

CHARLES UNIVERSITY
FACULTY OF SOCIAL SCIENCES
Institute of Economic Studies

Bachelor thesis

2019

Tomáš Křivohlavý

CHARLES UNIVERSITY
FACULTY OF SOCIAL SCIENCES
Institute of Economic Studies

Tomáš Křivohlavý

**Collaborative purchasing in public
procurement: A comparative study**

Bachelor thesis

Prague 2019

Author: Tomáš Křivohlavý

Supervisor: Mgr. Miroslav Palanský

Academic Year: 2018/2019

Bibliographic note

T. Křivohlavý, “Collaborative purchasing in public procurement: A comparative study,” Bachelor Thesis (Bc.), Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, Prague, 2019, Supervisor Mgr. Miroslav Palanský.

Abstract

This bachelor thesis deals with the issue of collaborative purchasing in public procurement. We describe possible effects of centralized purchasing and define the objectives and strategies of the European Union regarding procurement centralization. Then, we examine the effects of centralized procurement based on a unique dataset of tenders from the whole European Union using Quasi-Maximum likelihood estimation. We find a positive effect of central procurement on competition in three procurement sectors. We also find that the effect is higher in countries with a higher degree of corruption. Centralized purchasing is criticized because of possible disadvantaging of small enterprises. We show that this strategy has a negative effect on the probability of awarding contracts to small or medium companies in two procurement sectors. One of the recommendations of the European Union to solve this problem is the usage of tenders with multiple selection criteria. However, our results do not confirm the validity of this recommendation.

Abstrakt

Tato bakalářská práce se zabývá problematikou centrálního zadávání veřejných zakázek. Popisujeme možné efekty centrálního nakupování a definujeme cíle a strategie Evropské unie s ohledem na centralizaci. Dále pak zkoumáme efekty centrálních zakázek na základě jedinečných dat o tendrech z celé Evropské unie pomocí metody maximální kvazi-věrohodnosti. Zjišťujeme pozitivní vliv centrálního zadávání na míru soutěže ve třech odvětvích. Nalézáme také, že tento efekt je větší ve státech s vyšší korupcí. Centrální zadávání je kritizované kvůli možnému znevýhodňování malých firem. Ukázali jsme, že tato strategie má negativní efekt na pravděpodobnost, že

zakázka bude zadána malému nebo střednímu podniku ve dvou odvětvích. Jedno z doporučení Evropské unie na snížení tohoto problému je používání tendrů s více kritérii výběru. Avšak naše analýza platnost tohoto doporučení nepotvrdila.

Keywords

Public procurement, Collaborative purchasing, Maximum Quasi-likelihood estimation, European Union, Public tender data, Centralization

Klíčová slova

Veřejné zakázky, Centrální zadávání, Metoda maximální kvazi-věrohodnosti, Evropská unie, Data o veřejných tendrech, Centralizace

Range of thesis: 70 170

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague, July 31, 2019

Tomáš Krivohlavý

Acknowledgments

The author is grateful especially to his supervisor, Mgr. Miroslav Palanský, for valuable advice and guidance. This research has benefited from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 681228.

Institute Economic Studies

Bachelor thesis proposal

Author: Tomáš Krivohlavý

Supervisor: Mgr. Miroslav Palanský

Proposed topic: Collaborative Purchasing in Public Procurement: A Comparative Study

Research question and motivation

One of the currently discussed ways to make a public procurement more efficient is the collaborative purchasing. Therefore, European Union's legal framework on public procurement took this procurement practice into account in Directives and various member states reacted by implementing central purchasing strategies. Using central purchasing is beneficial for governments, because of bargaining power, transactions costs reduction and network effects.

In my thesis I will focus on the public central purchasing systems in various European countries. I will compare, in detail, institutional setup for central purchasing, centrally purchased commodities and I will examine outcomes of collaborative public procurements systems in these countries.

My research questions are as follows: Does collaborative purchasing have positive effect on public procurement competition? Are the small and medium enterprises less likely to win the centralized tender? Does the countries specific factors as corruption or centralization affect the tender outcome?

I think, that it is important to work on this topic to provide the analysis of central purchasing systems in other European countries and examine their efficiency, because collaborative public procurement might help governments to reduce the costs and to increase transparency. On the other hand, there is also need to study effect of aggregating demand on the market.

Contribution

Various studies providing conceptual background for collaborative purchasing can be found (McCue, 2007). There are several studies analyzing the central purchasing systems in the EU including the Czech Republic (Palanský and Skuhrovec, 2016).

However, an econometric analysis of this topic on data of public procurement from whole EU was not conducted yet. Empirical evidence on the practices of EU member states regarding collaborative public procurement purchasing can serve policy makers in designing the optimal strategy to achieve more efficient public procurement outcomes.

Methodology

Primarily I will analyze data provided by Datlab (project Dighiwist), where the information about public procurement since 2009 from EU member states and seven other states are captured. Data contains specifications of the buyer, winner of the public procurement, final price, type of the public procurement and other useful facts. I am going to conduct an econometric analysis using MLE and OLS.

Outline

Introduction

Effects of purchasing centrally

Central procurement in the EU

Empirical part

Conclusion

Palanský, M., Skuhrovec J. (2016), “Collaborative purchasing: Foreign best practises and lessons for Czech Republic” EconLab z.s.

List of academic literature:

Albano, G. L., Sparro, M. (2010) “Flexible strategies for centralized public procurement” *Review of Economics and Institutions*, 1.2.

McCue, C. , E. Prier (2007). “Using Agency Theory to Model Cooperative Public Purchasing. *Advancing Public Procurement: practices, Innovation and Knowledge-sharing*”. B. Raton, FL: PrAcademic Press: 45-70.

Reimarová, H. (2011). “Transaction Costs in Public Procurement” Retrieved from <http://ies.fsv.cuni.cz/work/index/show/id/1565/lang/en>

Walker, H., Schotanus, F., Bakker, E. and Harland, C. (2013), *Collaborative Procurement: A Relational View of Buyer–Buyer Relationships*. *Public Admin Rev*

OECD (2011), “Centralised Purchasing Systems in the European Union”, *Sigma Papers*, No. 47, OECD Publishing.

Contents

INTRODUCTION.....	6
1. BACKGROUND OF THE STUDY.....	7
1.1 <i>Literature overview</i>	7
1.2 <i>Public Procurement</i>	8
1.3 <i>Auction theory fundamentals</i>	9
1.4 <i>Collaborative procurement</i>	10
1.5 <i>Collaborative procurement organisational forms</i>	10
1.6 <i>Framework agreements and collaborative procurement</i>	12
2. EFFECTS OF PURCHASING CENTRALLY	14
2.1 <i>Effects of collaboration on the price and competition</i>	14
2.2 <i>Internal economies of scale</i>	15
2.3 <i>Other procurement centralization benefits</i>	16
2.4 <i>Information asymmetry</i>	16
2.5 <i>Nature of procured goods</i>	17
3. CENTRAL PROCUREMENT IN THE EU	18
3.1 <i>Public procurement objectives in the EU</i>	18
3.2 <i>SME sector accession and barriers to entry</i>	19
3.3 <i>Collaborative procurement in selected EU countries</i>	20
3.3.1 <i>Czech Republic</i>	20
3.3.2 <i>Finland</i>	22
3.3.3 <i>France</i>	24
3.3.4 <i>Italy</i>	25
3.3.5 <i>United Kingdom</i>	26
4. EMPIRICAL PART	28
4.1 <i>Research questions</i>	28
4.2 <i>Data description</i>	29
4.3 <i>Descriptive statistics</i>	30
4.4 <i>Modelling number of bidders</i>	36
4.4.1 <i>Data and variables</i>	37
4.4.2 <i>Methodology</i>	38
4.4.3 <i>Results and discussion</i>	41
4.5 <i>Modelling SME accession</i>	44
4.5.1 <i>Methodology</i>	44
4.5.2 <i>Results and discussion</i>	45

5. CONCLUSION..... 49

BIBLIOGRAPHY 51

LIST OF APPENDICES..... 55

APPENDICES 1

List of tables

Table 3.1: Mandatory commodities	21
Table 4.1: Mean and median final bid price (2016-2017).....	32
Table 4.2: Mean and median number of bids placed	33
Table 4.3: Categories of enterprises	35
Table 4.4: Description of the variables	38
Table 4.5: Modelling number of bidders using MLE and QLME	42
Table 4.6: Model 1 estimated separately for chosen CPV categories	43
Table 4.7: Modelling SME as bidder using MLE and QLME	47
Table 4.8: Model 3 estimated separately for chosen CPV categories	48

List of figures

Figure 1.1: Centralized (left), semi-centralized (middle) and decentralized (right) procurement form.....	11
Figure 1.2: Third-party(left) and virtual network (right) collaborative form.....	12
Figure 3.1: Centrally procured CPV categories (Number of tenders, Czech Republic, 2017).....	21
Figure 3.2: Central tenders procedure types (Number of tenders, Czech Republic, 2017).....	22
Figure 3.3: Centrally procured CPV categories (Number of tenders, Finland, 2017).....	23
Figure 3.4: Central tenders procedure types (Number of tenders, Finland, 2017).....	23
Figure 3.5: Centrally procured CPV categories (Number of tenders, France, 2017).....	24
Figure 3.6: Central tenders procedure types (Number of tenders, France, 2017)	25
Figure 3.7: Centrally procured CPV categories (Number of tenders, Italy, 2017).....	26
Figure 3.8: Central tenders procedure types (Number of tenders, France, 2017)	26
Figure 3.9: Centrally procured CPV categories (Number of tenders, United Kingdom, 2017).....	27
Figure 3.10: Central tenders procedure types (Number of tenders, United Kingdom, 2017).....	27
Figure 4.1: Year graph of number of tenders in our data.....	29
Figure 4.2: Year graph of number of tenders with total value.....	30
Figure 4.3: Number of tenders (EUR mil.).....	31
Figure 4.4: Tender Value (EUR mil.).....	31
Figure 4.5: Mean and median final bid price in EU countries (EUR thousands, 2016-2017).....	31
Figure 4.6: Volumes and number of tenders (Central procurement 2016-2017).	32
Figure 4.7: Histograms of number of bids placed.....	33
Figure 4.8: Histograms of number of bids placed (Selected CPV categories, all tenders).....	33

Figure 4.9: Histograms of number of bids placed (Selected CPV categories, central procurement only)	34
Figure 4.10: Mean and median of number of bids (Countries comparison)	34
Figure 4.11: SME share in public procurement by number of tenders	36
Figure 4.12: SME share in public procurement by procured value	36

Introduction

Public procurement takes place when the contracts between private and public sector ensure better price or quality than if needed goods or services were produced and provided by the public sector itself (Karjalainen 2011). The fact that public procurement generates 14 % of GDP in the states of the EU (European Commission, 2016), brings demand for researches examining the effectivity of public procurement systems.

There are various procurement strategies recently implemented in the EU member states. We can mention increasing transparency by usage publications of procurement data or the trend of conducting tenders online (e-procurement). Various regulations are focused on involving small and medium enterprises into public procurement. Finally, there is a certain trend of centralization and an attempt to make public procurement collaborative. These tendencies were institutionalized in EU Directives 2004/18 ES and 10 years later updated in 2014/24 EU (Krizova and Brojac 2015).

The goal of the collaborative purchasing in public procurement is to take advantage of synergy originated in the collaboration. There are various benefits including the economy of scale, transparency or standardizing of tenders (Palansky and Skuhrovec 2016). Nevertheless, the bottlenecks are also present for instance market distortion (Plaček, 2016).

Various researches focusing on collaborative strategies in public procurement are often examining these strategies in the same way as they would evaluate purchasing or supply chain management in the private sector (Murray, 2009). These studies often evaluate tender performance and recommend policies to reduce costs. However, public procurement constitutes a big part of the economy and consequently, it is significantly impacting the market. Therefore, it is very important to study the effect of collaborative procurement on supply side as well.

The purpose of this thesis is to evaluate the effect of collaborative procurement tenders in the EU in the context of wider EU procurement policies. Particularly, the thesis analysis to compare the centralized purchasing effect on competition in various countries. The results of this research should help policymakers to design an appropriate public procurement system.

1. Background of the study

1.1 Literature overview

The recent trend of publishing tender information enables researchers to conduct various empirical studies on public procurement. An example of data-based research on public procurement of homogenous goods is paper by Soudek and Skuhrovec (2016). The relevance of this analysis for my thesis lies in examining the effect of procured quantity on price. Results did not show the relation between volume and price and encouraged us to study other effects of the aggregation of demand.

Even though collaborative procurement is recently becoming a common practice in public governance, this field is not well explored yet. However, the conceptual background was examined by McCue, C. and E. Prier (2007). They described possible organizational forms of this strategy from a perspective of agent theory.

The dispute whether centralization or decentralization is a path towards more efficient public administration was brought by Oates (1972), who stated that decentralized structure is optimal because of information asymmetry between local central administrations. Oates was followed by Plaček (2017) and Brezovnik, Oplotnik and Vojinovic (2015), who studied benefits of public procurement decentralization on European data.

Researches of cost savings that emerged from procurement collaboration can be divided into studies of effects on unit price (Gineitienė and Šerpytis, 2011) and estimation of purchasing administration cost reduction (Karjalainen, 2011). Administration and transaction costs were further studied by Reimarová (2011).

Počarovská (2018) described aspects of collaborative procurement in the context of the Czech Republic. Furthermore, she showed the positive effect of centralization on competition in multiple sectors.

General comparison of collaborative procurement systems in the EU was made by OECD (2011). PWC (2014) conducted an empirical analysis of the procurement system in the EU with attention to aspects of centralized procurement, framework agreements and the accession of small and medium companies. They uncovered a significant difference in practices among EU member states.

Policy recommendations for the Czech Republic based on foreign practises added Palansky and Skuhrovec (2016).

