice than the number measured by PwC (2011) in Figure 2.

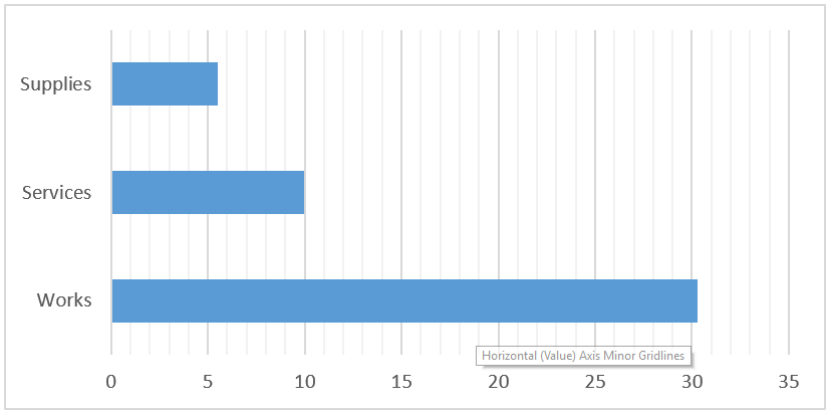
Figure 5: Average bidders by procedure used



Source: Own calculation in R

Between other control variables, we have included the type of contract. It could be either supplies, services or works (construction, demolition, electrical installation, plumbing, etc.). There is a great difference in the average value of contracts between these types of contract, as shown in Figure 6. We have selected services as our base group since it is the most used type of contract. Works, on the other hand, are underrepresented with only 4% contracts, this is, however, offset by the average final contract price being about 7 times higher than that of supplies and services. Again, according to Figure 2, based only on transaction costs, we would expect the coefficient of *works* being higher than 0 and the coefficient of supplies being either insignificant or slightly lower than 0.

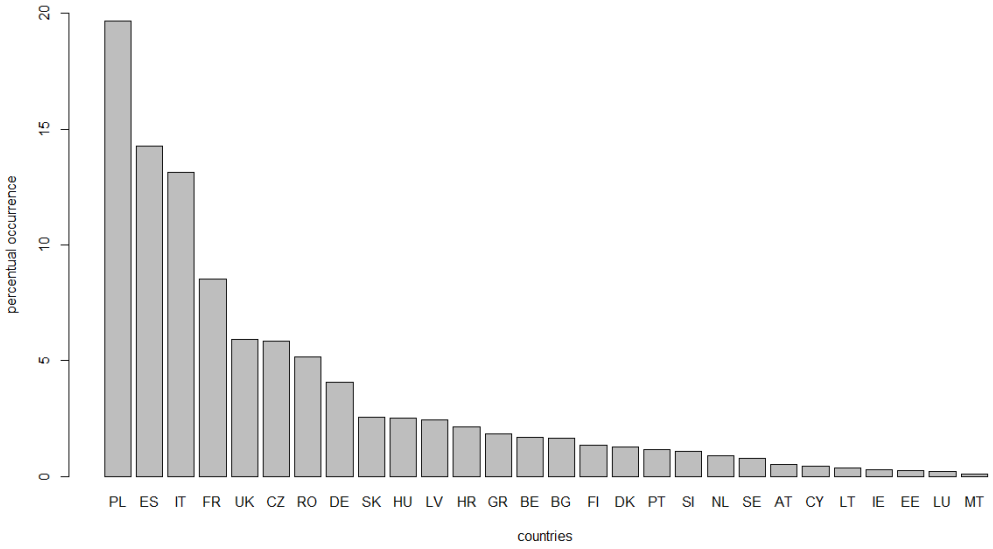
Figure 6: Average contract value of different contract types



Source: Own calculation in R, MS Excel

We also divided the data to control for the contract's country of origin. In the model, we use a factor of all country dummies. As we can see in figure 7, more than 40% of all observations originate in Poland, Spain, and Italy, in other words, the data does in no way reflect the population sizes of their respective states.

Figure 7: Number of contracts by countries



Source: Own calculation in R

Our last categorical control variable is the type of contracting authority. We have consolidated multiple values of this variable and created five groups: national or European authority or agency, regional authority or

agency, public body, utility companies, and other publicly controlled companies. We have felt the need to include "other" type of authorities, since, although we cannot with certainty know what those companies are, in our dataset, they account for almost 20% of the data. Regional authorities and regional agencies combined account for around 40% of the data in this case, therefore we have decided to use that as a base group. Using Figure 2, we can see that, except in the case of central authorities, neither the cost nor the average amount of bidders vary significantly and since regional public bodies appear to be average in those measures, we predict the coefficients to be small and of either sign.

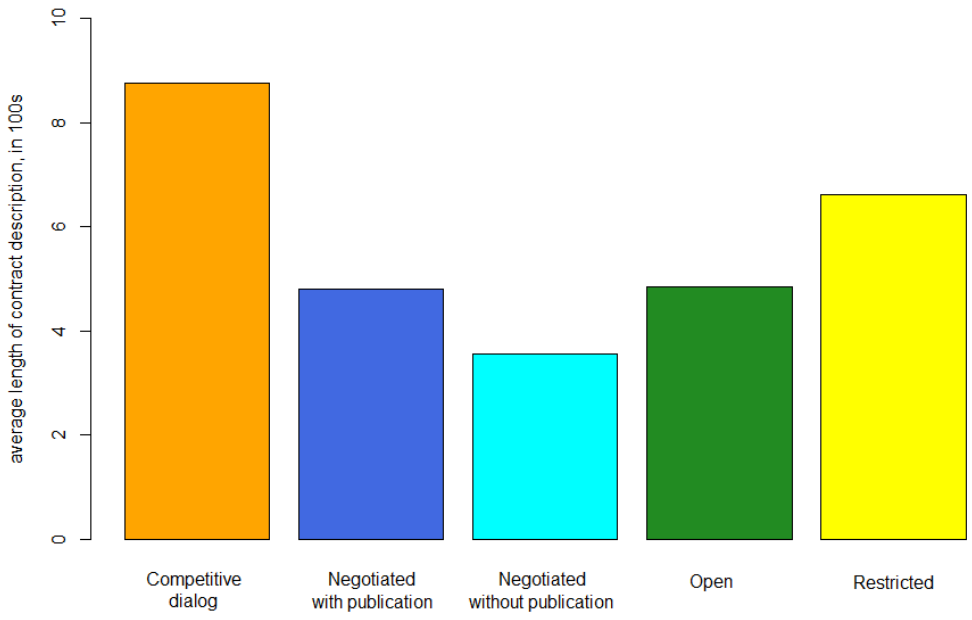
As the first among the dummy variables in our model, we have electronic auction. Only 26 986 auctions from our 483 010 (5.6%) have been conducted using electronic auction, even though the trend of electronic auction usage has been increasing over the observed period. We would expect this variable to decrease final price, since, as Pavel and Sičáková-Beblavá (2013) [33] claim, the use of electronic auction tends to increase the number of bidders and therefore indirectly decrease the final price, due to the increased competition. On the other hand, a PwC (2011) 2 study claims that electronic auctions increase the average person-days costs of the procedure by 6 days.

The second and last dummy variable is for the usage of EU funds. In our dataset, around 10% of tenders use EU funds, but unfortunately, we lack approximately 23% of the data on this variable. A PwC (2011) [38] study has found out that the usage of EU funds might be related with greatly increased transaction costs. They detected almost 50% increase in transaction costs in comparison with an average tender. Grega and Němec (2015) [19], in their analysis Slovakian public procurement contracts, calculated the effect of EU funds usage in a tender as a 1.54% increase in the ratio of final and estimated prices. We, therefore, also expect this coefficient to carry a positive sign, increasing the cost of auctions.

The last variable of our concern is a numerical variable; it is the length of the contract's description. It has been decided to measure this variable

in hundreds of words. The mean of this variable is equal to 4.90 with a median of 2.14 suggesting large values on the higher end. This, however, does not concerns us, since it is expected that there will be a small number of extremely complex contracts requiring a long description. The summary of average description lengths can be observed in Figure 8. It has been selected to act as a proxy variable for project complexity. The project complexity is expected to have a negative impact on the procurement efficiency due to the increased risk of renegotiation and therefore increased costs in case of highly complex projects. Botaso et. al. (2016) [5] have used the project value as a proxy and found it ultimately unsuitable due to its positive correlation with the use of negotiated procedure. In this case, we might not encounter this problem, since we do not expect a high correlation between the description length and used procedure. Additionally, we suffer from the problem of missing data in this variable (26% of data missing), therefore multiple models will be constructed depending on whether this variable will be included or not.