1.2 Public Procurement

Defining public procurement is not trivial and ambiguity in various definitions is present (Lloyd and McCue 2004). The most common approaches vary between the legal and economic point of view.

Law of the EU defines public procurement as follows: “The acquisition by means of a public contract of works, supplies or services by one or more contracting authorities from economic operators chosen by those contracting authorities, whether the works, supplies or services are intended for a public purpose.”¹ On the other hand, the economic definition is as follows: “Public procurement is a purchase by governments and state-owned enterprises of goods, services and works. The public procurement process is the sequence of activities starting with the assessment of needs through awards to contract management and final payment.”²

The difference between the economic and legal approach to the procurement is present in the examining quality of the procurement procedure. On one side, there are issues regarding compliance with local law or formal procedure aspects. But the strictly economic factors as competition and market structure are studied as well. The aim of this thesis is mainly to study economic aspects; therefore, we will follow the economic definition.

There are various terms essential for this thesis as follows:

- **Contracting authority:** Public body purchasing certain work, supply or service or agency conducting the public tender.
- **Bidder:** Potential supplier placing a bid in the public tender.
- **Central purchasing body (CPB):** Contracting authority that acquires goods or services or concludes framework agreements intended for one or more contracting authorities (EC Directive 2004/18/EC).
- **Framework agreement:** An aggregation technique that is defined by the EC Directive as: "an agreement between one or more contracting authorities and one or more economic operators that purpose of which is to establish the terms

¹ Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts: n.d.

² OECD. “Central Public Procurement Structures and Capacity in Member States of the European Union.” SIGMA Papers, January 1, 2007.

governing contracts to be awarded during a given period, in particular the terms as to price and, where appropriate, quality envisaged."³

- **CPV category:** Classification system for public procurement describing the subject of procurement contracts.

1.3 Auction theory fundamentals

To understand the context of efficiency and competition in public procurement, the auction theory is essential.

Procurement auctions are called reverse auctions because the procedure is initiated by the buyer and the supplier is in the role of the bidder. As in many cases, the procured good (service) cannot be perfectly specified and the price is not the only determinant of the auction winner. Therefore, the purpose of multidimensional auctions is to achieve the most economically advantageous outcome. In other words, the purchasing authorities are maximizing the value-for-money. Che designed model of bidding on two criteria, quality and price. Contracting authorities are awarding the contracts based on their utility function depending on price and quality (Che, 1993).

On the other hand, a value-for-money approach is not necessary for all tenders. Using only the lowest price criterion is suitable for purchasing highly homogenous goods (Počarovská, 2018).

Nemec, Měříčková Mikušova and Grega in 2014 studied selection methods in various European countries. They found a significant difference between the share of mono-criterial a multidimensional public contract assessment between studied countries. Western countries preferred multi-dimensional assessments more than eastern states.

Apart from the selection criteria, the tender procedures also differ in the way of engaging bidders in the tender. Three types of tender procedures can be distinguished: open procedure, restricted procedure and negotiated procedure. In the case of an open procedure, all suppliers are enabled to enter the tender. In the restricted procedure, potential qualified suppliers are selected first and only they can submit a bid. Winner of the tender in these two types is obtained through competitive bidding. The negotiated

³ Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts: n.d.

procedure means that the contracting authority either publishes its tender intention and supplier applies for engagement, or tenderer invites only a restricted number of potential suppliers. In both cases, the final conditions of the contracts are negotiated (Dmitri, 2006).

The effect of selection criteria on procurement outcome was the subject of various researches. Hanák and Muchová (2015) studied the role of qualification criteria in public work contracts. They recommended using a restricted procedure to ensure the quality of constructed infrastructure. On the other hand, they noted that restricted procedure can lead to lower competition and higher final price. Bajari and Tadelì (2006) described the positive effect of open tender on the competition. But they highlighted that procedure type must be decided based on the degree of complexity. For a more complex project, the negotiated procedure is more suitable.

1.4 Collaborative procurement

Collaborative or central procurement can have more meanings depending on the form and degree of collaboration. According to the EU directive, purchasing centrally stands for making acquisitions or awarding contracts on behalf of other contracting entities (EU Directives 2004/17/EC). In some studies, the notion of collaborative purchasing refers to horizontal collaboration (all parties are equal), while central procurement means vertical collaboration (one party is superior to the others). But for simplicity, both terms will be used as mutually interchangeable in this thesis.

Techniques of central procurement are implemented to increase the quality of public tenders according to 3E principles (Effectiveness, Efficiency, and Economics). Considerable advantages associated with procurement centralization are Bargaining power, Transaction costs reduction and Transparency. EU directive is mentioning an increase in competition as one of the goals of this centralization (EU Directives 2004/17/EC)

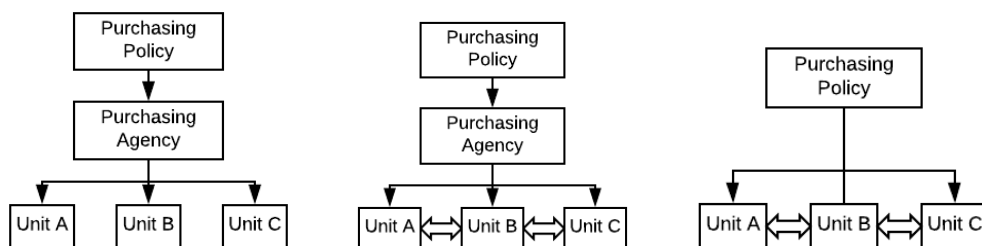
1.5 Collaborative procurement organisational forms

McCue and Pitzer (2000) described two extreme organisational forms in public procurement: Fully centralized hierarchal system of command and control and fully decentralized form without any central authority.

Under a fully centralized form, all essential responsibility for the purchasing process is taken by central procurement body. The competences of the final buyer are limited, and buying units are accountable to the central authority which controls the outcome of the procurement.

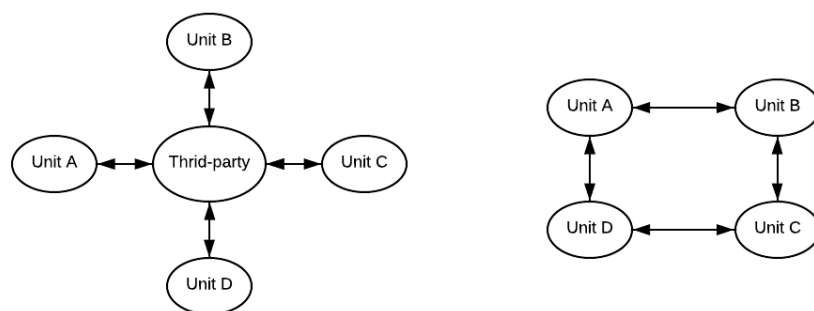
If final buyers are fully responsible for a purchase, then the system is fully decentralized. Buying managers are flexibly reacting to market situation and individual needs. While the buying unit has full authority over a purchase, control of another agency is rather limited. However, neither full decentralized nor full centralized models occur. Procurement forms are always a combination of both extremes and resulting models differ in the degree of centralization (Figure 1.1).

Figure 1.1: Centralized (left), semi-centralized (middle) and decentralized (right) procurement form



(Own construction based on McCue (2000))

On the other hand, Bakker and al. (2008) distinguished collaborative procurement forms according to types of collaboration. They recognized two extreme models: Virtual networks and third-party organisations. Virtual networks mean collaboration without a formal framework. The collaboration is not the main nor only job description of the involved staff. Unlike third-party form denotes the creation of another organisation fully dedicated to the collaboration (Figure 1.2). This concept is again capturing only the extreme cases and the real forms are rather combinations of both.

Figure 1.2: Third-party(left) and virtual network (right) collaborative form

(Own construction based on Bakker and al. (2008))

An example of collaboration closest to the informal network is “professional network” characterized by voluntary relationships focused mainly on sharing information and expertise. A little bit more different from the virtual network is “Piggybacking.” In this case, one of the involved agencies conducts the procurement on behalf of the others. Establishing a central purchasing body with the only task of collaborative purchasing is an example of third-party collaboration.

1.6 Framework agreements and collaborative procurement

Challenges in collaboration may emerge from the different expectation of procured commodities. The “one size fits all” approach can be used only for some goods – particularly the homogenous commodities. The involved parties might also demand various optional services, or the final delivery might be needed at different points in time. Albano and Sparro (2010) suggest, that demand heterogeneity problem can be mitigated with appropriate contract type.

Commonly used contract type in collaborative purchasing is a framework agreement (FA). FA is conducted between one or more buyers and one or more suppliers. It establishes terms governing contracts to be awarded during a given period (EU definition). The distinctive characteristic of FA is the degree of completeness. Agreements are incomplete mostly in the final volume, time of delivery or technical specifications (Počarovská 2018). Therefore, an incomplete framework can be a suitable tool to utilize collaboration benefits and also to tailor purchase for the individual buyer.

Types of framework agreements are widely used among CPBs in Europe. For instance, Italian Consip uses framework contracts in two stages. In the first stage terms

of procurement (price and quality) are defined and at the second stage consists only of purchase orders (Albano and Sparro, 2010).

2. Effects of purchasing centrally

2.1 Effects of collaboration on the price and competition

Commonly highlighted idea of procurement collaboration is that aggregated demand and higher volumes are attractive for the suppliers, so they are willing to bid lower price to win the tender and earn higher profit. Moreover, the lower unit price can be compensated to the supplier by the economy of scale resulting from higher volumes. However, it is problematic to measure the price difference, because obtaining the comparable unit price of goods is difficult.

Soudek and Skuhrovec studied determinants of the unit price in public procurement of electricity and natural gas in the Czech Republic. Homogeneity of these commodities enabled them to compare the final price with a benchmark (market price). Nevertheless, the quantity purchased was not a significant factor for the final prices (Soudek and Skuhrovec).

A study examining the impact of both competition (number of bidders) and purchased quantity on final price was conducted by Gineitienė and Šerpytis. They analysed data from central procurement body in Lithuania regarding purchasing identical and standardized goods. The procured quantity in this research was not significant as well, but the competition had a negative effect on prices. This fact can be explained by the insufficient motivation to bid lower if the competition is not strong enough, even though the procured volumes are high. However, the aggregated demand can also have an impact on an increase in competition, and that's why the relationship between the competition, the purchase volume and the price is complex. (Gineitienė and Šerpytis, 2011).

Various studies were analysing the impact of the competition on the final price. Hong and Schum (2002) suggest that increased competition results in more aggressive bidding, therefore there is a negative relationship between competition (number of bidders) and price. Because of the inverse relationship between price and competition, number of bidders is often used as a measure for the effectivity of public procurement procedure.

One of the objectives of centralized procurement is to increase competition by attracting bidders on higher procurement volume. However, the complete effect of aggregated volume is ambiguous. Sanchez-Graells and Anchustegui (2014) argue that higher procured volumes can result in market concentration and reduction in number of bidders. Desirable lowering of prices also reduces the profitability of public contracts and which might distract small and medium companies. Because SMEs are not taking advantage of economy of scale and higher HR and capital capacity. Entering large agreements can also cause a locked-in effect, in other words, a firm's capacity will be exhausted by a single contract. This can consequently reduce competition in the long run.

Nevertheless, the high procured volume may not be the only aspect of procurement collaboration attracting more suppliers. Singer and al. suggest that suitable centralization strategy using e-procurement can attract more bidders and consequently, the final unit price might also decrease because of broader competition (Singer and al., 2009).

2.2 Internal economies of scale

The second motivation to collaborate in purchasing is to avoid duplication of tenders and reduce transaction and administrative costs (Šerpytis and Gineitiéne, 2011). Unfortunately, it is hard to quantify the real savings as there are problems in comparing centralized and decentralized procedure costs (Karjalainen, 2011). Even analysing differences in various centralized models is challenging because factors like the commitment of involved parties play a significant role in the quality of the process (Cleverley and Nutt, 1984).

There are various studies estimating transaction costs savings regarding persons-days associated with the purchase. PWC (2014) surveyed purchasing authorities from the whole EU. According to their report, contracting authorities can save up to 80% of internal costs using centralized procurement. But the saving differs in the complexity of contracts and the number of involved authorities (PWC, 2014).

In the Czech Republic Reimarova estimated transaction costs and tested rationality of outsourcing of public procurement procedures. The results were different for small and big contractors. Big contractors were considered irrational to outsource procedure opposed to small ones (Reimarová 2011). Potential administrative savings in

the Czech Republic estimated both Palanský and Skuhrovec (2017), Ministry of Regional Development (2011). Both studies estimated the savings higher than initial costs, however, the Ministry's results were more optimistic.

Šerpytis, Vengrauskas and Gineitienė formulated a model of cost reduction combining centralization effect on final prices and administrative cost. According to this model, the centralized procurement in Lithuania in 2007-2010 brought savings in both factors.

2.3 Other procurement centralization benefits

Literature also suggests centralization benefits not directly connected to costs savings.

Currently, there is a trend of publishing public tender details to increase transparency. These publications are mandatory for tenders with volume above a certain threshold. Central procurement leads to higher tender value; therefore, these tenders are more likely to be reported publicly (Palansky and Skuhrovec, 2016).

The impact of centralization on corruption is not very clear (Plaček, 2017). According to Treisman, decentralized systems are likely to be more corrupt. However, we must distinguish different degrees, levels and types of centralization, because the results might differ. Various studies found a higher likelihood of corruption at the local levels because of the close personal relationship between the private and public sectors (Treisman, 2000). On the other hand, citizens might be more able to control tender procedure and public finance allocation at the local level (Barenstein, De Mello 2001).

Moreover, research opportunities and innovations are also associated with procurement collaboration and the work of Central procurement bodies (OECD, 2011). Example of CPB conducting procurement research is Consip in Italy.

2.4 Information asymmetry

Public procurement centralization is not without controversies. Oates (1972) stated his theorem claiming that decentralized structure is more efficient because of information asymmetry between local and central bodies. Plaček (2011) suggests that procurement should be managed at the lowest level to reflect the true needs of local administration.

2.5 Nature of procured goods

Obtaining benefits like cost reduction or bargaining power is possible only for goods or services with a certain degree of homogeneity. (Albano and Sparro, 2010). Procurement centralization is problematic when involved parties have a different expectation about the goods and services. This issue can be mitigated with a suitable framework agreement (See Chapter 1). Generally, collaborative procurement is suitable for highly standardized commodities demanded by many public entities.

In practice, common centrally purchased goods are both IT hardware and software, vehicles and utilities. In the case of services, CPBs procure IT and telecommunication services, transportation and maintenance services (Palansky and Skuhrovec, 2016).

3. Central procurement in the EU

3.1 Public procurement objectives in the EU

The objective of this thesis is examining collaboration procurement practises in the EU. Prior to analysis of the tender data, comprehension of key aspects of EU procurement strategies and their implementation in member states is necessary. Stating the EU goals of public procurement is important for specifying the hypothesis of this thesis.

As mentioned above, economic austerity following the financial crisis led policymakers to try to reduce inefficiency in public spending. European commission stated six public procurement policy priorities: Focusing on innovations, professionalising buyers, increasing access to SME, improving transparency, using new technologies and cooperating in procurement.⁴ These priorities are visible in various aspects, for example, publishing tender data using TED in 2011⁵ or issuing rules for e-procurement in 2016. The trend of centralized tenders and large contracts is observed in the EU and especially in the UK since 2008 (PWC, 2014).

However, the public procurement framework was already significantly changed by EC directives 2004/18 and 2004/17. These directives were associated with an objective to simplify and modernize the procurement in the EU. One of the topics institutionalized in these Directives is central procurement. The Directive 2004/18/EU states the benefits of central procurement as follows: “In view of the large volumes purchased, those techniques help increase competition and streamline public purchasing.” Moreover, there is a definition of a central procurement body as an institution conducting public procurement on behalf of another body. Member states are free to choose whether to establish CPB or to use framework agreement.

More recent Directive 2014/24/EU complements the central public procurement legislation. It mentions economies of scale, including lower prices, reducing transaction costs as professionalising as benefits of central procurement. On the other hand, the Directive refers to the need for monitoring centralization due to the concentration of

⁴ Public procurement priorities of the European Commission are described at: https://ec.europa.eu/growth/single-market/public-procurement_en

⁵ Access to TED database is at: <https://ted.europa.eu/TED/main/HomePage.do>

purchasing power and the possibility of collusion. The Directive also deals with the accession of the SME sector. It encourages contracting authorities to divide large contracts into lots.

3.2 SME sector accession and barriers to entry

Small and medium enterprises or SME are defined by the European Commission as companies employing less than 250 persons and not having an annual turnover above 50 million EUR, or companies with balance sheet not exceeding 43 million EUR.⁶

SME sector is commonly marked as a backbone of the European economy. They create 99% of European companies. However, the estimates indicate that the representation of SME companies in public procurement is significantly lower than in other sectors (PWC, 2014). Next, to other problems connected to market distortion caused by the public sector, there is enough research showing that higher competition leads to lower unit procurement prices. And SME involvement enables buyers to broaden their supplier base. Walker suggests other benefits of procuring from smaller enterprises including social, health and environmental aspects (2008). Because of these reasons, SME accession to public procurement is an important objective of the EU procurement policy.

In 2008 “European code of best practices facilitating the access by SMEs to public procurement contracts”⁷ was issued. The document states the importance of SMEs in public procurement. More importantly, The Code brings various practices within the EU regulatory framework that increase the participation of SMEs in public tenders (OECD, 2016). Suggested practise of reducing the barrier of the procured amount is dividing contact into lots. Dividing into lots should mainly promote tender participation and increase competition. This strategy might also reduce collusion. On the other hand, it might prevent contracting authorities from taking advantage of large contracts, such as economy of scale. In countries such as Germany, dividing the contract into lots is for some tenders obligatory, however, according to OECD, it should be carefully considered at every single tender. (OECD, 2016).

⁶ This definition is cited from web page of European Commission (available at: https://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en

⁷ The Code is available at:

http://ec.europa.eu/internal_market/publicprocurement/docs/sme_code_of_best_practices_en.pdf

There are more strategies implemented in the EU to involve more suppliers in one contract, such as promoting cooperation on supply-side or making framework agreements with more suppliers.

The second highlighted strategy is e-procurement or using information technologies in public tender. This approach should provide suppliers with tender information equally. Also, it is supposed to reduce administrative demands for smaller suppliers. The legislative framework for e-procurement is developed in the Directive 2014/24/EU and the E-Invoicing Directive 2014/55/EU. Considering aspects of collaborative procurement, CPB is commonly agencies conducting e-procurement. For example, Italian Consip runs the e-procurement portals to purchase a high variety of products (Palanský and Skuhrovec, 2017)

The EU documents and various researchers also propose procedural recommendations. The Code suggests choosing multi-criteria award procedures as smaller companies cannot offer as low price as large companies. On the other hand, they can provide different quality aspects as a local or innovative approach.

3.3 Collaborative procurement in selected EU countries

In this part, I will present five EU Collaborative procurement systems. Main sources for this overview are studies conducted by OECD (2007 and 2011), Krizova and Brojac (2015), Palansky and Skuhrovec (2016). The information from the literature was amended with figures based on data from the Czech company Datlab. Unfortunately, these data are incomplete. Therefore, the presented figures must not be taken as precise information about central tenders in these countries.

3.3.1 Czech Republic

EU Directives 2004/17/EC and 2004/18/EC were implemented in national legislation in 2006. The legislation defined the notion of a central procurement body and enabled public authorities to procure collaboratively. However, no CPB at the state level was established (Počarovská, 2018).

Resolution in 2011 obliged central government administration (Ministries and other bodies) to procure certain commodities centrally (Table 3.1). Resolution in 2016 slightly change the mandatory commodities and splits responsibility for centralized procurement between the Ministry of Finance (MOF) and the Ministry of social development (MOSD). MOSD is mainly supervising centralized tender processes in

individual institutions and regular reporting of procurement performance. MOF is responsible for maintaining the list of mandatory commodities and for controlling the quality of procured goods.

Table 3.1: Mandatory commodities

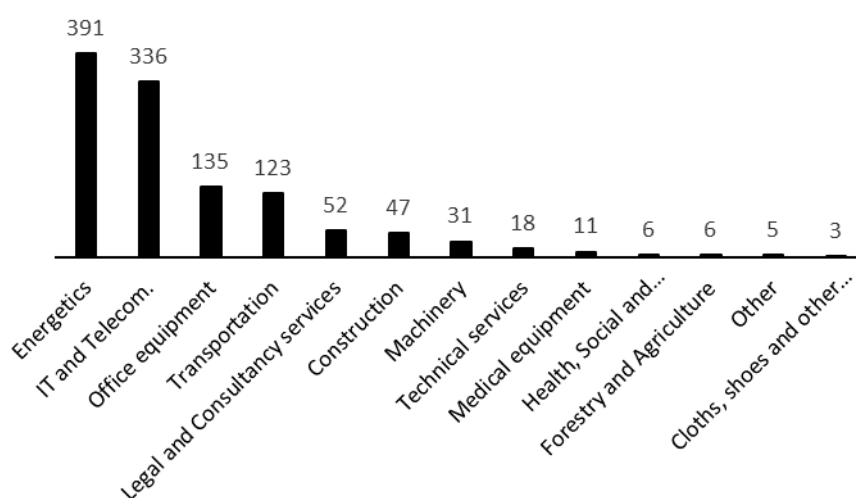
Product category	no. 930/2011	no.24/2016
Electricity	×	×
Gaseous fuels	×	×
Telecommunications services	×	×
Office machinery	×	×
Computer equipment and supplies	×	×
Passenger cars	×	×
Furniture	×	×
Office equipment	×	×
Security services	×	

(Source: own construction based on Government resolutions no. 930/2011 and no. 24/2016)

According to the data obtained from company Datlab, in 2017 in the Czech Republic, 1164 centralized tenders were conducted with average final bid price 914,759 EUR.

The most central purchases were related to Energetics or IT and telecommunications. There were also many central purchases regarding office equipment and transportation. Structure of central purchases in Figure 3.1 goes along with the list of mandatory commodities (Table 3.1).

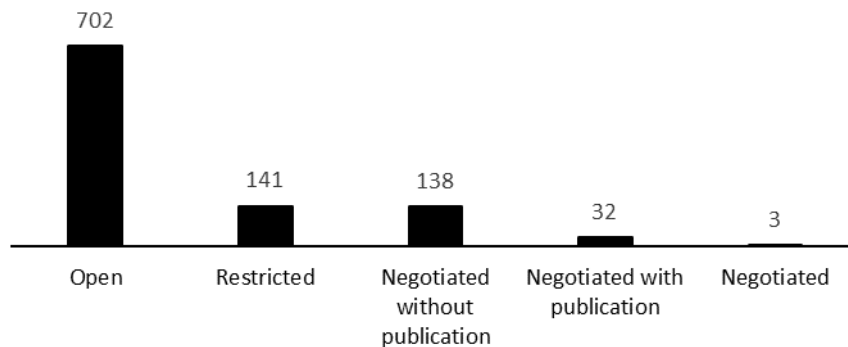
Figure 3.1: Centrally procured CPV categories (Number of tenders, Czech Republic, 2017)



(Source: Own construction based on Datlab data)

Central procurement in the Czech Republic employs various procedure types. The most of tenders were processed with Open procedure, however, the restricted and negotiated procedures are there represented with quite large numbers as well (Figure 3.2).

Figure 3.2: Central tenders procedure types (Number of tenders, Czech Republic, 2017)



(Source: Own construction based on Datlab data)

3.3.2 Finland

Finland's Public procurement structure is decentralized as procurement function is split among many intuitions. Generally, the country is vertically decentralized because regions a municipality have an important role in the procurement system (OECD, 2017). This aspect is present in central purchasing. There are two main CPBs: Hansel and Kuntahankinnat.

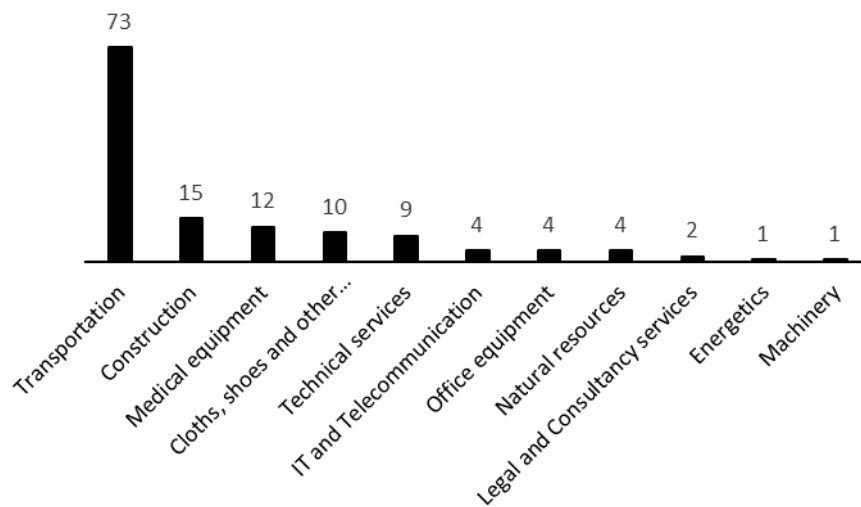
Hansel operates under the Ministry of Finance and offers its services to the central government administrations, unincorporated government enterprises, off-budget funds, universities and the Finnish Parliament. Main activities are arranging framework agreements regarding purchasing Electricity, Occupational health care services, IT hardware products.

Hansel usually awards framework agreements with multiple criteria and electronic methods are usually not used. Except for the cost-saving purpose, Hansel considers SME accession to tenders as a priority. Hansel is financed from the fees paid by suppliers (OECD, 2011).

Unlike Hansel, KL- Kuntahankinnat purchases products as energy, IT, social and health services and administrative supplies on behalf of local administrations and municipalities (Palanský and Skuhrovec, 2016).

Datlab's dataset includes 135 central tenders with 1,175,396 EUR final price. Procured CPV categories according to Figure 3.3 differs from the commodities usually procured by Hansel and KL- Kuntahankinnat. This aspect might be caused by data incompleteness.

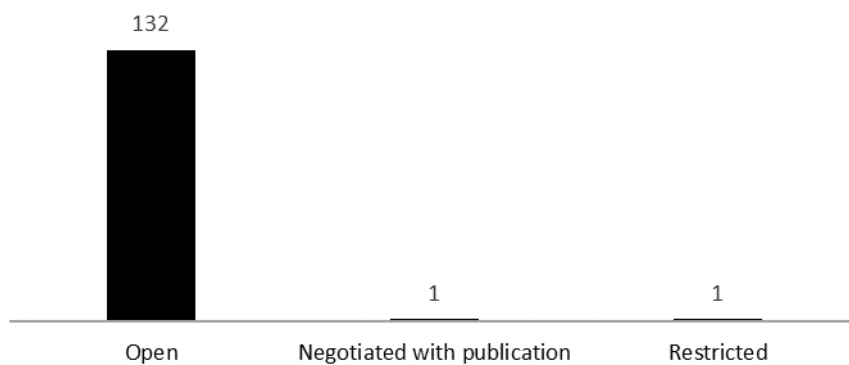
Figure 3.3: Centrally procured CPV categories (Number of tenders, Finland, 2017)



(Source: Own construction based on Datlab data)

According to our data, central tenders almost exclusively employ the open procedure (Figure 3.4).