Figure 8: Average description length of different procurement procedures



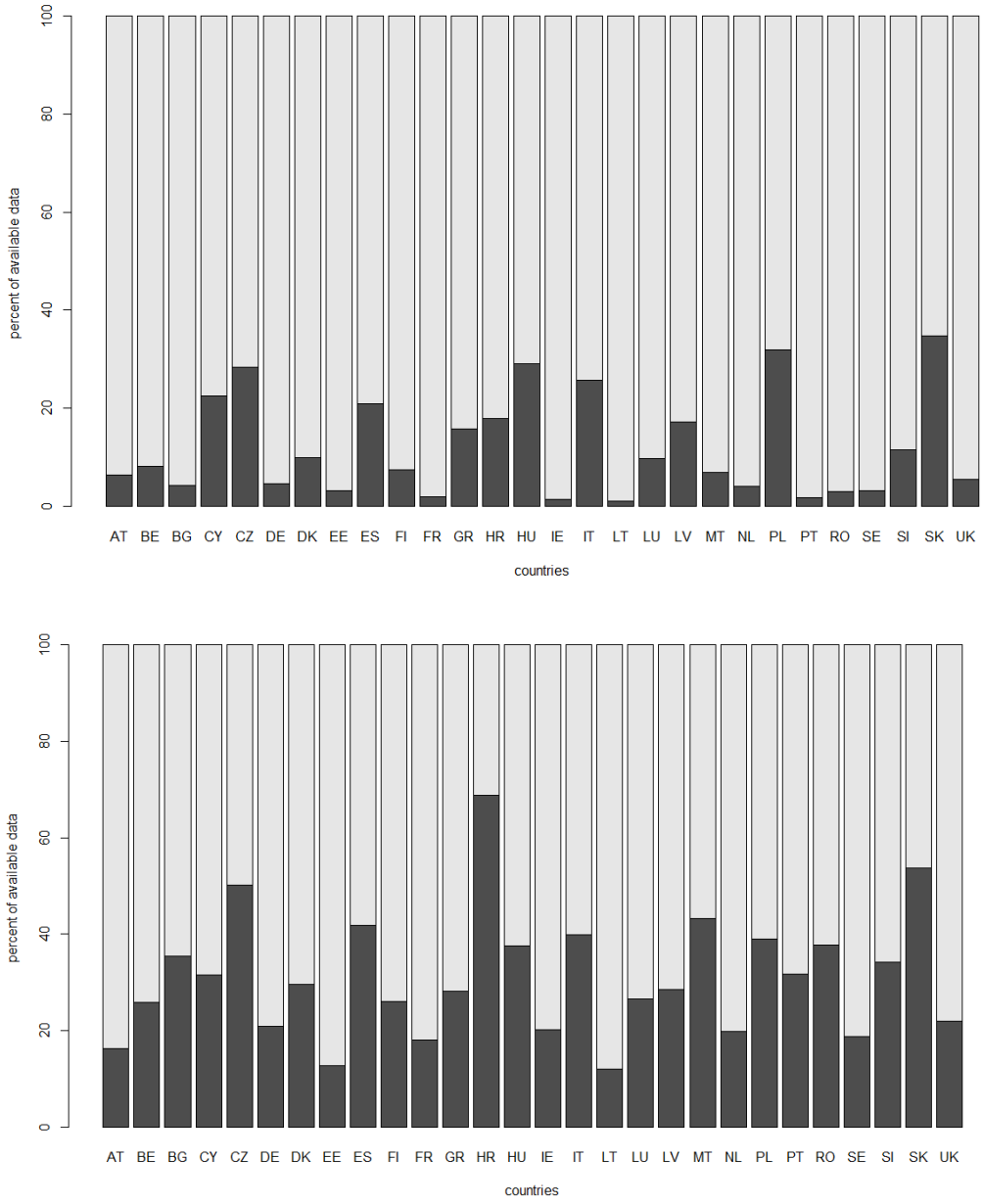
Source: Own calculation in R

2.3 Methodology

For our analysis, variables denoting procurement procedure, the final price of the contract and a price estimated by the contracting authority are crucial and unfortunately, around 70% of contracts did not have their final price filled in, around 75% had their estimated price column left blank and 13% of observations do not have the used procurement procedure denoted. Since those variables are so essential and trying to insert values for them could invalidate our regression, we decided to leave those observations out, which has left us with a dataset of 2 555 330 observations. From there, only contracts with their price over the threshold triggering EU-wide rules were selected, since otherwise national rules for contracts can be used and it is not in the scope of this study to examine the effect of national types of procurement procedures. This could, according to Palguta et. al. (2012) [31] lead to an overall decrease in the dependent variable, since more strict rules tend to lower the final tender price. This last change has left us with a final dataset of 555 674 observations.

As we can observe, the drop-off rate is decidedly high, however, since the initial dataset was of considerable size and therefore even the final dataset is as well, we can still safely perform a sound statistical analysis. It would seem that we might encounter an endogenous selection bias here, but luckily we believe that this might not be the case. In Figure 9, we can see that compared to the initial dataset (top graph), the dataset with only tenders which are considered above threshold on average have a much better data quality (around 5% of the initial data). It is probable that small, below threshold tenders will have a larger portion of data missing, because they are likely to be less supervised and the contracting authorities might more often not bother with filling in all the contract information.

Figure 9: Percent of available data in final price, estimated price and procurement procedure variables comparison



Source: Own calculation in R

A comparison of the initial and reduced datasets can be found in Appendix E. From there, we can see that most of the variables have a similar descriptive statistics, only the initial dataset contains more missing data. This would suggest there is not necessarily an endogenous bias, although, due to the quality of the available data, we cannot state this with an absolute

certainty.

After inspecting the data distribution, it has been found that a large portion of data in the dependent variable is outside of the 1.5 interquartile range, making them outliers according to the 1.5 IQR rule. We have decided that since the aim of our study is to investigate the non-deviant contracts, all of the data outside of the 1.5 IQR will be removed from the analysis. Since setting the outlier range is an arbitrary decision, a table with alternative results in case a different rule to identify outliers was selected will be available in Appendix A. By setting the outlier range as 1.5 IQR, we have discovered and removed from the analysis a fairly large number of outliers, which has left us with a total of 487 318 observations remaining, meaning slightly over 12% of the data was dropped due to being outliers. After removing outliers in numbers of bidders, as described in Data description, we get the final number of observations of 483 010.

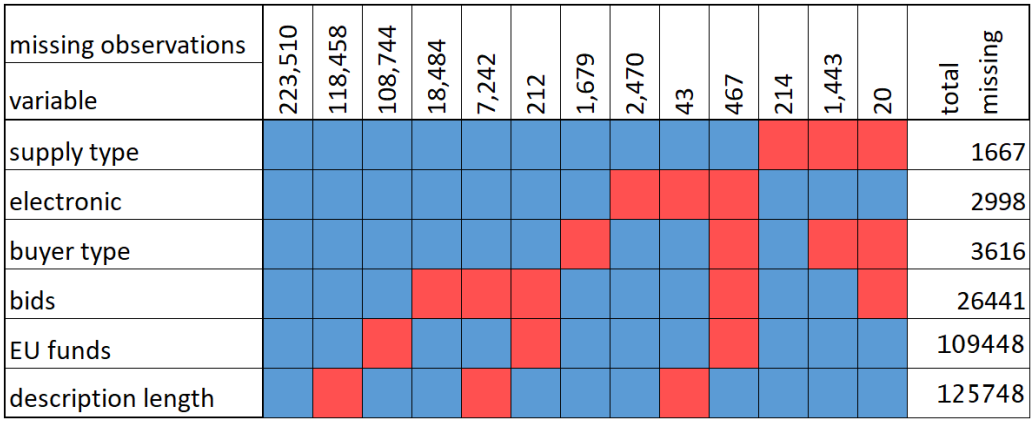
The origin of the bulk of dependent variable outliers is expected to be errors in data collection. For example, if a form was filled in and in the column for estimated or final prices a local currency instead of EURO was used, this can cause a great shift in the dependent variable. We assume similar errors to be a cause for most of the extreme observations and therefore removing them should not cause any difficulties.

For the analysis, we shall use a simple OLS regression, since we are searching for relations of variables with a distribution that can be reasonably considered a normal one. Also, as described in the section 2.5, the assumptions for the use of OLS estimation are either fulfilled or, if they are not, it is not hard to remedy that. Additionally, this method is used in most of the aforementioned studies. Due to the combination of these reasons, we have selected the OLS estimation as a sufficient and suitable method for our needs.

Another issue we shall address is the missing data issue. As already mentioned, a bulk of data had one of our crucial variables missing, however, there is little we can do to remedy this since all of those data are needed for the meaningfulness of our analysis. Nevertheless, the remaining control

variables suffer from missing data issue as well, as is illustrated in Figure 10, we have only 233 510 observations without any data missing, around 48% of our data.

Figure 10: Missing data visualization



Note: For clarity of information, combinations of missing variables occurring in less than 10 observations were left out.

Source: Own calculation in R

The preceding graph shows us that for approximately half of our dataset, we are dealing with incomplete observations. Moreover, we can observe that for more than 98% of our data, at most one variable is missing. This is useful since we are easily able to perform various robustness checks including model variations (dropping individual regressors) of the final dataset.

As was already mentioned, most of the data missing is due to the ineffectiveness of bureaucratic processes or due to different data collecting and storing standards in different countries, therefore we dare say that in that case, the data is missing at random (MAR). As a treatment of this issue, we have decided for the list-wise deletion method, thus if a value of a variable is not present in a particular observation, the whole observation will be disregarded for the needs of one test.

However, and this is true mainly for binary variables (*electronic* and $eufunds$ in our case), we suspect that most of the missing data is, in fact, the case of not utilizing the concerned variable - for example, with no data on the usage of electronic auction, it is most likely that the e-auction was not used,

only the authorities had not deemed it necessary to fill out that information. This would make it a case of data missing not at random (MNAR), which would, unfortunately, render the OLS method invalid. Nevertheless, since we are constrained by the data available and we consider those two variables to be too important to simply drop them out of the equation, we have constructed an additional model, which is available in Appendix B. There we can observe that even if we use a dataset with no missing entries (the 233510 observations as mentioned above), the results of the analysis are reasonably similar to our original regression and therefore, hopefully, no major problems should arise if we use the full dataset.

2.4 Model and hypotheses

As stated above, the aim of this study is to identify the impact of procurement procedures on the cost of public procurement. The cost of public procurement, in this case, is depicted by the percentage difference between final and estimated costs, which is our dependent variable. This research question can be broken down into several hypotheses:

- ***Hypothesis H1:*** *Open procurement affects the cost of procurement in a more positive way than its alternatives.*
- ***Hypothesis H2:*** *Negotiated procedure with publication affects the cost in a more negative way than open procedure.*
- ***Hypothesis H3:*** *Negotiated procedure without publication affects the cost in a more negative way than negotiated procedure with publication.*
- ***Hypothesis H4:*** *Restricted procedure affects the cost of procurement in a more negative way than both types of negotiated procedures.*
- ***Hypothesis H5:*** *Competitive dialog, as a specialized measure, affects the cost of procurement in the most negative way of the surveyed procedures.*
- ***Hypothesis H6:*** *The procedure costs savings on a single bidder are the greatest in open procedure.*

For our final model, we will use a dependent variable and a set of 8 independent variables, as described in the Data description section. Interaction terms ($procedure * bids$) were tested only between procedure type and the number of bids and are included in a separate model available in Table 4. Later, squares of the number of bidders and their interaction terms with procurement procedures were tested in a separate model, available in Table 5. The final model is designated as follows:

Figure 11: Regression equation

$$\begin{gathered} percentage\ difference\ between\ final\ and\ estimated\ prices = \\ \alpha + \beta_1\ number\ of\ bidders + \beta_2\ DUMMY\ procedure\ type + \\ \beta_3\ DUMMY\ electronic\ auction + \beta_4\ DUMMY\ buyer\ type + \beta_5\ DUMMY\ supply\ type + \\ \beta_6\ DUMMY\ use\ of\ EU\ funds + \beta_7\ 100\ words\ of\ contract's\ description\ + \\ \beta_8\ DUMMY\ set\ of\ fixed\ country\ effects + \epsilon \end{gathered}$$

2.5 OLS assumptions assessment

The method of ordinary least squares (OLS) was used for the regression analysis. In the following section, the OLS assumptions will be discussed briefly.

Firstly, as can be seen from our regression equation (Figure 11, our model clearly meets the first criteria, linearity in parameters. The second assumption, random sampling of data, was already discussed in the Data description section, however, to sum up the final conclusion: although a large portion of data is missing, since we were not able to discover the reason for this, we assume the data is missing at random and that the dataset used in the OLS regression is a subset of the original sample.

The next assumption, homoskedasticity of residuals, is not fulfilled, as can be seen in Table 1 below, in all iterations of the regression, heteroskedasticity was discovered. However, this largely does not concern us, as heteroskedasticity in residuals renders the standard errors and t-statistics invalid, but does not cause bias in estimators. Moreover, after applying heteroskedasticity robust standard errors, we are able to asses statistical significance using the t-statistics as usual.

Table 1: Breusch-Pagan test, H0: homoscedasticity in residuals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
χ^2	948.5	1900.4	2331.4	3137.2	4446.2	3990.8	7807	7770
$P > \chi^2$	0	0	0	0	0	0	0	0

Source: Own calculation in R

Further, we tested zero conditional mean of errors and the results show that they indeed are very close to zero. Another issue is the normal distribution of residuals, however, since it is useful mostly for calculating confidence intervals and alternative significance tests, we may disregard this assumption. Moreover, due to our dataset being rather large, we do not have to rely on this assumption and we can rely on central limit theorem instead.

After testing for multicollinearity, no significantly large relation was found using the variance inflation factor (VIF) method and therefore the possibility of multicollinearity being present in the model was ruled out. All of the OLS assumptions were validated, therefore it is possible for us to use OLS estimation.

3 Results and discussion

3.1 Results interpretation

The results consist of multiple regression equations, which are a subset of the regression equation as described in Figure 11. Therefore, a sensitivity analysis comparing the different models will be carried out. The sensitivity analysis consists of 8 stages of models, adding one variable at a time as can be observed in Table 2. Later, we will also estimate models where we gradually drop one variable after another from the final model to observe the effects of the missing variables. Results of dropping single variables can be found in Table 3. Following that, a single model assessing the effect of a single bidder in different procurement procedures will be described in Table 4.

Table 2: Regression results: sensitivity analysis

	Dependent variable: Percentage difference between final and estimated prices							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-11.343^{***}	-12.148^{***}	-12.136^{***}	-13.916^{***}	-15.974^{***}	-16.371^{***}	-8.096^{***}	-6.150^{***}
	(0.042)	(0.044)	(0.045)	(0.133)	(0.139)	(0.153)	(0.487)	(0.801)
bids	-0.421^{***}	-0.420^{***}	-0.419^{***}	-0.420^{***}	-0.397^{***}	-0.424^{***}	-0.479^{***}	-0.509^{***}
	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.010)
restricted		4.623^{***}	4.629^{***}	4.646^{***}	5.126^{***}	5.218^{***}	2.263^{***}	2.074^{***}
		(0.128)	(0.128)	(0.128)	(0.130)	(0.139)	(0.150)	(0.237)
negotiated		4.855^{***}	4.860^{***}	5.259^{***}	5.972^{***}	6.202^{***}	3.823^{***}	1.773^{***}
		(0.155)	(0.155)	(0.156)	(0.156)	(0.170)	(0.173)	(0.284)
negotiated wo. p.		8.229^{***}	8.366^{***}	7.997^{***}	8.536^{***}	8.834^{***}	7.330^{***}	5.096^{***}
		(0.148)	(0.144)	(0.144)	(0.147)	(0.149)	(0.147)	(0.292)
competitive dialog		9.124^{***}	9.127^{***}	9.103^{***}	9.939^{***}	9.995^{***}	5.487^{***}	6.845^{***}
		(0.525)	(0.526)	(0.527)	(0.525)	(0.686)	(0.679)	(1.146)
electronic			-0.581^{***}	-0.517^{***}	-1.544^{***}	-0.770^{***}	-0.313^{*}	0.316
			(0.153)	(0.154)	(0.155)	(0.163)	(0.179)	(0.199)
buyer EU or national				3.208^{***}	3.330^{***}	2.533^{***}	0.395^{**}	-1.609^{***}
				(0.150)	(0.149)	(0.166)	(0.169)	(0.196)
buyer public body				2.292^{***}	2.033^{***}	2.177^{***}	0.884^{***}	-1.579^{***}
				(0.142)	(0.142)	(0.156)	(0.156)	(0.178)
buyer utilities				0.337^{**}	0.679^{***}	0.619^{***}	-0.066	-2.373^{***}
				(0.142)	(0.142)	(0.157)	(0.158)	(0.177)
buyer other				2.435^{***}	2.498^{***}	3.109^{***}	2.570^{***}	1.566^{***}
				(0.147)	(0.147)	(0.160)	(0.160)	(0.175)
supplies					3.720^{***}	3.985^{***}	3.484^{***}	4.564^{***}
					(0.070)	(0.078)	(0.078)	(0.103)
works					3.420^{***}	2.383^{***}	2.657^{***}	1.993^{***}
					(0.152)	(0.167)	(0.164)	(0.261)
EU funds						1.964^{***}	1.325^{***}	2.051^{***}
						(0.102)	(0.106)	(0.134)
country fixed effects							included	included
description100								0.010^{***}
								(0.003)
Observations	456,569	456,569	454,048	450,926	450,712	341,968	341,968	223,510
R^2	0.010	0.018	0.018	0.021	0.028	0.037	0.077	0.086
Adjusted R^2	0.010	0.018	0.018	0.021	0.028	0.037	0.077	0.086
Residual Std. Error	22.340	22.245	22.207	22.207	22.133	21.176	20.737	21.840
Degrees of freedom	456,567	456,563	454,041	450,915	450,699	341,954	341,927	223,468

Note: *p<0.1; **p<0.05; ***p<0.01

Source: Own calculation in R

The model (1) contains only an intercept and the number of bidders variable. It is clearly underspecified and suffers from missing variable bias and yields biased predictions. However, in this case, we care only about the sign and significance of coefficients. R^2 of this model is also rather low, only 0.01. Nevertheless, the basic expectation we had of this model, that with an increasing number of bidders, the dependent variable will decrease, was in this case met and it tells us that if we disregard all other possible effects, one extra bidder will reduce the tender price by 0.42 percentage points of the tender estimated price which corresponds to 0.474% change of the final price. Moreover, this effect is highly significant. This number is lower than was anticipated, as Pavel (2009) [32] estimates this effect to be 4 percentage points while Kuhlman and Johnson (1983) [26] arrived to a reduction in price of 2% per additional bidder.