Figure 3.4: Central tenders procedure types (Number of tenders, Finland, 2017)



(Source: Own construction based on Datlab data)

3.3.3 France

Several CPBs operate in France. The largest is Union des groupements d'achats publics (UGAP), which obtained CPB status in 2004. However, on the state level operates also Direction d'achats de l'État (DAE). There are other specialized bodies conducting procurement on behalf organizations from a specific sector. For instance, UNI-Ha and RESAH are procuring for hospitals and medical departments (Palansky and Skuhrovec, 2016)

UGAP purchase a large amount of widely used goods and redistributes them to the national government, local administrations and hospitals. Involved parties utilize Ugap's services on a voluntary basis (Palansky and Skuhrovec, 2016).

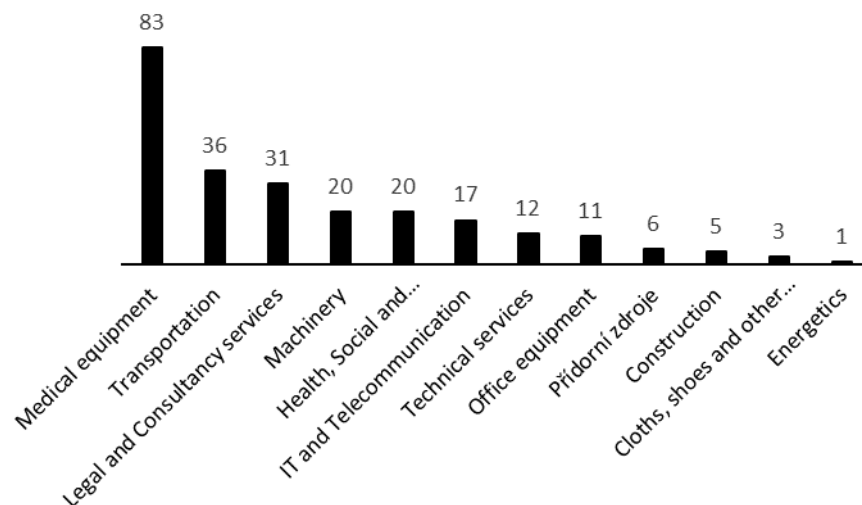
DAE conduct framework agreement only on behalf of the central government. Various goods are mandatory for the government to purchase centrally with DAE (furniture, hardware, software, telecommunication services etc.).

French legislative framework highlights the importance of small and medium companies in public procurement and mandates procurement bodies to divide the contract into lots (Bianchi and Guaidi, 2010).

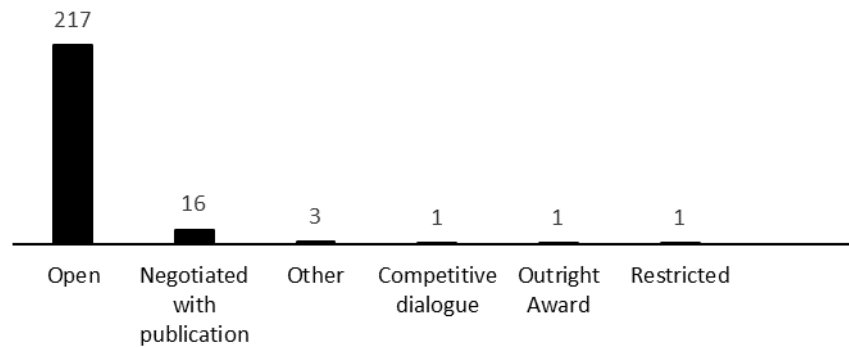
Our data includes 245 central tenders in France in 2017 with an average final bid price 8,750,317 EUR. The largest CPV family in tender data is Medical equipment (Figure 3.5), it can correspond to activities of UNI-Ha and RESAH.

The vast majority of central tenders in our data were conducted with Open procedure (Figure 3.6).

Figure 3.5: Centrally procured CPV categories (Number of tenders, France, 2017)



(Source: Own construction based on Datlab data)

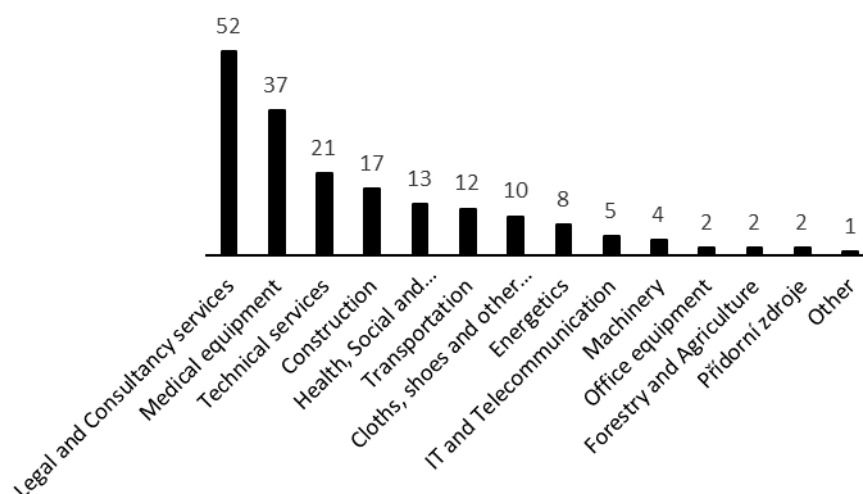
Figure 3.6: Central tenders procedure types (Number of tenders, France, 2017)

(Source: Own construction based on Datlab data)

3.3.4 Italy

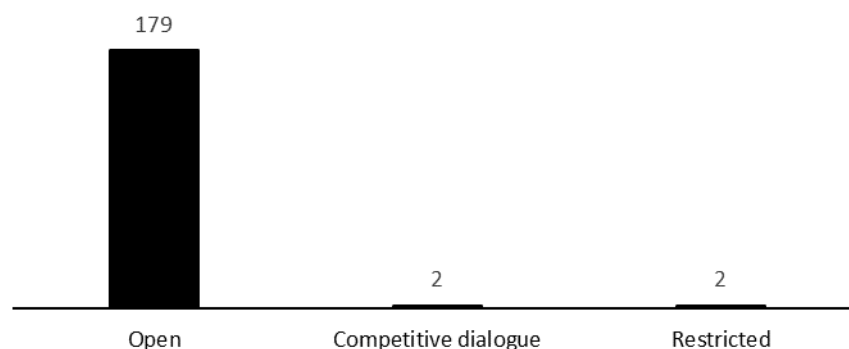
Italy implemented a legal framework for centralized purchasing in 2006 (Decreto legislativo 2006, n. 163). The regulation enables the establishment of a central purchasing body and it (Křížová and Brojac, 2015). The main central purchasing body is Consip, totally and directly owned by the Ministry of Economy and Finance (Bianchi and Guaidi, 2010). The goal of Consip is to utilize technology and procurement innovation to minimize expenditures of State administrations. The main activities conducted by Consip are framework purchases of standardized goods and framework agreements setting basic rules with multiple suppliers for public purchase of certain products. These framework agreements enable the final buyer to run the simplified tender procedure. The state administration is obliged to use Consip's framework contracts, while lower government levels are free to use them (OECD, 2011). Consip is the main CPB, however, the regions can also set their agencies purchasing on behalf of local and regional administrations (Bianchi and Guidi, 2010).

According to our data 186 central tenders were conducted in 2017. The average final bid price was 3,426,580 EUR. Italian central tenders are mostly used for Legal and Consultancy services and Medical equipment (Figure 3.7). Surprisingly, the Energetics and IT and telecommunication are not represented with a large number of tenders, but these commodities are very homogenous, so they can be procured with a smaller number of central contracts.

Figure 3.7: Centrally procured CPV categories (Number of tenders, Italy, 2017)

(Source: Own construction based on Datlab data)

Central tenders in Italy employed almost exclusively the Open procedure (Figure 3.8).

Figure 3.8: Central tenders procedure types (Number of tenders, France, 2017)

(Source: Own construction based on Datlab data)

3.3.5 United Kingdom

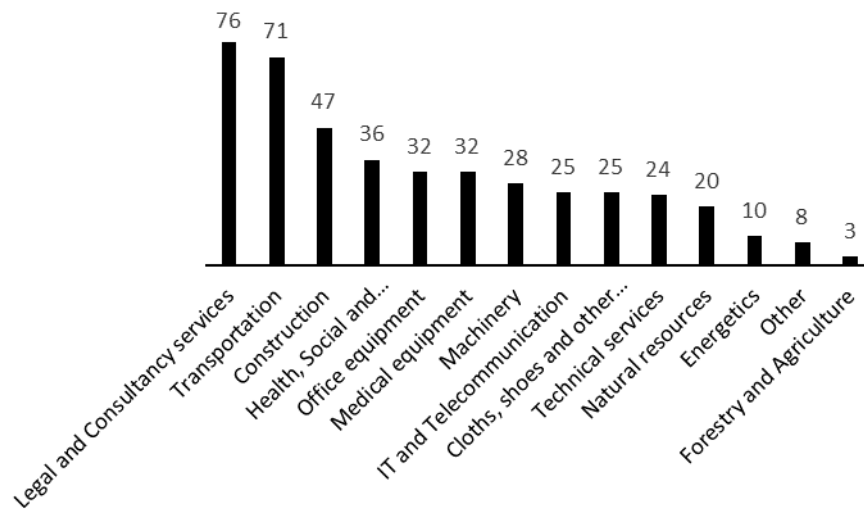
Key institution of the United Kingdom procurement system is the Office of Government Commerce (OGC). OGC with the central government is setting procurement policies to improve factors as price, quality, time of delivery or SME accession (Bianchi and Guaidi, 2010). The function of CPB is maintained by Buying solutions (unit of OGC). Around 40 institutions acting as CPB, nevertheless, the Buying solutions are the largest (OECD, 2011).

Buying solutions procures and supplies a wide range of products including ICT and telecommunication, energy, maintaining services, travel and fleet. However, there is no obligation to use Buying solutions, so it must earn customers. The body is financed by user fees (OECD, 2011).

Figure 3.9 shows that central tenders in the UK are spread more uniformly among the CPV families. The average final bid price is 23,738,472 EUR, this suggests that procured quantities in the UK are higher than in previous countries.

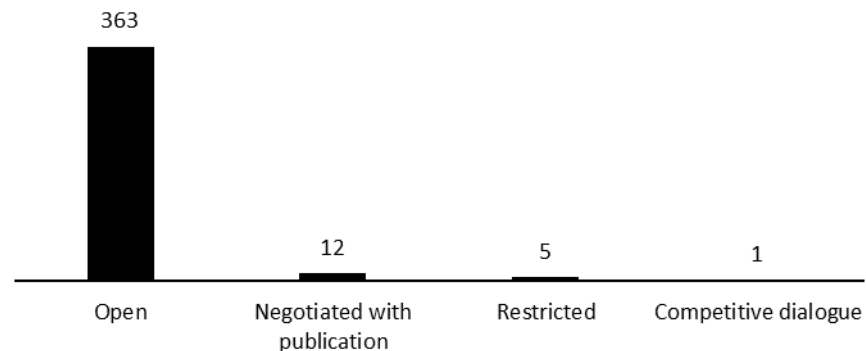
Central procedure types are almost exclusively Open (Figure 3.10).

Figure 3.9: Centrally procured CPV categories (Number of tenders, United Kingdom, 2017)



(Source: Own construction based on Datlab data)

Figure 3.10: Central tenders procedure types (Number of tenders, United Kingdom, 2017)



(Source: Own construction based on Datlab data)

4. Empirical part

4.1 Research questions

The objective of this thesis is to examine the effect of collaborative procurement in the context of the wider EU procurement strategy. Considering EC directive 2014/18: “In view of the large volumes purchased, those techniques help increase competition and streamline public purchasing.” My first hypothesis is as follows:

Hypothesis 1: Centralized procurement has a positive effect on competition.

One of the benefits of central procurement is reducing the risk of corruption and ensuring a fair market environment. Corruption might be reduced with standardization of the processes and control independent on the final buyer. Unfortunately, this effect is not very clear. However, our dataset enables us to analyse and compare tenders from various countries with different risk of corruption. If central procurement reduces the risk of corruption, we can assume that central procurement will impact the effectivity more in more corrupt countries. In countries with a lower risk of corruption, the effect will be lower, because the risk of corruption is not the source of in effectivity of the tender. Therefore, our second hypothesis is as follows:

Hypothesis 2: Centralized procurement impact on tender effectivity is higher in countries with higher corruption

Proving our second hypothesis might confirm that central procurement reduces the risk of corruption. Moreover, it will uncover role of country-specific effects on central tender results.

One of the suggested recommendations to improve SME accession to public procurement is using multiple selection criteria. SME might not be able to offer the lowest bid price, but they might offer other qualities. To examine whether this recommendation is appropriate, our third hypothesis is as follows:

Hypothesis 3: Multiple selection criteria have a positive effect on the probability of awarding public procurement to SME.

A barrier of entry is a common counter-argument against centralization. Therefore, my last hypothesis is as follows:

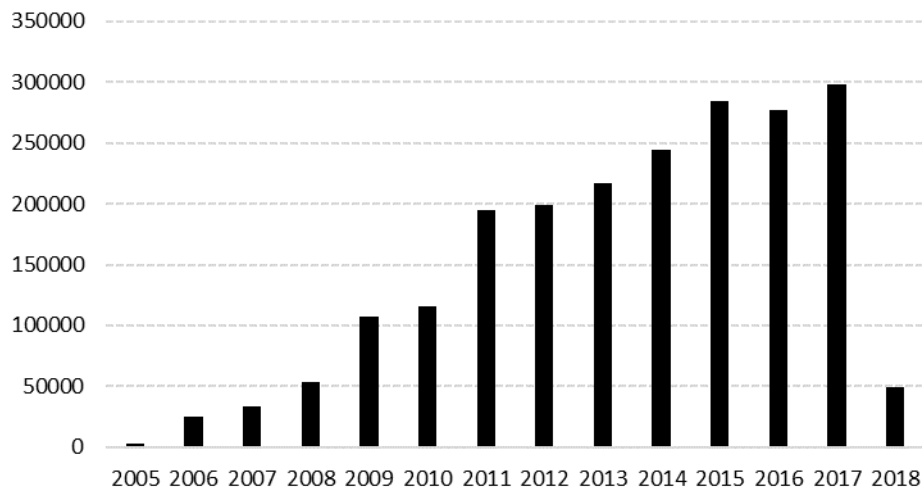
Hypothesis 4: Centralized procurement decreases the probability of awarding public procurement to SME.