In the second model, we added set of dummy variables portraying procedure use. Immediately, we observe a substantial increase in R^2, from 0.01 in the previous model to 0.018 in the current one. Moreover, all of the variables - dummies for competitive dialog, restricted procedure and both cases of negotiated procedures, are highly statistically significant and practically large. They suggest that tenders cost 4.62, 4.86, 8.23 and 9.12 percentage points more, which corresponds to 5.2%, 5.47%, 9.31% and 10.32% increase, when comparing to the open procedure for restricted, negotiated, negotiated without publication and competitive dialog procedures, respectively. At the same time, the coefficient of *bids* has not changed at all, and neither did its significance level.

In the next step, we added the dummy for electronic auction usage. Although the effect of this variable is highly significant and expressing a -0.5% change in dependent variable, the addition had little effect on the effect of other variables - all other variables, have remained without a large change. Also the R^2 of the regression has remained the same. The only change was a slight coefficient increase in the *negotiated without publication* variable, which might be because this type type of procedure rarely uses electronic auction. The sign of *electronic* is in accordance with our expectations, however, we expected electronic procurement to have larger impact. This could be because electronic auction fails to bring in more bidders to offset its higher transaction costs.

In the model (4), we incorporated the type of contracting authority into the equation. This increased our R^2 from 0.018 in the previous model to

0.021, which is not a very significant increase. All coefficients of freshly introduced variables except the dummy for utility companies - which is slightly less significant and practically small - are highly significant and positive. That, however, is not the expected direction we predicted the coefficients will have since as the base group, we selected regional authorities and agencies, which were supposed to be average with regard to their procurement costs. According to our results, contracting authorities which are EU-level, national, public bodies or fall into the "other" category have 2-3.3 effect on our dependent variable, while utility companies are only 0,34 percentage points different from regional authorities in terms of cost. The addition of this variable increased the coefficient of *negotiated* and decreased the coefficient of *negotiated without publication*. This leads us to believe that different contracting authorities tend to use different procedure types, which, as we investigated, is indeed the case, for example, utility companies are almost 8 times more likely to use the negotiated procedure than other authority types, while the most frequent users of negotiated procedures without publication are national authorities. The coefficients of other variables remained largely unchanged.

In the following model, we extended the analysis with dummy variables for the type of requested good - either supplies, services or works. The coefficient of supplies suggests that, *ceteris paribus*, auctioning supplies and works results in 3.7 percentage points and 3.4 percentage points increase in price when compared to auctioning services, respectively. Both of these effects are highly significant. The addition of this variable has increased the R^2 of the equation to 0.028. Among other effects, it increased the sizes of all *procedure* dummy coefficients, which could be explained by auctions for supplies or works using open procurement procedure considerably more often than other types of procedures. After further investigation, we discovered that this is true mainly for auctions of supplies, with more than 86% of supplies actions being auctioned through open auction. The inclusion of this variable has also decreased the coefficient of electronic auction from -0.52 to -1.54, which can be explained by similar reasoning, supplies auctions using electronic auction more often than other types of supply do. This makes sense since supplies auctions tend to be mostly routine contracts with a greater emphasis put on price, rather than the quality of execution, which is suited for electronic auction usage.

Model (6) has the dummy variable for the use of EU funds included. This

came with an increase in R^2 of 0.009 compared to the previous model but at the cost of reducing the number of observations from approx. 451,000 to 342,000 due to the missing data in the added variable. The coefficient is highly significant with a size that expresses an expected 1.96 percentage points rise in the cost of procurement if EU funds are used during the auction, which is in line with predictions by Grega and Němec (2015) [19]. The addition of this variable had a small positive impact on the coefficients of procurement procedures, suggesting that EU funds are more used during the open procedures. Moreover, the coefficient of *bidders* increased slightly, however, it still kept its sign and significance. The coefficient of *works* decreased, we expect this to be because larger projects, which construction works incline to be, tend to make use of EU funds more often. The coefficient of electronic increased as well, presumably, tenders using e-auction tend to make use of EU funds more often.

The next addition had a rather significant result on the results. We have decided to add the factor of dummy country variables for all 28 countries of the EU. This has proved to be the right step since we can observe an increase of R^2 to 0.077. With this addition, the effects of majority of variables became smaller, nevertheless, the signs of all variables remained the same. However, there was a decrease in the significance of *electronic* and *buyer EU or national* variables and *buyer other* completely lost its significance. We can, therefore, conclude that the procurement practices in the countries of the EU are quite different in various states and that those local procurement customs have a great impact on the costs of public procurement.

For the last and final addition to our model, we have selected the length of description variable, a proxy variable for project complexity. Due to this, our final dataset has shrunk to 223,510 observations; this is because we are missing a considerable number of values in the newly included variable (approx. 25%). The highly significant coefficient tells us that on average, every 100 words of contract description raises the difference between final and estimated prices by 0.01 percent points. This is seemingly not a large effect since the average value of this variable is 4.9, but in the case of outliers with extremely complex descriptions, we might observe a significant effect. The R^2 of our final model is 0.086, telling us that the model explains around 8.6% of the variability of the response data around its mean. This is not a large number, however, since in our case, the aim of our study was to draw

conclusions about the size of effects procurement procedures have on the price of auctions and we are able to do that in spite of low R^2. Therefore, we should not be overly concerned about that.

The final addition had a large impact on the size of regression coefficients. The coefficients of *negotiated* and *negotiated without publication* fell to 1.77 and 5.01, those were also the procedures with the shortest average lengths of description. On the other hand, the coefficient of *restricted* changed to 2.07, a slight decrease compared to the previous model, and the coefficient of *competitivedialog* increased to 6.85. This is surprising, as both types of procedure have significantly higher average description length than the open procedure and thus we would expect them to shift the same way. Therefore, it seems like we might have arrived at a problem with the data, the missing values in the *description*100 might be missing not at random. As already stated, we have tried to remedy this by conducting the same sensitivity analysis only on the subset of dataset on which this final regression was performed (see Appendix B), however, that way, we arrive at a data selection issue and also reduce our dataset strength for models (1) - (7). Nevertheless, we can still observe that in this case, the open procedure is the most advantageous of the procedures of interest, which is in accordance with our expectations.

Among other changes, the coefficient of *electronic* has fully lost its significance, hinting that possibly, electronic auction might pay off only for larger auctions, where the potential benefit of attracting more bidders will outweigh the higher initial costs. The coefficient of *works* has decreased to 1.99, while at the same time, the coefficient of supplies increased to 4.56. We can attribute this change to varying levels of complexity of different types of supply; construction works tend to be very complex while delivering supplies tends to not be very complicated. Also the coefficient of almost all types of buyers has changed, in fact, all except the *buyer other* have completely changed signs, becoming negative, while reestablishing their high significance. This could be explained by all affected types of contracting authorities dealing with on average less complex projects than regional and other authorities.

Table 3: Regression results: dropping variables

	Dependent variable: Percentage difference between final and estimated prices							
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Intercept	-10.183^{***}	-5.457^{***}	-6.146^{***}	-6.766^{***}	-4.180^{***}	-5.253^{***}	-17.176^{***}	-8.096^{***}
	(0.806)	(0.795)	(0.800)	(0.789)	(0.787)	(0.531)	(0.168)	(0.487)
bids		-0.506^{***}	-0.511^{***}	-0.496^{***}	-0.551^{***}	-0.449^{***}	-0.373^{***}	-0.479^{***}
		(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.007)
restricted	2.471^{***}		2.072^{***}	2.419^{***}	1.611^{***}	2.669^{***}	3.816^{***}	2.263^{***}
	(0.231)		(0.237)	(0.237)	(0.235)	(0.202)	(0.231)	(0.150)
negotiated	1.745^{***}		1.782^{***}	2.513^{***}	1.040^{***}	1.876^{***}	4.126^{***}	3.823^{***}
	(0.265)		(0.283)	(0.276)	(0.283)	(0.233)	(0.281)	(0.173)
negotiated wo. p.	4.642^{***}		5.388^{***}	5.463^{***}	3.886^{***}	4.561^{***}	9.119^{***}	7.330^{***}
	(0.274)		(0.298)	(0.290)	(0.284)	(0.287)	(0.307)	(0.147)
competitive dialog	7.739^{***}		6.872^{***}	6.784^{***}	5.935^{***}	7.761^{***}	9.652^{***}	5.487^{***}
	(1.126)		(1.138)	(1.141)	(1.150)	(0.689)	(1.103)	(0.679)
electronic	0.794^{***}	0.188		0.130	1.355^{***}	-0.851^{***}	-0.0004	-0.313^{*}
	(0.189)	(0.199)		(0.199)	(0.198)	(0.178)	(0.175)	(0.179)
buyer EU or national	-1.115^{***}	-1.930^{***}	-1.606^{***}		-1.692^{***}	-0.428^{**}	0.956^{***}	0.395^{**}
	(0.187)	(0.192)	(0.196)		(0.196)	(0.170)	(0.190)	(0.169)
buyer public body	-1.395^{***}	-1.932^{***}	-1.592^{***}		-0.792^{***}	-1.480^{***}	0.071	0.884^{***}
	(0.169)	(0.174)	(0.177)		(0.177)	(0.156)	(0.178)	(0.156)
buyer utilities	-2.111^{***}	-2.787^{***}	-2.258^{***}		-2.511^{***}	-1.704^{***}	-2.633^{***}	-0.066
	(0.168)	(0.172)	(0.177)		(0.177)	(0.155)	(0.176)	(0.158)
buyer other	1.913^{***}	1.248^{***}	1.641^{***}		1.733^{***}	0.563^{***}	1.819^{***}	2.570^{***}
	(0.167)	(0.172)	(0.174)		(0.175)	(0.157)	(0.175)	(0.160)
supplies	5.368^{***}	4.354^{***}	4.465^{***}	4.577^{***}		3.839^{***}	5.293^{***}	3.484^{***}
	(0.099)	(0.101)	(0.102)	(0.100)		(0.086)	(0.103)	(0.078)
works	0.387	2.007^{***}	1.948^{***}	1.956^{***}		3.349^{***}	2.229^{***}	2.657^{***}
	(0.254)	(0.260)	(0.260)	(0.259)		(0.212)	(0.267)	(0.164)
EU funds	1.844^{***}	1.974^{***}	2.003^{***}	2.051^{***}	2.325^{***}		3.408^{***}	1.325^{***}
	(0.132)	(0.134)	(0.134)	(0.131)	(0.134)		(0.129)	(0.106)
country fixed effects	included	included	included	included	included	included		included
description100	0.011^{***}	0.011^{***}	0.012^{***}	0.008^{***}	0.005^{**}	0.009^{***}	0.019^{***}	
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	
Observations	241,994	223,510	225,980	225,182	223,724	332,254	223,510	341,968
R^2	0.077	0.085	0.085	0.084	0.078	0.073	0.036	0.077
Adjusted R^2	0.077	0.084	0.085	0.084	0.078	0.072	0.036	0.077
Residual Std. Error	22.106	21.859	21.925	21.825	21.940	22.703	22.433	20.737
Degrees of freedom	241,953	223,472	225,939	225,144	223,684	332,213	223,495	341,927

Note: *p<0.1; **p<0.05; ***p<0.01

Source: Own calculation in R

In Table 3, we perform an analysis of results in case we dropped certain variable from the regression equation. One might notice that model (16) is the same as model (7), this was done due to the convenience of viewing. Due to all but one variable being included at all times and due to missing data in some variables, the average number of observations is notably lower than that of the models in Table 2.

We can observe that aside from some variation in the size of coefficients on *bids* and *intercept*, said coefficients manage to retain both sign and significance through all models. As the literature generally agrees, this is the standard and so it speaks in support of our model's validity. An analogous statement can be said about the effect of procedures. Notably, running the regression without the *bidders* variable makes the effect of *restricted* smaller, which is expected due to restricted procedure having the largest average amount of bidders in our sample, while the procedures with less amount of bidders report the opposite change. When *supply type* variable was removed from the equation, we can see a decrease in procedure coefficients across the board, confirming out the suspicion that supplies and services are more frequently auctioned through open procedure. We can observe further changes in coefficients on *procedures* and all other variables in the case with omitted country fixed effects, however, it is difficult to state a reason for these changes as country fixed effects include dummies for all 28 countries of the EU and have coefficients of either signs and with a varying significance. Further, dropping the proxy for project complexity causes considerable changes in *procedure* coefficients, however, we dare not say whether it is from the altered dataset (*description* variable has the most missing observations of all variables) or if it is due to actual variable interactions.

Another issue is with the *electronic* variable. Depending on which variables we drop, the sign and significance of its coefficient change unpredictably anywhere on the scale of -0.85 in case we decided to drop the use of EU funds from the equation to 1.36 in the case supply types were dropped. Therefore, we do not dare to express any predictions on what effect does electronic auction have on the price of auctions.

As stated before, the contracting authority variable seems to be heavily influenced by the contract's complexity and the use of EU funds, we even observe a loss of significance of in the models with said dropped variables.

Table 4: Results with interaction terms

	Dependent variable: Percentage difference between final and estimated prices
Intercept	-5.714^{***}
	(0.803)
bids	-0.573^{***}
	(0.011)
restricted	1.088^{***}
	(0.326)
negotiated	0.004
	(0.361)
negotiated wo. p-	2.347^{***}
	(0.349)
competitive dialog	5.306^{**}
	(2.591)
bids∗restricted	0.215^{***}
	(0.057)
bids:∗negotiated	0.463^{***}
	(0.061)
bids∗negotiated wo. p.	0.361^{***}
	(0.018)
bids∗competitive dialog	0.430
	(0.708)
set of other control variables	included
Observations	223,510
Adjusted R^2	0.087
Residual Std. Error	21.83

Note: *p<0.1; **p<0.05; ***p<0.01

Source: Own calculation in R

In Table 4, we investigate the effect of addition of a single bidder using our main model with interaction terms between procurement procedure and the number of bidders included. The number of observations is therefore the same as in the main model, 223,510. We can observe that there indeed are considerable differences between various procedures. While the savings on one bidder in open procedure equal 0.57 percentage points of estimated price, for restricted procedure it is 0.36 percentage points, for negotiated procedure without publication it is 0.21 percentage points and for negotiated procedure with publication only 0.11 percentage points. The coefficient of $bids * competitive\ dialog$ is insignificant, therefore we cannot state any difference in return per bidder between open and competitive dialog procedure, however, this is most likely to be because of the small sample size of competitive dialog contracts. Additionally, this tells us that the open auction is the most sensitive to the number of bidders, in case the contracting authorities would fail in bringing a sufficient amount of interested parties, the effectiveness of open auction would suffer significantly more than that of the other procedures.

With the average amount of bidders, we can calculate a 2.46 percentage points decrease in price to the number of bidders in open procedure, 1.823 percentage points in the competitive dialog, 1.773 percentage points in the restricted procedure, 0.803 percentage points in the negotiated procedure with publication and 0.45 percentage points in negotiated procedure without publication.

We can also see that with interaction terms included, the coefficient of *negotiated* becomes insignificant and therefore ,*ceteris paribus*, the only thing that differentiates the savings on open and negotiated procedures is the number of bidders present in the auction.

Table 5: Results with interaction terms and bidders^2

	Dependent variable: Percentage difference between final and estimated prices
Intercept	−0.631
	(0.820)
bids	−1.807***
	(0.025)
bids^2	0.045***
	(0.001)
restricted	−0.413
	(0.448)
bids:restricted	0.712***
	(0.133)
bids^2:restricted	−0.015***
	(0.006)
negotiated	−1.803***
	(0.530)
bids∗negotiated	0.913***
	(0.181)
bids^2∗negotiated	−0.012
	(0.008)
negotiated wo. p.	1.099***
	(0.386)
bids∗negotiated wo. p.	0.769***
	(0.067)
bids^2∗:negotiated wo. p.	−0.025***
	(0.002)
competitive dialog	2.987
	(3.477)
bids∗compdial	0.866
	(1.566)
bids^2∗compdial	0.034
	(0.173)
set of control variables	included
Observations	223,510
Adjusted R^2	0.103
Residual Std. Error	21.60
Note:	*p<0.1; **p<0.05; ***p<0.01

Source: Own calculation in R

In Table 5, regression results with the number in bidders both in linear and quadratic form, along with its interactions with the interaction terms between those and procurement procedures are displayed. The goal of this model is to determine the optimal number of bidders for all of the studied procedure types or in other words, the number of bidders where an additional bidder no longer brings a positive benefit. We can observe that if we control for both $bidders$ and $bidders^2$, the open procedure is no longer the most advantageous procedure, however, it still has the strongest effect of a single bidder on final price.

Moreover, we can calculate the bidder number which will no longer bring any positive effect to the auction - winner's curse effect will offset the competition effect, as described by De Silva, Jeitschko and Kosmopolou (2009) [9]. These results are summarized in Table 6. When compared with the results of Onur and Tas (2019) [30], we notice a significantly lower optimal bidder levels, however, this is most likely due to the fact that in our dataset, the mean number of bidders is almost 50% higher than in the dataset the authors were using.

Moreover, no significant difference beween the additional bidder effects of open procedure and competitive dialog was detected, but this is again most likely due to the small sample of competitive dialog procedures being available. Furthermore, the unusually high number of optimal bidders for the negotiated procedure without publication is most likely due to the unexpectedly large average amount of bidders of that procedure in our dataset.

Table 6: Optimal number of bidders in procedures

	open	restricted	negotiated	negotiated wo. o.	competitive dialog
bids effect	-1.81	-1.1	-0.9	-1.04	-1.81
bids^2 effect	0.045	0.03	0.045	0.02	0.045
optimal bidders	20.1	18.3	10	26	20.1

Source: Own calculation in MS Excel

3.2 Hypotheses evaluation

Now we shall assess what can be stated about our initial hypotheses:

- ***Hypothesis H1:*** *Open procurement affects the cost of procurement in a more positive way than its alternatives.*

  A difference in final and estimated contract price significant on the 0.01 significance level in all other studied procedure types was detected by our model. Therefore, we cannot reject hypothesis H1. We have detected detected that restricted procedure usage increases the final price by 2.07% of estimated price, use of negotiated procedure with publication increases it by 1.77%, negotiated procedure without publication by 5.1% and 6.85% in case of competitive dialog, when comparing to open procedure. The reason for that seems to be the high return to single added bidder along with a high average amount of bidders in this procedure type.