4.2 Data description

The main data source for empirical research is the Czech company Datlab. Datlab is engaged in project Opentender funded by the EU and provides unique dataset consisting of data describing both above and below threshold public tenders. The dataset is a combination of information retrieved from the TED database and the national databases (vestnikverejnychzakazek.cz etc.). It enables an analysis of public tenders in all member states of the EU, Norway, Iceland, Switzerland and Georgia that were conducted since 2005.

For the purpose of this thesis, I have obtained only data with known buyer and suppliers. Data contains 2,102,628 observations and one observation stands for one public tender. Observation contains a specification of the whole tender process including buyer and bidder details, award procedure or centralized procurement.

Figure 4.1: Year graph of number of tenders in our data



(Source: own construction based on Datlab database)

An important issue regarding the dataset is the very unbalanced quality of tender information in both country and year dimension. Data from the years 2005 to 2010 and the year 2018 contain a low number of tenders compared to other years (Figure 4.1). Moreover, many included tenders are not complete, and some information is missing. Particularly variable whether the procurement was central is not available for most years (See Appendix 1). Because of this reason I have decided to focus only on tenders from the years 2016 and 2017 in the EU. However, the resulting sample is still grossly incomplete (Appendix 2).

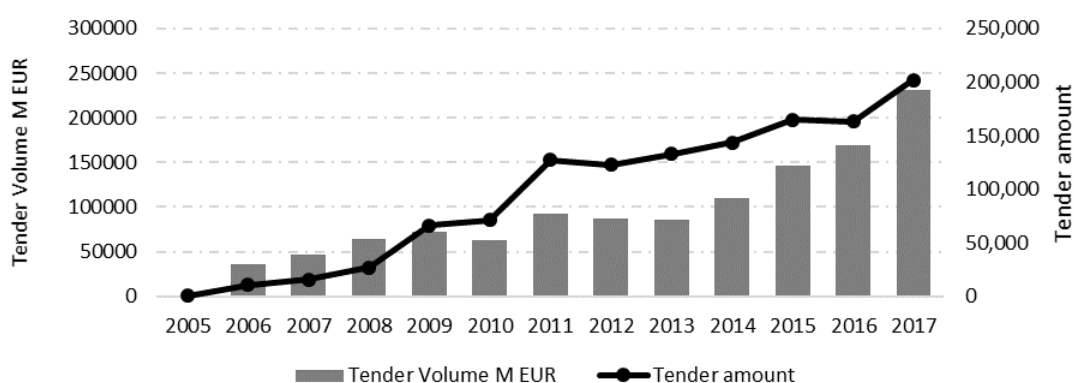
The tender dataset was complemented with country-specific indicators: As information indicating a perception of public governance quality and corruption, the World Bank's Government effectiveness and Control of corruption indexes from the year 2017 were chosen⁸. Indicator SME share stands for the percentage of people employed in a company with less than 250 employees in a certain country. This information was obtained from Eurostat⁹ and it was not available for all EU states, therefore SME share is missing for Ireland, Greece, Portugal, Cyprus and Denmark. Country specific indicators used are captured in Appendix 3.

4.3 Descriptive statistics

Due to gross incompleteness of dataset, it is impossible to indicate true procured volumes. So, the following figures serve as a description of the available data rather than exact tender statistics.

However, on the data with known final bid price consistent growth in a number of tenders conducted. The total volume had been also increasing except for the years 2010 and 2012. These procured volumes might be lower because of economic austerity during the financial crisis (Figure 4.2).

Figure 4.2: Year graph of number of tenders with total value



(Source: own construction based on Datlab database)

⁸ The Worldwide Governance Indicators (WGI) project offers six governance indicators based on surveying enterprises and individuals from over 200 countries. WGI dataset with description of the methodology is available at <https://info.worldbank.org/governance/wgi/>

⁹ Data obtained from Eurostat are available at <http://appsso.eurostat.ec.europa.eu/>

The most of published tenders are below-threshold (It is not mandatory to publish them in the TED database). Most of the total tender value make over-threshold contracts (Figures 4.3 and 4.4).

Figure 4.3: Number of tenders

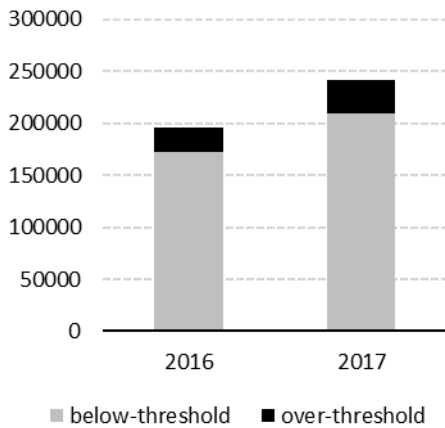
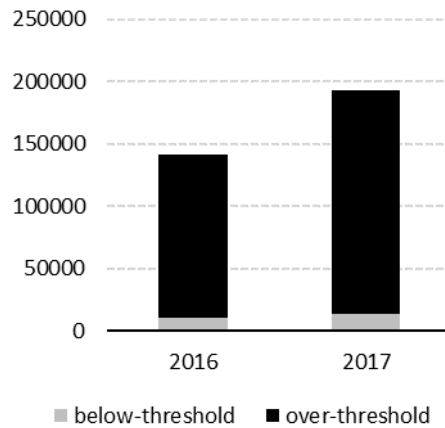
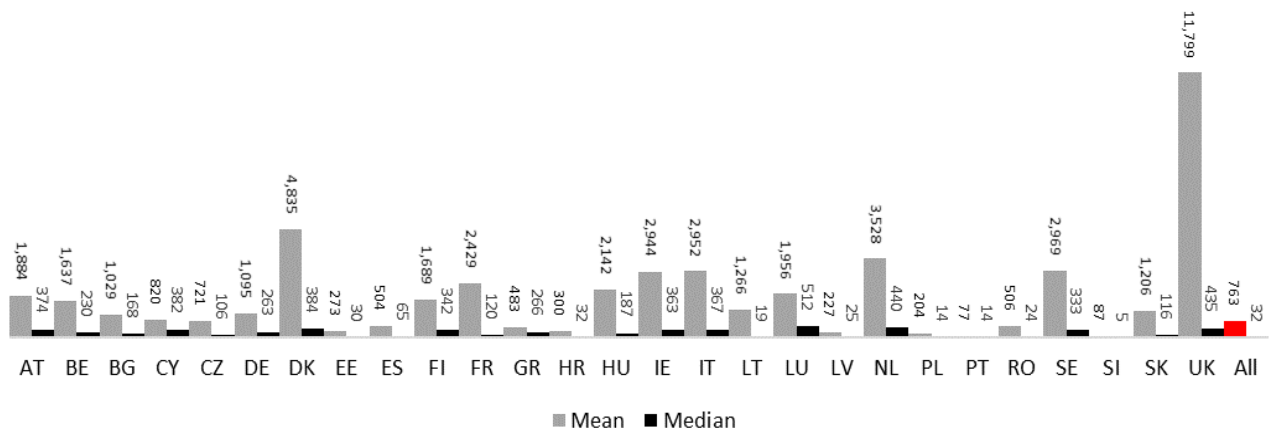


Figure 4.4: Tender Value (EUR mil.)



Descriptive statistics of the tender volume also indicates a large number of tenders with a small value and few very large contracts as mean tender value is much above the median in most countries (Figure 4.5). Figure 4.5 also shows big differences in tender volumes among EU members. Countries like the United Kingdom, Denmark or Netherlands purchase larger volumes than eastern states like the Czech Republic, Hungary or Poland. These differences can be caused by different economy factors as price level or size of the public sector. The varying procurement practises as the degree of centralization can be also significant, because the average final bid price is more than four times higher than EU final bid price average (Table 4.1).

Figure 4.5: Mean and median final bid price in EU countries (EUR thousands, 2016-2017)



(Source: Own construction based on Datlab data)

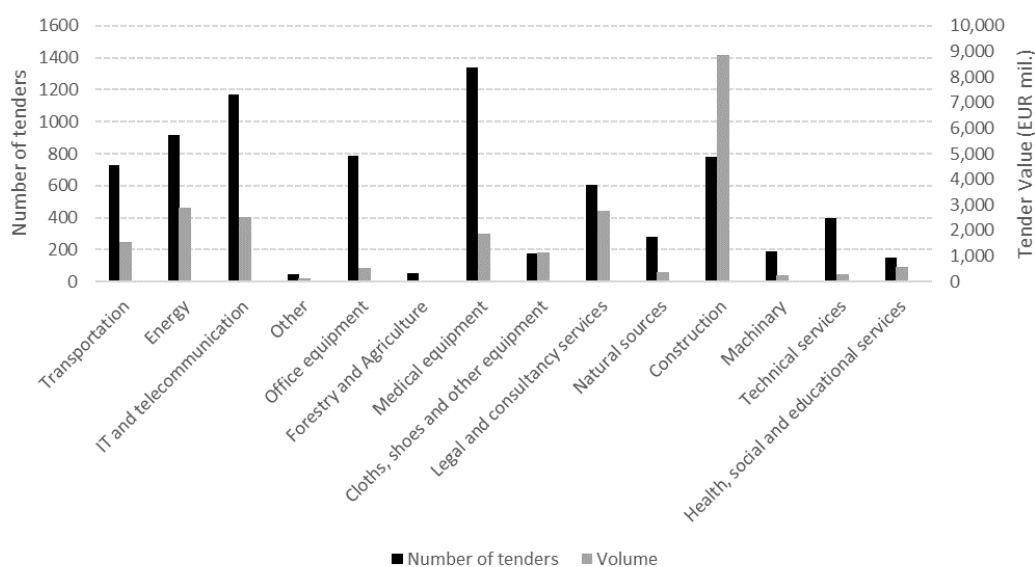
Table 4.1: Mean and median final bid price (2016-2017)

	Median	Mean
Total EU procurement	32,290 EUR	763,300 EUR
Centralized procurement	150,501 EUR	3,125,036 EUR

(Source: Own construction based on Datlab data)

In the previous chapter, it was mentioned that only some categories of goods are suitable for central procurement. However, in our dataset at least some centralized tenders from each CPV categories family are present. Most frequent commodities purchased centrally are medical equipment, IT and telecommunications or Energy. But the largest overall volume was performed by construction tenders.

Figure 4.6: Volumes and number of tenders (Central procurement 2016-2017)



(Source: Own construction based on Datlab data)

The histograms of number of bidders follow exponential distribution (Figure 4.7). The tenders with single bidder are most probable, and probability decreases exponentially with more bidders. It corresponds with the results of Křišťoufek and Skuhrovec (2012). A number of bidders in case of centralized procurement are distributed similarly. However, the centralized tenders have a slightly higher average number of bids placed (Table 4.2).

Figure 4.7: Histograms of number of bids placed

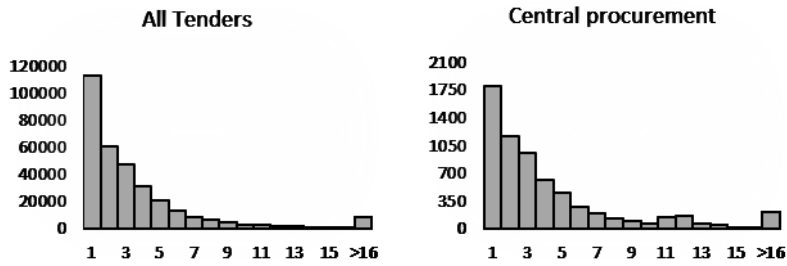


Table 4.2: Mean and median number of bids placed

	Median	Mean
All tender	2	3.502
Centralized tenders	3	4.123

(Source: Own construction based on Datlab data)

Histograms of number of bidders split according to sector families are also highly skewed to the right for all our CPV families (Figure 4.8). This also applies to most CPV families in case of centralized procurement. However, the distribution of number of bidders in Energetic differs from the others, because most frequent tenders have one, eleven and twelve bidders (Figure 4.9).