- ***Hypothesis H2:*** *Negotiated procedure with publication affects the cost in a more negative way than open procedure.*

  We have discovered an increase in final costs of 2.81% of estimated price for negotiated procedure with publication when compared to open procedure on 0.01 significance level. Therefore we cannot reject hypothesis H2. We have also found that the difference in prices of open procedure and negotiated procedure with publication consists primarily from the different return on average bidder, which is -0.57 percentage points in case of open procedure and only -0.21 percentage points in case of negotiated procedure. In other aspects the two procedures seem to yield comparable results.

- ***Hypothesis H3:*** *Negotiated procedure without publication affects the cost in a more negative way than negotiated procedure with publication.*

  On 0.01 significance level, we have found a difference in final and estimated costs in negotiated procedure without publication compared to open procedure of 5.1% of estimated price. Thus, since we have detected a higher difference than in negotiated procedure with publication, we cannot reject hypothesis H3. The negotiated procedure without publication was found out to be the procedure least sensitive to number of

bidders as one additional bidder brings only 0.11% of estimated tender price as savings.

- ***Hypothesis H4:*** *Restricted procedure affects the cost of procurement in a more negative way than both types of negotiated procedures.*

  On 0.01 significance level, we have detected a difference in final and estimated prices of 2.26% of estimated price when compared with the open procedure. However, this number is much lower than was anticipated, as the restricted procedure was expected to be one of, if not the, most expensive procedures, both in terms of transaction costs and the overall effect. Per estimations of Palguta et. al. (2012) [31], the final price should even be 0.85 percentage points higher than the estimated price, on average. We have not detected such a high increase in price, in our model, final price in restricted procedures is still expected to end up being 5.83% lower then the estimated price. This might be because of the high average number of bidders and a good return of an additional bidder in restricted procedures. The negative impact of restricted procedure is also lower than that of negotiated procedure without publication, therefore, we reject the hypothesis H4.

- ***Hypothesis H5:*** *Competitive dialog, as a specialized measure, affects the cost of procurement in the most negative way of the surveyed procedures.*

  We found a difference between final and estimated tender prices which is significant on a 0.01 significance level and corresponds to an increase in final price equal to 7.33% of estimated price, even when project complexity is accounted for. Therefore, it is the most expensive procedure of our studied procedures and thus we cannot reject the hypothesis H5. We need to take into account, though, that the fraction of tenders using the competitive bidding procedure in our sample is just 0.25% and therefore the results might not be as robust as the results we achieved with other procedures.

- ***Hypothesis H6:*** *The procedure costs savings on a single bidder are the greatest in open procedure.*

  A significant difference between reductions in the dependent variable

between the surveyed procedures was found in nearly all of the procedure types. While open procedure yields a 0.57 percentage points decrease, restricted procedure yields just 0.36 percentage points negotiated with publication 0.21 percentage points and negotiated procedure without publication only 0.11 percentage points reduction in final price in terms of estimated price. No statistically significant difference was detected for competitive dialog, however, this might be due to only a small portion of data using this procurement procedure. Therefore, we cannot reject hypothesis H6.

4 Conclusion

Public procurement spending represents a considerable share of GDP and makes use of public funds, therefore it should be considered a vital area. It is regulated by the Directive 2014/24/EU on public procurement, where also different types of procurement procedures are described. These tend to have a significant impact on the transparency and efficiency of public procurement and thus the choice of public procedure is an important part of the decision the public authorities have to make when obtaining goods or services.

This thesis focused on describing the effects of public procurement procedures on the price of tenders, its effects on returns on an additional bidder, how they are affected by other variables we controlled for and what is the optimal bidder participation in them. On the dataset of 483 010 public procurement tenders and lots from the countries of the EU, we first performed a sensitivity analysis to asses the effects the control variables had on the relative savings of open, restricted, negotiated with and without publication and competitive dialog procedures. To ensure the robustness of our results, we constructed an additional two datasets, one with a more liberal approach to outliers and the second using only complete cases of data. Both of these models had yielded reasonably similar data to the primary model, supporting the robustness of our data. Later, we constructed a model in order to estimate the benefit of a single bidder for each of the studied procedures. Finally, we built one last model in order to examine the optimal bidder participation in different procedures.

We have detected significant effects on all types of procurement procedures, with open procedure as the leading procedure in terms of monetary savings. According to our model, negotiated procedure with publication costs 1.77% of estimated price more, restricted procedure costs 2.07% of estimated price more, negotiated procedure without publication costs 5.01% of estimated price more and finally, competitive dialog costs 6.85% more than open procedure. We controlled for the number of bidders, the type of contracting authority, the type of supplied good or service, whether electronic auction was used, whether EU funds were used, country fixed effects and contract complexity.

From the available data, we were not able to observe any stable effects of electronic auction, neither we dare to state any conclusions on the effect of the contracting authority, as we found that the effect of both of those

variables depends to a large extent on the presence of other variables.

In the following model, we also detected significant differences in the reduction of final price between the majority of the studied procedures. Again, the open procedure was identified as the procedure with the largest return on an additional bidder, 0.57% of estimated price saved per extra bidder, thus we can conclude it is the most sensitive to changes in the number of bidders. The returns on a single bidder in other procedures are as follows: restricted procedure offers a 0.36% decrease bidder, negotiated procedure with publication just 0.21% and just 0.11% in case negotiated procedure without negotiated was used. No significant differences between competitive dialog and open procedure were detected.

In the last test, we have detected differences between the optimal number of bidders. The ideal number of bidders range from 10 in case of negotiated procedure with publication, 18 in case of restricted procedure, 20 in case of open procedure, to 26 in case of negotiated procedure without publication. The last number is likely to be skewed by unexpectedly high average number of bidders in the respective procedure, though. No significant differences between competitive dialog and open procedure were detected.

The results of this thesis are mostly in line with the results that can be found in existing literature. Similarly to Palguta et. al. [31], it has been detected that the open procedure has the most positive effect on tender savings, however, the negative results of other procedures as described by this thesis are by approximately 50% less extreme than those described by the authors. The average effect of an additional bidder, 0.509% of estimated price as estimated by us, is also much lower than in general literature, which estimates the effect to be anywhere from 2% (Kuhlman and Johnson (1983) [26]) to 7.5% (Onur and Tas (2019) [30]). Next, we have partially succeeded to confirm the claim of Bulow and Klemperer (1996) [6], who claim that additional bidder open procedure outweighs the cost of reduction of negotiating power. In our tests, the value of an additional bidder was the highest in open procedure. Our last findings regarding the optimal number of bidders, however, were not in line with the findings of Onur and Tas (2019) [30], who predicted much lower optimal bidder numbers than we did.

Our findings have multiple applications for policymakers. Firstly, if the contract characteristics allow it, the contracting authorities should make use of the open procedure as often as possible, since it offers the best monetary payoff combined with a high degree of transparency. Secondly, as we have

discovered that the average number of bidders is much lower than the optimal numbers would be combined with the fact that we have detected an average reduction in price of 0.509% of estimated tender price per additional bidder across all procedures, which equals to a decrease of 2.2% with the average amount of bidders, the contracting authorities are advised to devote resources to finding as many bidders as possible.

References

[1] M. Amaral, S. Saussier, and A. Yvrande-Billon. "Expected number of bidders and winning bids: Evidence from the London bus tendering model". In: *Journal of Transport Economics and Policy (JTEP)* 47.1 (2013).

[2] P. Bajari, R. McMillan, and S. Tadelis. "Auctions Versus Negotiations in Procurement: An Empirical Analysis". In: *The Journal of Law, Economics, and Organization* 25.2 (Oct. 2009), pp. 372–399.

[3] P. Bajari and L. Ye. "Deciding between competition and collusion". In: *Review of Economics and statistics* 85.4 (2003), pp. 971–989.

[4] Patrick Bajari and Steven Tadelis. "Incentives versus transaction costs: A theory of procurement contracts". In: *Rand journal of Economics* 32.3 (2001), pp. 387–408.

[5] S. Baldi et al. "To bid or not to bid: that is the question: Public procurement, Project complexity and corruption". In: *European Journal of Political Economy* 43 (2016), pp. 89–106.

[6] J. Bulow and P. Klemperer. "Auctions Versus negotiations". In: *American Economic Review* 86 (Mar. 1996), pp. 180–194.

[7] E. Chong and A. Staropoli C.and Yvrande-Billon. "Auction versus negotiation in public procurement: Looking for empirical evidence". In: (2014).

[8] C. J. Dahlman. "The Problem of Externality". In: *Journal of Law and Economics* 22.1 (Apr. 1979), pp. 141–162.

[9] D. G. De Silva, T. D. Jeitschko, and G. Kosmopoulou. "Entry and bidding in common and private value auctions with an unknown number of rivals". In: *Reviewof Industrial Organization* 35 (2009), pp. 73–93.

[10] D. G. De Silva et al. "The impact of public information on bidding in highway procurement auctions". In: *European Economic Review* 52.1 (2008), pp. 150–181.

[11] Simon Domberger, Christine Hall, and Eric Ah Lik Li. "The determinants of price and quality in competitively tendered contracts". In: *The Economic Journal* 105.433 (Nov. 1995).

[12] European Commission. 2014. URL: `https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0025&from=EN`.

[13] European Commission. *Directive 2004/18/EC of the Eurepean Parliament and of the Council*. Mar. 2004. URL: `https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004L0018&from=en`.

[14] European Commission. *Directive 2014/24/EU of the European Parliament and of the Council*. Feb. 2014. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02014L0024-20180101&from=EN.

[15] European Commission. *European semester thematic factsheet: Public procurement*. 2017. URL: https://ec.europa.eu/info/sites/info/files/file_import/european-semester_thematic-factsheet_public-procurement_en_0.pdf.

[16] European Commission. *Public Procurement Guidance for Practitioners*. Feb. 2018. URL: https://ec.europa.eu/regional_policy/sources/docgener/guides/public_procurement/2018/guidance_public_procurement_2018_en.pdf.

[17] Conley T. G. and F. Decarolis. "Detecting Bidders Groups in Collusive Auctions". In: *American Economic Journal: Microeconomics* 8.2 (May 2016), pp. 1–38.

[18] V. Goldberg. "Competitive bidding and the production of precontract information". In: *The Bell Journal of Economics* 8.1 (1977), pp. 250–261.

[19] M. Grega and J. Nemec. "Factors influencing final price of public procurement: evidence from Slovakia". In: *Procedia Economics and Finance* 25 (2015), pp. 543–551.

[20] G. Heijboer and J. Telgen. "Choosing the open or the restricted procedure: A big deal or a big deal?" In: *Journal of Public Procurement* 2.2 (2002), pp. 187–215. ISSN: 1535-0118. URL: https://doi.org/10.1108/JOPP-02-02-2002-B002.

[21] J. Hlaváček. "Homo se assecurans". In: *Politická ekonomie* 34 (1987).

[22] G. Holmes. "To tender or to negotiate: the buyer's dilemma". In: *Journal of Marketing Practice: Applied Marketing Science* 1.3 (1995), pp. 7–17.

[23] H. Hong and M. Shum. "Increasing Competition and the Winner's Curse: Evidence from Procurement". In: *The Review of Economic Studies* 69 (2002).

[24] R. Ishii. "Favor exchange in collusion: Empirical study of repeated procurement auctions in Japan". In: *International Journal of Industrial Organization* 27.2 (2009), pp. 137–144.

[25] P. Klemperer. *Auctions: Theory and Practice*. Princeton, New Jersey: Princeton University Press, 2004.

[26] John M. Kuhlman and Stanley R. Johnson. "The Number of Competitors and Bid Prices". In: *Southern Economic Journal* 50.1 (1983), pp. 213–220.

[27] JJ Laffont and D Martimort. *The theory of incentives: the principal-agent model*. Princeton university press, 2009.

[28] S. A. MacManus. "Why Businesses are Reluctant to Sell to Governments". In: *Public Administration Review* 51.4 (1991), pp. 328–344.

[29] OECD. *Guidelines for Fighting Bid Rigging in Public Procurement*. 2009. URL: https://www.oecd.org/daf/competition/cartels/42851044.pdf.

[30] I. Onur and B. K. T. Tas. "Optimal bidder participation in public procurement auctions". In: *International Tax and Public Finance* 26.3 (2018), pp. 595–617.

[31] F. Palguta J .and Pertold, M. Vozár, and P. Nikolovová. "Public Contracts in the Czech Republic. What the Data Say on Behaviour of Contracting Authorities?" In: *IDEA Working Papers* (2012).

[32] J. Pavel. *Veřejné zakázky v České republice*. Národohospodářský ústav Josefa Hlávky, 2009.

[33] Jan Pavel and Sičáková-Beblavá. "Do e-auctions really improve the efficiency of public procurement? The case of the Slovak municipalities". In: *Prague Economic Papers* 22.1 (2013), pp. 111–124.

[34] M. Pesendorfer. "A Study of Collusion in First-Price Auctions". In: *The Review of Economic Studies* 67.3 (July 2000), pp. 381–411.

[35] Hana Reimarová. "Transaction Costs in Public Procurement". PhD thesis. Charles University in Prague, 2011.

[36] J. Soudek. "Public Procurement of homogeneous goods: Czech Republic case study". PhD thesis. Charles University, 2013.

[37] D. F. Spulber. "Auctions and Contract Enforcement". In: *J. Law Econ. Org.* 6 (1990), pp. 325–344.

[38] I. Strand et al. "Public procurement in Europe. Cost and effectiveness". In: *Bruss. PwC Lond. Econ. Ecorys* (Mar. 2011).

[39] S. Tadelis and P. Bajari. "Incentives and award procedures: competitive tendering vs. negotiations in procurement". In: *Handbook of procurement* (2006), pp. 121–139.

List of tables and figures

List of Figures

List of Tables

Appendix A: Alternative results with less strict outlier rules

In Table 7 find alternative regression results in case more conservative outlier specification method was used, with the outlier region boundaries being set as 2.5 IQR instead of 1.5 IQR, as in the main study. It can be observed that the size of coefficients is higher and also all of the variables are significant, however, the signs of coefficients are the same in our main model.

Table 7: Regression results: sensitivity analysis with alternative outliers in dependent variable

	Dependent variable: Percentage difference between final and estimated prices							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-17.774^{***}	-18.541^{***}	-18.409^{***}	-17.642^{***}	-18.313^{***}	-19.713^{***}	-8.153^{***}	-3.943^{***}
	(0.061)	(0.063)	(0.065)	(0.163)	(0.171)	(0.191)	(0.624)	(0.997)
bids	-0.169^{***}	-0.176^{***}	-0.179^{***}	-0.179^{***}	-0.175^{***}	-0.173^{***}	-0.185^{***}	-0.154^{***}
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.012)	(0.011)
restricted		4.921^{***}	4.902^{***}	5.068^{***}	5.474^{***}	7.669^{***}	3.479^{***}	2.379^{***}
		(0.179)	(0.179)	(0.180)	(0.181)	(0.182)	(0.196)	(0.314)
negotiated		6.811^{***}	6.761^{***}	6.866^{***}	7.182^{***}	8.371^{***}	5.242^{***}	1.170^{***}
		(0.210)	(0.210)	(0.213)	(0.213)	(0.229)	(0.235)	(0.380)
negotiated wo. p.		4.439^{***}	6.081^{***}	6.035^{***}	6.242^{***}	6.543^{***}	4.777^{***}	-7.208^{***}
		(0.264)	(0.259)	(0.259)	(0.259)	(0.262)	(0.259)	(0.469)
competitive dialog		13.990^{***}	13.923^{***}	14.056^{***}	14.621^{***}	15.101^{***}	9.484^{***}	10.961^{***}
		(0.715)	(0.717)	(0.718)	(0.720)	(0.879)	(0.881)	(1.544)
electronic			-1.591^{***}	-1.564^{***}	-2.039^{***}	-1.725^{***}	1.138^{***}	3.683^{***}
			(0.203)	(0.204)	(0.206)	(0.231)	(0.251)	(0.279)
buyer EU or national				0.874^{***}	0.831^{***}	0.437^{**}	-1.544^{***}	-5.822^{***}
				(0.191)	(0.192)	(0.216)	(0.219)	(0.258)
buyer public body				-2.379^{***}	-2.557^{***}	-1.690^{***}	-3.300^{***}	-9.017^{***}
				(0.180)	(0.181)	(0.201)	(0.202)	(0.233)
buyer utilities				-0.417^{**}	-0.310^{*}	0.578^{***}	-1.072^{***}	-4.528^{***}
				(0.176)	(0.176)	(0.196)	(0.200)	(0.225)
buyer other				-1.237^{***}	-1.273^{***}	-0.334	-0.556^{***}	-2.789^{***}
				(0.188)	(0.188)	(0.209)	(0.209)	(0.231)
supplies					1.487^{***}	1.502^{***}	1.921^{***}	2.305^{***}
					(0.094)	(0.106)	(0.105)	(0.137)
works					-0.923^{***}	2.585^{***}	3.252^{***}	1.575^{***}
					(0.229)	(0.214)	(0.214)	(0.352)
EU funds						3.146^{***}	2.065^{***}	3.273^{***}
						(0.144)	(0.152)	(0.192)
country fixed effects							included	included
description100								0.044^{***}
								(0.006)
Observations	507,014	507,014	503,652	500,370	500,139	377,710	377,710	255,456
R^2	0.006	0.010	0.011	0.012	0.013	0.018	0.068	0.088
Adjusted R^2	0.006	0.010	0.011	0.012	0.013	0.018	0.068	0.087
Residual Std. Error	31.579	31.514	31.375	31.392	31.382	30.431	29.647	31.828
Degrees of freedom	507,012	507,008	503,645	500,359	500,126	377,696	377,669	255,414