Figure 4.8: Histograms of number of bids placed (Selected CPV categories, all tenders)

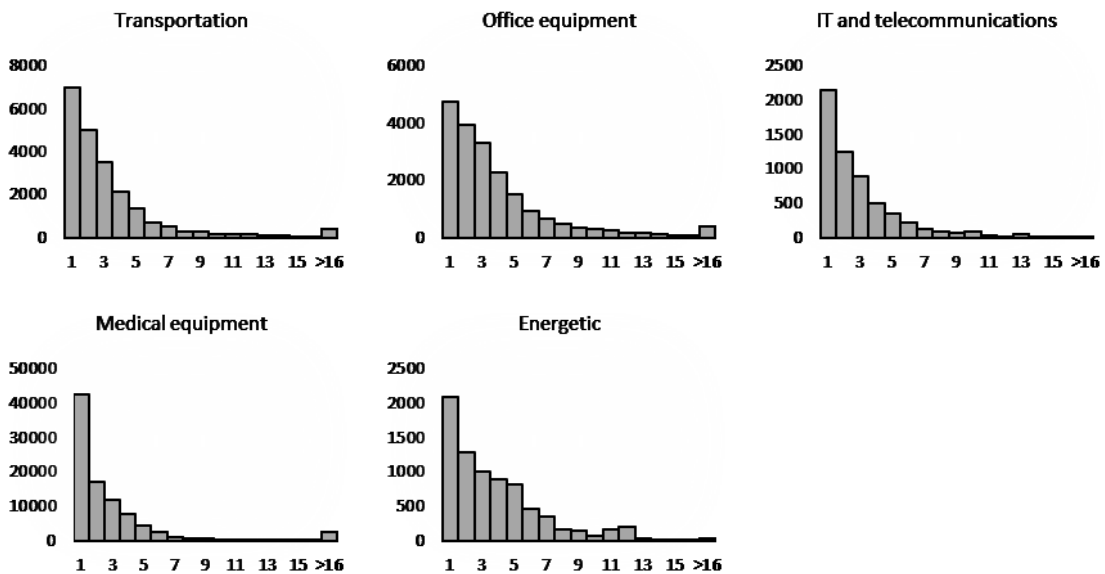
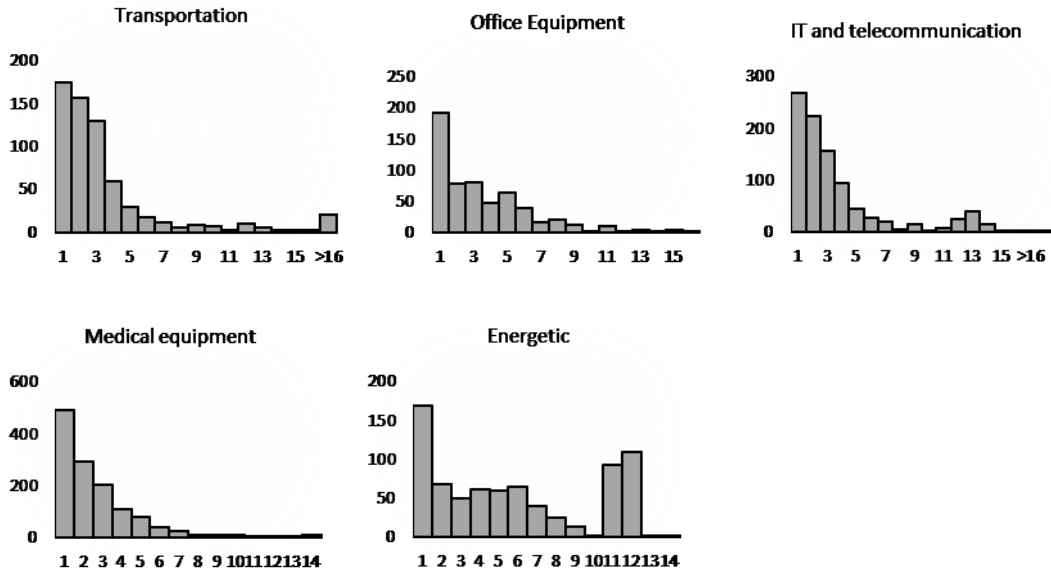


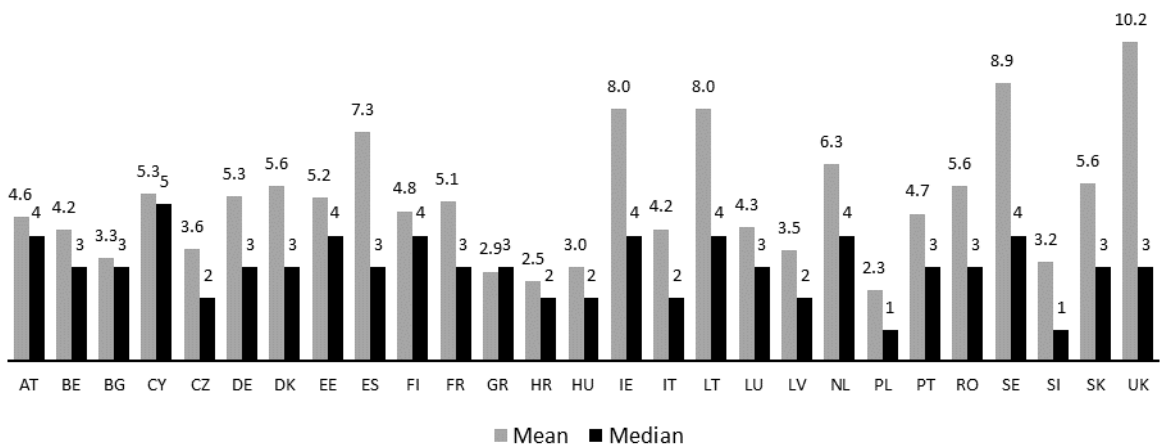
Figure 4.9: Histograms of number of bids placed (Selected CPV categories, central procurement only)



(Source: Own construction based on Datlab data)

Comparison of number of bidders according to states shows that practises differ a lot. Countries with a median number of bidders above the EU median are Finland, Sweden, Ireland and the Netherlands. On the other hand, a median number of bidders below EU median has countries from Central Europe (Czech Republic, Poland, Hungary, Slovenia) and Italy (Figure 4.10).

Figure 4.10: Mean and median of number of bids (Countries comparison)



(Source: Own construction based on Datlab data)

Our dataset does not enable us to determine whether the tender winner is SME according to the European Commission's criteria, because we do not have data about company's annual turnovers. Nevertheless, to show at least some information about the structure of enterprises winning public tenders, we have classified the final supplier according to a number of employees (Table 4.3) and define SME as a company with less than 250 employees.

Table 4.3: Categories of enterprises

Category	Number of employees
Micro	< 10
Small	< 50
Medium	< 250
Large	≥ 250

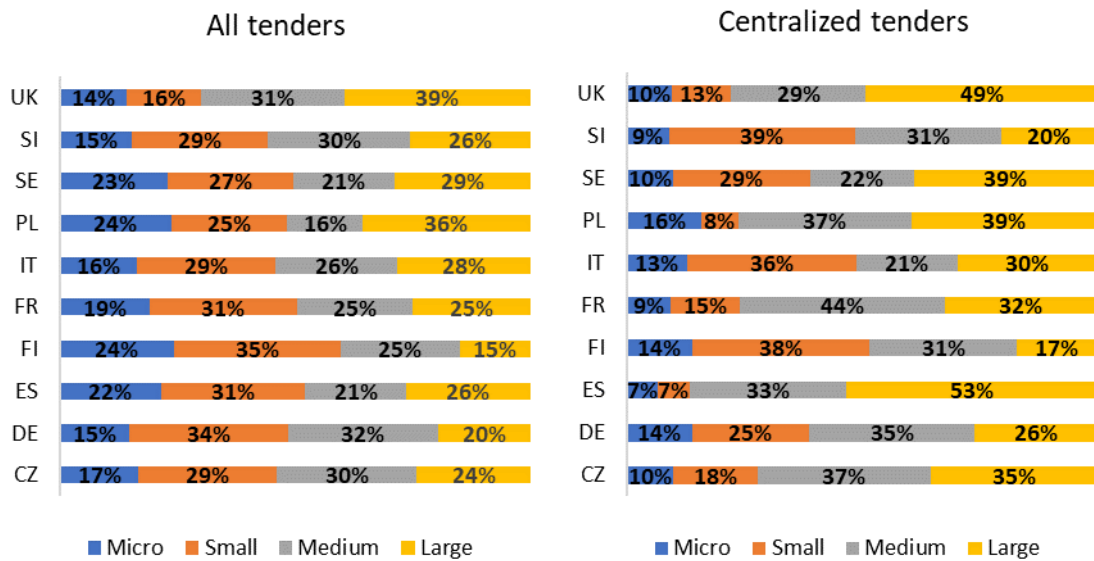
(Source: Own construction based on Datlab data)

According to our data, in the years 2016 and 2017, around 63% of above-threshold tenders and 79% of all tenders were awarded to SME. This number is higher than the estimation conducted by PWC (2014), which was around 55% of above-threshold contracts. The difference can be caused by slightly different SME classification. Further, only 52% of the value of all above-threshold and 55% of all contracts in our 2016-2017 data was awarded to SME. These results differ a lot from PWC (2014) because they estimated the value of contract won by SME to around 30%. Our figures must be treated with caution because of missing data.

Figures 4.11 and 4.12 offer comparison of SME shares in public tenders in selected EU countries. For most countries, the SME sector is less represented in centralized procurement compared to all tenders in terms of both the amount and value of tenders.

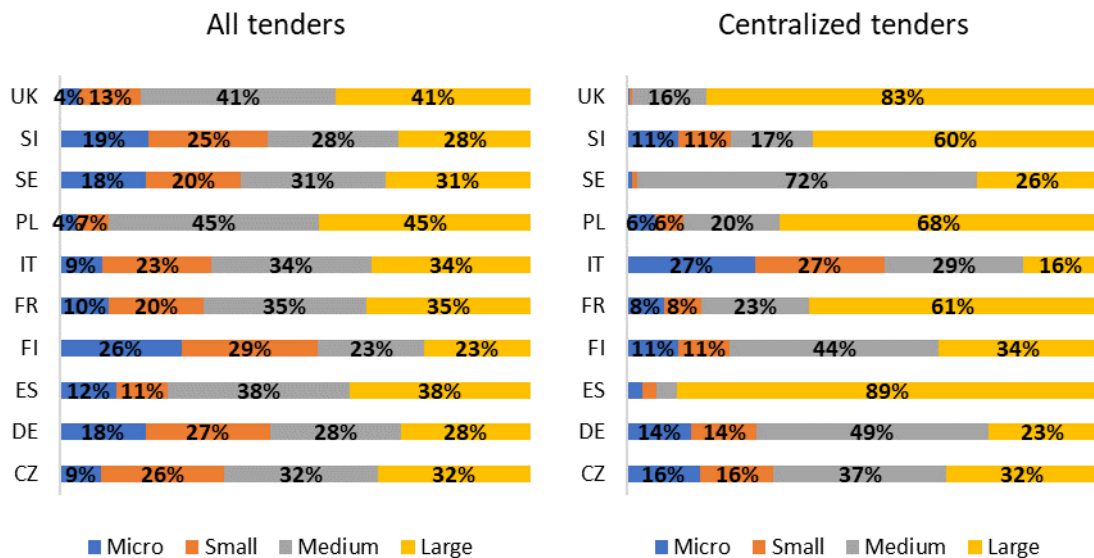
Interestingly, there is not so large difference between SME share in tenders between all tenders and centralized procurement. But there is a large difference when we measure the share in contracts value. Only exceptions are Germany and Italy, where all the tenders value awarded to SME is higher than in case of central procurement.

Figure 4.11: SME share in public procurement by number of tenders



(Source: Own construction based on Datlab data)

Figure 4.12: SME share in public procurement by procured value



(Source: Own construction based on Datlab data)

4.4 Modelling number of bidders

Various approaches can be chosen to analyse the effectiveness of public procurement tender. Plaček (2017) and Kožišek (2015) modelled ratio between final and expected tender price. Unfortunately, this practice is not suitable for our dataset due to many missing observations regarding the expected price.

The observed negative relationship between final price and number of bidders (Soudek and Skuhrovec, 2016) enables us to assume that the effectiveness of the tender procedure is increasing with number of offers. Number of bidders is also commonly used as a proxy variable for competition. Consequently, estimating the number of bidders as dependent variable can be a good approach to examine procurement collaboration effect on both tender effectiveness and tender competition.

4.4.1 Data and variables

Datlab's data enables us to analyse tenders from a long period of time and a large group of countries. However, due to gross incompleteness of the dataset, the data from Malta, Bulgaria, Romania, Greece and Cyprus were excluded. Also, the years were limited only to 2016 and 2017.

Regarding the incompleteness of data, we must be aware that observations reported by CPBs are more likely to be complete and not missing compared to tenders conducted by other authorities. It can be caused by higher volumes in central procurement and higher professionalism of central procurers. Therefore, observations in our data might be missing systematically and regression results might be biased.

Considering the specific nature of centrally procured goods, the regression analysis will be conducted only on tenders from five CPV families (Energetics, IT and telecommunication, Office equipment, Medical equipment and Transportation). Chosen categories contain commodities commonly procured centrally in the EU.

A possible drawback of having *Number of bidders* as the dependent variable is the difference of bidder definition in different procedure types. Moreover, the central procurement in many countries is conducted almost exclusively with open procedure type. Therefore, only tenders with the open procedure have been analysed.

The final analysis was conducted on a cross-sectional dataset consisting of 66,104 tenders from 23 countries.

Independent variables can be divided into tender specific and country-specific variables and their description is elaborated in Table 4.4.

Table 4.4: Description of the variables

Variable	Type	Description
Bidders count	integer	Number of bidders
Energetic	dummy	Purchase of commodities or services regarding energy or electricity
IT and telecommunication	dummy	Purchase of commodities or services regarding IT and telecommunication
Office equipment	dummy	Purchase of commodities or services regarding Office equipment
Medical equipment	dummy	Purchase of commodities or services regarding Medical equipment
MEAT	dummy	Most economically advantageous tender selection method was adopted
Central procurement	dummy	Purchase was conducted centrally
Final bid price	Rational number	Final bid price in millions EUR
Governance	Rational number	Government effectiveness Indicator (WGI)
Corruption	Rational number	Control of Corruption Indicator (WGI)

Among variables for CPV category families, Transportation serves as a base group.

World Bank offers WGI indicators serving as a measure of various factors of public governance. The Corruption and Governance variables were chosen to represent country-specific procurement environment.

4.4.2 Methodology

The methodology was chosen regarding the nature of our data. *Number of bidders* variable is a count variable following an exponential distribution. Count variables are usually treated with Maximum likelihood estimation, specifically with Poisson regression (Wooldridge, 2013). However, the assumptions of standard Poisson regression might be too restrictive in our case as it assumes variance is equal to the mean (1).

$$\text{Var}(y|x) = E(y|x) \quad (1)$$

This assumption is likely to be violated, because of the heterogeneity in our data: The individual tenders are grouped within the country as well as CPV category. Each country has slightly different procurement legislation, policy priorities and purchasing practises and different CPV category markets differ in number and type of suppliers or final price. Therefore, we can suspect that variance is larger than the mean (overdispersion).

As a treatment for overdispersion in Poisson regression, Wooldridge (2013) suggests assuming that variance is proportional to mean and Φ is a dispersion parameter (2).

$$Var(y|x) = \Phi E(y|x) \quad (2)$$

If Φ is equal to 1, it is a case of Poisson Variance. If Φ is greater than one, overdispersion is present. Assuming (2) we can estimate the model using Iteratively-reweighted least squares (IRLS). Resulting estimates are called Quasi-maximum likelihood estimates (QMLE). In the case of overdispersion, QMLE standard errors will be larger than errors in standard Poisson regression (Cameron, 2013).

To detect whether the overdispersion is present, we will use the test suggested by Wilson and Koehler (1991). Test relies on Pearson χ^2 statistic defined as follows:

$$\chi_p^2 = \sum_{i=1}^n \frac{(y_i - \mu_i)^2}{var(y_i)} = \sum_{i=1}^n \frac{(y_i - \mu_i)^2}{\Phi \mu_i} \quad (3)$$

If the ratio between χ_p^2 and degrees of freedom of the model is equal to one, Φ is equal to 1 than there is no overdispersion (Rodriguez, 2013). If the ratio is larger than 1, the standard Poisson regression is not appropriate.

For both MLE and QMLE, the estimated equation is as follows:

$$\begin{aligned} \text{Bidders count} = & \alpha + \beta_1 \text{Energetic} + \beta_2 \text{IT and telecommunication} + \\ & \beta_3 \text{Office equipment} + \beta_4 \text{Medical equipment} + \beta_4 \text{MEAT} + \\ & \beta_5 \text{Central procurement} + \gamma_1 \text{Governance} + \gamma_2 \text{Corruption} + \varepsilon \end{aligned} \quad (\text{Model 1})$$

Estimation of Model 1 enables us to examine ceteris paribus effect of tender and country-specific variables. For distinction of country and individual tender factors, the different coefficient signs are used. The intercept is denoted by α and ε stands for unobserved factors. Because we deal with Poisson regression, we must be aware of a different interpretation of coefficients than in case of level-level OLS regression. The

expected value of the outcome is modelled as an exponential function. Therefore, we can interpret the coefficient as a percentage change in dependent variable associated with a unit change of independent variable (Wooldridge, 2012).

To answer all the research questions, we must find how Corruption interacts with a centralized procurement dummy variable. Therefore, we add an interaction variable and estimate Model 2.

$$\begin{aligned} \text{Bidders count} = & \alpha + \beta_1 \text{Energetic} + \beta_2 \text{IT and telecommunication} + \\ & \beta_3 \text{Office equipment} + \beta_4 \text{Medical equipment} + \beta_4 \text{MEAT} + \\ & \beta_5 \text{Central procurement} + \gamma_1 \text{Governance} + \gamma_2 \text{Corruption} + \\ & \beta_6 \text{Central procurement} * \text{Corruption} + \varepsilon \end{aligned} \quad (\text{Model 2})$$

QLME can be used to treat overdispersion. However, the issue of the clustered data structure will not be solved. Moulton (1990) emphasized that the OLS model on data with observations independent between groups (countries and CPV) and correlated within groups suffers from invalid standard errors. And he proposed as a treatment to use a Cluster robust standard error. Unfortunately, we cannot conduct the same method for Poisson regression models.

The proper solution for clustering can be Multilevel (Hierarchical) modelling with mixed effects (Aiken et al., 2015). However, this approach is computationally very demanding especially for nonlinear models and large datasets. Therefore, my analysis will focus on Quasi-likelihood Poisson regression.

Nevertheless, I will present the results for OLS with clustered robust standard errors in the Appendix. For this purpose, I have divided the tenders into 115 clusters according to the respective country and CPV category. Wooldridge (2003) highlights the importance of a large number of clusters for cluster robust standard errors to be valid, however, 115 clusters should be sufficiently large. To account for the exponential distribution of *Number of bidders*, we will use the OLS models in log-linear form.

A large amount of data clustered in a large number of groups brings difficulties within an understanding and interpreting regression results. Therefore, we will also include results from five QMLE regression models, computed separately using data from each of the five chosen CPV families. A similar approach was used by Soudek and Skuhrovec (2016) and Počarovská (2018).

4.4.3 Results and discussion

According to the Methodology, we estimated Model 1 and unrestricted Model 2 employing both MLE and QMLE (Table 4.5).

Prior to evaluating this hypothesis using the computed regressions, we will decide whether MLE or QMLE is more appropriate for our data. In the case of Model 1, the ratio between χ^2_p statistic and degrees of freedom is equal to 4.566. χ^2_p statistic is significant at 0.001 significance level and the ratio is high enough to assume that overdispersion is present. For Model 2, the ratio is equal to 4.4915 with χ^2_p also highly significant. Therefore, we can conclude that in our case QLME is more suitable. In the regression results, we can see that QLME standard errors are higher than in the case of MLE, it causes different significance of included variables.

Because the overdispersion was detected, only the QLME results will be interpreted. In Model 1 (Table 4.5), all variables except *Final bid price* are significant. Literature suggests that procured quantity is more attractive for suppliers. However, our estimation does not prove that behaviour. On the other hand, the *Final bid price* might not be a good proxy for procured quantity as we cannot compare the price to any benchmark such as unit price.

The significant positive effect of *MEAT* variable suggest that multi-criteria actions attract more bidders. The suppliers might be motivated by higher prices in case of providing high-quality products.

The results of the country-specific variable correspond to the notion that more efficient governments and less corrupt systems have a significantly higher number of bids and they can conduct procurement more effectively. Administrations with higher effectivity might be more capable of promoting the tender among suppliers. In countries with lower corruption, the risk of collusion might be smaller and the connections between the private and public sector might be lower.

Model 1 was also estimated using OLS with clustered standard errors (Appendix 4). The OLS coefficients had the same sign of slopes, but the significance differs a lot. Interestingly, the *Final bid price* in OLS was significant and variables as *Corruption* or *Central procurement* were not.

Table 4.5: Modelling number of bidders using MLE and QLME

	Model 1 (MLE)	Model 1 (QLME)	Model 2 (MLE)	Model 2 (QLME)
(Intercept)	0.4973*** (0.0112)	0.4973*** (0.0629)	0.2957*** (0.0116)	0.2957*** (0.0651)
Energetics	-0.1044*** (0.0111)	-0.1044. (0.0623)	-0.1017*** (0.0111)	-0.1017 (0.0625)
IT and Telecommunication	-0.1257*** (0.0081)	-0.1257** (0.0457)	-0.1438*** (0.0081)	-0.1438** (0.0459)
Office equipment	0.161*** (0.0087)	0.161*** (0.0488)	0.1317*** (0.0087)	0.1317** (0.0491)
Medical equipment	-0.2028*** (0.0068)	-0.2028*** (0.038)	-0.1125*** (0.0069)	-0.1125** (0.039)
MEAT	0.0724*** (0.0046)	0.0724** (0.0259)	0.0684*** (0.0046)	0.0684** (0.026)
Central procurement	0.2259*** (0.0085)	0.2259*** (0.0475)	1.2267*** (0.0154)	1.2267*** (0.0869)
Final bid price (EUR mil.)	0.0002* (0.0001)	0.0002 (0.0006)	0.0003* (0.0001)	0.0003 (0.0006)
Governance	0.9713*** (0.012)	0.9713*** (0.0674)	1.0116*** (0.0119)	1.0116*** (0.0671)
corruption	-0.3023*** (0.0076)	-0.3023*** (0.0425)	-0.1845*** (0.0077)	-0.1845*** (0.0432)
Central procurement*Corruption			-0.8202*** (0.012)	-0.8202*** (0.0675)
Observations	66,104	66,104	66,104	66,104

(Note: ***, **, *, . stand for significance at 0.001, 0.01, 0.05, 0.1 respectively; standard errors are in the brackets)

Variable Central procurement is related to the first hypothesis of this thesis. Hypothesis 1 states, that central procurement have a positive effect on competition. The significant positive effect of *Central procurement* suggests accepting this hypothesis. However, estimating Model 1 separately on five samples (each for one CPV category) showed that the *Central procurement* effect is not the same for all procured commodities (Table 4.6).

Effect of *Central procurement* is significantly positive for procurement regarding Office equipment, IT and telecommunication and Energetics. This result might be caused by quite homogenous nature of these CPV categories and by the necessity of these commodities for most public bodies.

We do not have enough evidence to prove any effect of central procurement regarding transportation. And the *Central procurement* is significantly negative in case of Medical equipment.

To compare the collaboration effect between countries with different degree of corruption, we estimated Model 2. The interaction variable *Central procurement*Corruption* was added to find out whether the *Central procurement* effect depends on the magnitude of the *Corruption* variable. The interaction effect is significant and negative in both QLME and clustered OLS models (Appendix 4). These results are in favour of our Hypothesis 2. Because WGI rating is higher for less corrupt countries. It suggests that the Central procurement effect on number of bidders is higher in more corrupt countries. Our explanation is as follows: Corruption is not a source of the ineffectiveness of procurement in countries with low corruption. Therefore, the central procurement will affect number of bidders (a proxy for effectivity) less than in countries with high corruption. This result is important because it indirectly shows that Central procurement can be used to decrease the risk of corruption. We can recommend to policymakers in South and Eastern Europe, where the problem with corruption are high to utilize the option of collaborative procurement.

Table 4.6: Model 1 estimated separately for chosen CPV categories

	Transportation	Office equipment	IT and Telecom.	Medical equipment	Energetics
(Intercept)	0.7453* (0.3008)	-0.113 (0.206)	0.6645*** (0.142)	0.0353 (0.0304)	0.8543*** (0.0466)
MEAT	-0.0229 (0.1307)	0.4743*** (0.0736)	0.0544 (0.0722)	0.0519** (0.019)	-0.2712*** (0.0331)
Central procurement	-0.1341 (0.2702)	0.8474*** (0.0859)	0.7753*** (0.0906)	-0.8025*** (0.0597)	0.1294** (0.0422)
Final bid price (EUR mil.)	0.0001 (0.0018)	0.0000 (0.0015)	-0.0001 (0.0019)	0.0043*** (0.0009)	0.0000 (0.0004)
Governance	0.8455* (0.3785)	1.5807*** (0.2561)	0.5171** (0.18)	1.0988*** (0.0465)	0.4067*** (0.0661)
Corruption	-0.3115 (0.2102)	-0.5758*** (0.1387)	-0.1427 (0.1068)	-0.0798* (0.034)	-0.0193 (0.0427)
Observations	8,695	4,518	8,540	41,338	3,313

(Note: ***, **, *, . stand for significance at 0.001, 0.01, 0.05, 0.1 respectively; standard errors are in the brackets)

4.5 Modelling SME accession

Besides the analysis of components impacting a number of bidders in the tender, we want to examine factors increasing or decreasing the probability that the winning bidder is a small or medium company. Similarly, as Pucek (2015) who studied barriers to entry in public procurement, I have decided to choose an econometric model with a binary dependent variable.

It was already described that we do not have enough information to decide whether the tender was awarded to SME or not according to EC definition. However, as we have data about a number of employees of winning bidder, we will consider SME as a company with less than 250 employees. Therefore, we can use our SME category as the binary dependent variable.

To be consistent with our Competition model, independent variables will be almost the same as in the previous model. The only new variable is country-specific SME share, which stands for the percentage of employees employed by SMEs. This variable reflects that structure of companies differs within economies and we can expect a higher probability of SME in countries with a higher share of small companies in terms of a number of employees.

Unfortunately, data about the share of SME in the economy are not available for all EU countries. Therefore, we must restrict dataset from the previous model and exclude tenders from Ireland, Denmark and Portugal. Consequently, we will analyse data from 20 countries consisted of 37,834 tenders. Finally, the estimated equation is as follows:

$$SME = \alpha + \beta_1 \text{Energetic} + \beta_2 \text{IT and telecommunication} + \beta_3 \text{Office equipment} + \beta_4 \text{Medical equipment} + \beta_4 \text{MEAT} + \beta_5 \text{Central procurement} + \gamma_1 \text{Governance} + \gamma_2 \text{Corruption} + \varepsilon$$

(Model 3)

4.5.1 Methodology

The simplest model with a binary dependent variable is the Linear Probability Model (LPM) estimated using OLS. However, this method suffers from various drawbacks: Standard errors of LPM are always heteroskedastic and the fitted values can be less than zero or greater than one (Wooldridge, 2013). Therefore, it is suitable to use more sophisticated models as Logit.

Logit regression is a type of MLE used when the dependent variable follows the binomial distribution. Similarly, as in the case of modelling of a number of bidders, the clustered structure of our data might cause that the variance of the observed response is much higher than the binomial variance (overdispersion).

As in the previous approach, we will assume that the variance of the dependent variable is proportional to the variance of Binomial distribution:

$$\text{Var}(y|x) = \Phi\sigma^2 \quad (4)$$

Using the IRLS we will obtain the Quasi-likelihood estimates. To test whether MLE or QMLE is appropriate, we will conduct the Pearson χ^2 test similarly as in Modelling of a number of bidders.

The proposed methods will be compared to the LPM model with clustered standard errors. And as in the previous model, we will present the QMLE calculated separately on data split among CPV categories.

4.5.2 Results and discussion

According to the described Methodology, we estimated Model 3 employing both MLE and QMLE (Table 4.7).