Note: *p<0.1; **p<0.05; ***p<0.01

Source: Own calculation in R

Appendix B: Alternative regression results with complete data only

Table 8: Regression results: sensitivity analysis with complete data

	Dependent variable: Percentage difference between final and estimated prices							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-13.354^{***}	-13.689^{***}	-13.850^{***}	-14.034^{***}	-16.904^{***}	-17.045^{***}	-6.130^{***}	-6.150^{***}
	(0.061)	(0.062)	(0.064)	(0.155)	(0.167)	(0.167)	(0.801)	(0.801)
bids	-0.379^{***}	-0.409^{***}	-0.404^{***}	-0.404^{***}	-0.362^{***}	-0.376^{***}	-0.509^{***}	-0.509^{***}
	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)
restricted		2.941^{***}	2.957^{***}	2.900^{***}	3.764^{***}	3.833^{***}	2.085^{***}	2.074^{***}
		(0.227)	(0.227)	(0.227)	(0.231)	(0.231)	(0.237)	(0.237)
negotiated		3.189^{***}	3.205^{***}	3.227^{***}	4.037^{***}	4.111^{***}	1.778^{***}	1.773^{***}
		(0.272)	(0.273)	(0.280)	(0.281)	(0.281)	(0.284)	(0.284)
negotiated wo. p.		8.391^{***}	8.500^{***}	8.125^{***}	9.123^{***}	9.081^{***}	5.087^{***}	5.096^{***}
		(0.302)	(0.302)	(0.298)	(0.308)	(0.307)	(0.292)	(0.292)
competitive dialog		8.046^{***}	7.958^{***}	8.462^{***}	9.834^{***}	9.769^{***}	6.918^{***}	6.845^{***}
		(1.112)	(1.108)	(1.119)	(1.095)	(1.104)	(1.146)	(1.146)
electronic			1.675^{***}	1.404^{***}	0.069	-0.015	0.300	0.316
			(0.173)	(0.174)	(0.175)	(0.175)	(0.199)	(0.199)
buyer EU or national				1.639^{***}	1.509^{***}	0.937^{***}	-1.602^{***}	-1.609^{***}
				(0.187)	(0.186)	(0.190)	(0.196)	(0.196)
buyer public body				0.879^{***}	0.106	0.070	-1.583^{***}	-1.579^{***}
				(0.177)	(0.178)	(0.178)	(0.178)	(0.178)
buyer_utilities				-2.864^{***}	-2.531^{***}	-2.631^{***}	-2.353^{***}	-2.373^{***}
				(0.176)	(0.176)	(0.176)	(0.177)	(0.177)
buyer_other				2.173^{***}	2.044^{***}	1.831^{***}	1.566^{***}	1.566^{***}
				(0.174)	(0.174)	(0.175)	(0.175)	(0.175)
supplies					5.424^{***}	5.256^{***}	4.548^{***}	4.564^{***}
					(0.102)	(0.102)	(0.102)	(0.103)
works					3.355^{***}	2.266^{***}	2.019^{***}	1.993^{***}
					(0.262)	(0.266)	(0.261)	(0.261)
EU funds						3.470^{***}	2.084^{***}	2.051^{***}
						(0.129)	(0.134)	(0.134)
country fixed effects							included	included
description100								0.010^{***}
								(0.003)
Observations	223,510	223,510	223,510	223,510	223,510	223,510	223,510	223,510
R^2	0.008	0.013	0.013	0.020	0.033	0.036	0.086	0.086
Adjusted R^2	0.008	0.013	0.013	0.020	0.033	0.036	0.086	0.086
Residual Std. Error	22.753	22.701	22.697	22.614	22.467	22.435	21.841	21.840
Degrees of freedom	223508	223504	223503	223499	223497	223496	223469	223468

Note: *p<0.1; **p<0.05; ***p<0.01

Source: Own calculation in R

Appendix C: Thesis proposal

Motivation

The public procurement spending corresponds to approximately 14% of GDP annually. It is therefore important to have a clear idea of how to assure that the process of public procurement is transparent. In my thesis, I will be interested in the manner how each of the procurements are issued. Mainly I will focus on the influence the type of procurement procedure has on other variables, such as the difference between the final and estimated bidded price. I will try to find out whether each type of procedure is more commonly found in certain sectors, or if some of the EU countries seem to prefer one kind of procedure over the rest. This will be, however, made harder due to the fact that different EU states use slightly different types of procedure each, so I will have to look into the individual differences in each country in detail.

Our goal therefore is to investigate whether we can observe any positive effect on the prices of the procurements and if the prices could be lowered if the state institutions started using more open types of procurement procedures.

Hypotheses

i. There is a significant difference in the price as estimated by authorities and the final price when comparing open procurement procedure and other types.

ii. All sectors tend to use open procurement procedure just as often as others.

iii. The countries in the Western and Northern Europe use the open type of procedure more often than the other states.

Contribution

The main cause why my study could contribute to already existing literature is that a relatively recently made dataset will be used in the process of making the models. This dataset combines all data on public procurement from all the countries of the EU (plus several others), making it the first dataset containing all the data at once. Before that, most of the studies

seemed to be made on smaller scale, usually only one country (Gelderman, Ghijsen, Brugman, 2006; Aschhoff, Sofka, 2009). Therefore, the findings will be original and potentially useful for writing larger scale studies.

Methodology

The thesis will be split into two parts, theoretical and empirical. The main focus of the theoretical part will be assessing directives and law of the EU and the examined countries. This will be done by analyzing the available documents and their comparison. In the empirical part, I will firstly try to give a general overview of my dataset, which will be a list of public contracts of the EU. After that, I will test the above stated hypotheses using regression analysis based on ordinary least squares method. Through that, I will try to identify the relationships between the type of public procurement procedure as a dependent variable and other variables like the estimated value of the contract, final value, number of bidders, etc.

Outline

i. Introduction

ii. Literature review

iii. Theoretical part

   a. Definitions of basic terms

   b. Procurement procedures in states of the EU

iv. Epirical part

   a. Description of data

   b. Used methods

   c. Data assessment and analysis

   d. Testing hypotheses

   e. Description of results

v. Conclusion

References

Sánchéz Graells, Albert. *Public procurement and the EU competition rules.* 1st print. Oxford: Hart, 2011. xxii, 457 s. ISBN 978-1-84946-066-8.

Palguta, Ján & Filip, Pertold. 2016. *K čemu vede (ne)transparentnost veřejných zakázek?*, studie 3/2016. IDEA CERGE-EI. Retrieved from `https://idea.cerge-ei.cz/files/IDEA_Studie_4_2016_Netransparentnost_verejnych_zakazek/files/downloads/IDEA_Studie_4_2016_Netransparentnost_verejnych_zakazek.pdf`

Kolektiv autor/ru. 2012. *Veřejné zakázky v ČR: Co říkají data o chování zadavatelů?*, studie 5/2012. IDEA CERGE-EI. Retrieved from `https://idea.cerge-ei.cz/documents/studie_2012_05.pdf`

Cees J. Gelderman, Paul W. Th. Ghijsen, Marc J. Brugman, (2006) *Public procurement and EU tendering directives - explaining non-compliance* , International Journal of Public Sector Management, Vol. 19 Issue: 7, pp.702-714, `https://doi.org/10.1108/09513550610704716`

Chvalkovská, J.; Skuhrovec, J.(2010): *Measuring transparency in public spending: Case of Czech Public e-Procurement Information System*, IES working paper 11/2010

Směrnice Evropského Parlamentu a Rady 2014/24/EU ze dne 26. února 2014. Retrieved from `https://eur-lex.europa.eu/legal-content/CS/TXT/HTML/?uri=CELEX:02014L0024-20180101&from=EN`

PAVEL Jan: *Efektivnost fungování kontrolních systémů veřejných zakázek v České republice.* Transparency International - Česká republika. Praha, 2009. ISBN 978-80- 87123-10-2

Appendix D:

Table 9: Datasets comparison

initial dataset							
Statistic	Missing	Mean	Min	Pctl(25)	Median	Pctl(75)	Max
estimated price	76%	1,591,454	0	3,871	22704	127,382.200	1,370,238,421
final price	78.5%	1,011,444	0	3,7505	20196	136,890.200	1,436,162,574
number of bidders	70%	6.473	0	1	2	5	999
description100	29%	6.32	0.01	0.59	1.58	5.12	2,2120

above threshold only							
Statistic	Missing	Mean	Min	Pctl(25)	Median	Pctl(75)	Max
estimated price	42.2%	14031377	100	426985	912853	3939659	1370238421
final price	26.3%	8148971	0	348320	730485	2507463	1436162574
number of bidders	28.8%	6.73	0	2	3	6	999
description100	33%	4.56	0.01	1.12	2.22	5.18	2220

Statistic	Missing	Services	Supplies	Works
above threshold only	0.21%	49.8%	42.8%	7.2%
initial dataset	34.04%	21.51%	32.71%	11.49%

Statistic	Missing	Open	Negotiated	Negotiated wo. p.	Restricted	Competitive dialog
above threshold only	1.4%	76.1%	7.8%	4.6%	9.4%	0.6%
initial dataset	11.5%	57.57%	2.78%	2.8%	2.5%	0.27%

Statistic	Missing	EU or national	Regional	Public body	Utilities	Other
above threshold only	1.4%	15.6%	38.5%	22.8%	7.8%	15.2%
initial dataset	29.6%	5.8%	22.7%	17.3%	2%	22.4%

Statistic	Missing	yes	no
above threshold only - electronic	1%	3.9%	95.1%
initial dataset - electronic	46.3%	1.7%	52%
above threshold only - EU funds	28.7%	6.7%	64.6%
initial dataset - EU funds	53.4%	4.8%	41.8%

Source: Own calculation in R