Similarly, as in the previous model, χ^2_p is used to decide whether MLE or QMLE is more appropriate for our data. In the case of Model 3, the ratio between χ^2_p statistic and degrees of freedom is equal 1.065 and χ^2_p statistic is significant at 0.001 significance level. The ratio is not high enough to assume that overdispersion is present. Moreover, the standard errors are very similar in both MLE and QLME. So, we can interpret only the MLE results.

All included variables in Model 3 estimated with MLE are significant at least with p-value smaller than 0.05. The variables in OLS model with clustered standard errors are less significant. The sign of the coefficients is the same for all variables in both OLS and MLE (Table 4.7 and Appendix 5). But in interpreting the coefficients we must be aware of different scales of Logit and LPM models.

Unlike the previous model, *Final bid price* variable is a significant negative factor for the probability of *SME*. This aspect is often mentioned as the drawback of aggregating demand in central procurement. It is expectable that large procurement volumes require larger human and capital capacities than SME have. However, the use of *Final bid price* as a proxy for volume is limited.

All country-specific variables included in Model 3 have a significant positive effect in both MLE and OLS models. It confirms that more effective governments can set the tender processes in the way to be suitable for smaller suppliers.

Our third hypothesis states that employing MEAT selection criteria helps to involve SME in public procurement. Hypothesis reflects the EU recommendations. However, the negative significant effect of *MEAT* variable is not in favour of that strategy. Refusing of Hypothesis 3 is supported also by the negative coefficient of *MEAT* variable in LPM model (Appendix 5). The negative slope of *MEAT* variable coefficient holds also for separate estimation on data split among CPV categories (Table 4.8).

There are more recommendations for SME accession as using e-procurement, dividing tender into lots and generally to reduce the administrative burden connected to the tender process. There is a possibility that MEAT selection combined with other strategies lowering administrative burden has desired effect, but we are not able to evaluate it with our data.

Table 4.7: Modelling SME as bidder using MLE and QLME

	Model 3 (MLE)	Model 3 (QLME)
(Intercept)	-12.3451*** (0.3454)	-12.3451*** (0.3423)
Energetics	-0.5878*** (0.0527)	-0.5878*** (0.0523)
IT and Telecommunication	-0.2603*** (0.0412)	-0.2603*** (0.0408)
Office equipment	0.7065*** (0.057)	0.7065*** (0.0565)
Medical equipment	0.1718*** (0.037)	0.1718*** (0.0367)
MEAT	-0.2296*** (0.026)	-0.2296*** (0.0258)
Central procurement	-0.12* (0.0537)	-0.12* (0.0532)
Final bid price (mil. EUR)	-0.0011* (0.0005)	-0.0011* (0.0005)
Governance	1.0589*** (0.0599)	1.0589*** (0.0594)
Corruption	0.5883*** (0.0383)	0.5883*** (0.038)
SME share	17.3039*** (0.4734)	17.3039*** (0.4691)
Observations	37,834	37,834

(Note: ***, **, *, . stand for significancy at 0.001, 0.01, 0.05, 0.1 respectively; standard errors are in the brackets)

Hypothesis 4 states that the central tender has a negative effect on awarding procurement to SME. There is a negative effect of *Central procurement* in the Model 3 estimated on the full dataset with p-value smaller than 0.05 (Table 4.7). However, this result does not apply for all CPV categories (Table 4.8).

Central procurement variable estimated tenders regarding Transportation and IT and telecommunication is significant with a positive slope.

Data suggests accepting Hypothesis 4 on data regarding tenders in Transportation and IT and telecommunications industries. *Central procurement* variable

is not a significant factor for the probability of SME on data regarding Medical equipment. Energetics and Office equipment data suggest opposite to Hypothesis 4.

We do not have information about the type and form of central procurement, therefore we cannot fully explain the differences in effect among CPV categories. big differences between commodities suggest that the decision whether to conduct the tender centrally should depend on individual circumstances.

Table 4.8: Model 3 estimated separately for chosen CPV categories

	Transport.	Office equipment	IT and Telecom.	Medical equipment	Energetics
(Intercept)	-8.5917*** (0.7436)	1.7012** (1.3683)	-6.2514*** (0.7468)	-22.1886*** (0.6183)	-0.5866 (1.1335)
MEAT	-0.1151. (0.0605)	-0.3335** (0.1047)	-0.2372*** (0.0589)	-0.2146*** (0.0384)	-0.924*** (0.0994)
Central procurement	-0.484*** (0.1066)	0.5981*** (0.1788)	-0.6289*** (0.0849)	0.1182 (0.2079)	0.2714. (0.1484)
Final bid price (mil. EUR)	-0.0019* (0.0008)	0.0025 (0.0058)	-0.0026 (0.0021)	-0.0144* (0.0072)	0.001 (0.0013)
Governance	0.3319* (0.1533)	-0.3182 (0.2637)	1.7884*** (0.1389)	0.9721*** (0.0882)	-0.3684. (0.2175)
Corruption	0.4707*** (0.0831)	-0.0529 (0.1284)	-0.3304*** (0.075)	1.995*** (0.0753)	0.5187*** (0.1525)
SME share	13.1811*** (0.9892)	0.8254 (1.8119)	8.033*** (1.0082)	30.6169*** (0.862)	1.7422 (1.5434)
Observations	4,876	2,185	4,888	24,059	1,826

(Note: ***, **, *, . stand for significancy at 0.001, 0.01, 0.05, 0.1 respectively; standard errors are in the brackets)

Conclusion

We have studied the aspects of collaborative procurement in the EU. The essential features of public auctions and forms of collaborative procurement were described. We have summarized the results of various researchers regarding the effect of procurement centralization. The theoretical part of the thesis was complemented with objectives and strategies of the EU and quantitative analysis of a unique dataset of tenders from EU countries.

In the first part, we have defined the essential terms in public procurement. We explained the basic types of public auctions. Based on the available literature we have concluded that Open procedure has a positive effect on competition, but the restricted auctions are more suitable for complex projects. Then we have described that possible collaborative procurement forms depend on the degree of centralization and type of collaboration.

Procurement collaboration is associated with various benefits as unit price reduction and internal economies of scale. There is no consensus among researchers, whether the higher procured volumes directly lead to lower unit price. However, studies are showing that savings emerged from the collaboration are higher than the initial costs of this strategy. Moreover, there are other suggested benefits such as reducing the risk of corruption and opportunity for research. There are also disadvantages of central procurement as information asymmetry or market distortion.

In the following part, the context of central procurement in the EU was described. The EU Directives highlight benefits of procurement collaboration as an increase in competition. The Directives also warn that central procurement might exclude small and medium companies from the procurement, because of their limited capacities. To engage these companies more, EU recommends using multiple selection criteria, use e-procurement and divide the tenders into a lot.

In the empirical part, we have studied the effect of central procurement on competition and on the probability of awarding the tender to SME. The analysis using Quasi-Maximum likelihood estimation showed the positive effect of competition in tenders regarding Office equipment, IT and Telecommunications and Energetics. Our results also suggest that central procurement has a higher effect in more corrupt

countries, and we have suggested using central procurement to mitigate the risk of corruption.

The analysis showed that central procurement decreases the probability of SME in tenders regarding Transportation and IT and telecommunications. Our study did not confirm that employing multiple selection criteria helps to involve SME more in the procurement.

Our results are limited because of the incompleteness of our data. We can expect that central tenders will be more likely complete than other tenders. This fact might cause bias in our results.

This work might be further extended in deeper analysis of country-specific factors and examining the effects of e-procurement and dividing into lots on the central tender outcome.

Bibliography

- [1] R. E. Lloyd and C. McCue, 'What is public procurement? Definitional problems and implications', in *International public procurement conference proceedings*, 2004, vol. 3.
- [2] C. McCue and E. Prier, 'Using agency theory to model cooperative public purchasing', *Journal of Public Procurement*, vol. 8, no. 1, pp. 1–35, Mar. 2008.
- [3] H. Reimarová, 'Transaction Costs in Public Procurement', Diploma Thesis (Mgr.), Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, Prague, 2011.
- [4] Z. Gineitienė and K. Šerpytis, 'The Impact of Competition and Purchase Volume on the Price in Public Procurement Tenders (article in Lithuanian)', *Societal Studies*, vol. 3, no. 2, pp. 473–485, 2011.
- [5] M. Plaček, 'The effects of decentralization on efficiency in public procurement: Empirical evidence from Czech republic.', *Lex Localis*, vol. 15, pp. 67–92, leden 2017.
- [6] W. O. Cleverley and P. C. Nutt, 'The effectiveness of group-purchasing organizations', *Health Serv Res*, vol. 19, no. 1, pp. 65–81, Apr. 1984.
- [7] T. Bianchi and V. Guidi, 'The comparative survey on the national public procurement systems across the PPN'. Public Procurement Network, 2010.
- [8] D. Treisman, 'The causes of corruption: a cross-national study', *Journal of Public Economics*, vol. 76, no. 3, pp. 399–457, Jun. 2000.
- [9] A. Počarovská, 'The Aspects of Collaborative Procurement: Centralization, Scope and Different Market Structures.', Diploma Thesis (Mgr.), Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, Prague, 2018.
- [10] I. PWC, *Study on SMEs access to public procurement markets and aggregation of demand in the EU*. Luxembourg: Publications Office, 2014.
- [11] OECD, 'Small and Medium-sized Enterprises (SMEs) in Public Procurement', SIGMA Papers, Sep. 2016.
- [12] European Commission, 'Public Procurement', *Internal Market, Industry, Entrepreneurship and SMEs - European Commission*, 05-Jul-2016. [Online]. Available: https://ec.europa.eu/growth/single-market/public-procurement_en. [Accessed: 30-Jul-2019].
- [13] J. Soudek and J. Skuhrovec, 'Procurement procedure, competition and final unit

- price: The case of commodities’, *Journal of Public Procurement*, vol. 16, no. 1, pp. 1–21, Mar. 2016.
- [14] M. Rodrigues-Motta, H. P. Pinheiro, E. G. Martins, M. S. Araújo, and S. F. dos Reis, ‘Multivariate models for correlated count data’, *Journal of Applied Statistics*, vol. 40, no. 7, pp. 1586–1596, Jul. 2013.
- [15] J. R. Wilson and K. A. Lorenz, ‘Modeling Binary Correlated Responses Using Sas, Spss and R’, *Technometrics*, vol. 58, p. 529, Nov. 2016.
- [16] J. M. Wooldridge, *Introductory econometrics: a modern approach*, 5th ed. Mason, OH: South-Western Cengage Learning, 2013.
- [17] H. Hong and M. Shum, ‘Increasing Competition and the Winner’s Curse: Evidence from Procurement’, *The Review of Economic Studies*, vol. 69, no. 4, pp. 871–898, Oct. 2002.
- [18] J. Murray, ‘Improving the validity of public procurement research’, *International Journal of Public Sector Management*, vol. 22, pp. 91–103, Feb. 2009.
- [19] A. Sanchez Graells and I. Herrera Anchustegui, ‘Impact of Public Procurement Aggregation on Competition’, in *Risks, Rationale and Justification for the Rules in Directive 2014/24*, R. Fernandez and P. Valcarcel, Eds. Madrid: Civitas-Thomson Reuters, 2016, pp. 129–163.
- [20] T. Hanák and P. Muchová, ‘Impact of Competition on Prices in Public Sector Procurement’, *Procedia Computer Science*, vol. 64, pp. 729–735, 2015.
- [21] E. Bakker, H. Walker, F. Schotanus, and C. Harland, ‘Choosing an organisational form: the case of collaborative procurement initiatives’, *International Journal of Procurement Management*, vol. 1, no. 3, p. 297, 2008.
- [22] N. Dimitri, G. Piga, and G. Spagnolo, Eds., *Handbook of Procurement*. Cambridge: Cambridge University Press, 2006.
- [23] H. Walker and L. Preuss, ‘Fostering sustainability through sourcing from small businesses: public sector perspectives’, *Journal of Cleaner Production*, vol. 16, no. 15, pp. 1600–1609, Oct. 2008.
- [24] G. L. Albano and M. Sparro, ‘Flexible Strategies for Centralized Public Procurement’, *Review of Economics and Institutions*, vol. 1, no. 2, Oct. 2010.
- [25] W. E. Oates, *Fiscal Federalism*. New York: Harcourt Brace Jovanovich, 1972.
- [26] L. R. de Mello and M. Barenstein, ‘Fiscal Decentralization and Governance; A Cross-Country Analysis de Mello, Luiz R. and Barenstein, Matias’, International Monetary Fund, May 2001.
- [27] L. Kristoufek and J. Skuhrovec, ‘Exponential and power laws in public procurement markets’, *EPL*, vol. 99, no. 2, p. 28005, Jul. 2012.

- [28] K. Šerpytis, V. Vengrauskas, and Z. Gineitienė, 'Evaluation of financial effects of procurement centralisation', *Ekonomika*, vol. 90, no. 3, pp. 104–119, Jan. 2011.
- [29] European Commission, 'European Code of Best Practices Facilitating Access by SMEs to Public Procurement Contracts', Staff Working Document, 2008.
- [30] K. Karjalainen, 'Estimating the cost effects of purchasing centralization - empirical evidence from framework agreements in the public sector', *Journal of Purchasing and Supply Management*, vol. 17, no. 2, pp. 87–97, 2011.
- [31] M. Singer, G. Roubik, G. Konstantinidis, and E. Befferman, 'Does e-procurement save state money?', *Journal of Public Procurement*, vol. 9, no. 1, pp. 58–78, 2009.
- [32] 'Directive 2014/55/EU of the European Parliament and of the Council of 16 April 2014 on electronic invoicing in public procurement: n.d.'
- [33] 'Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance: n.d.'
- [34] 'Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts: n.d.'
- [35] 'Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004 coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors: n.d.'
- [36] Y.-K. Che, 'Design Competition through Multidimensional Auctions', *RAND Journal of Economics*, vol. 24, no. 4, pp. 668–680, 1993.
- [37] J. Nemeč, B. Meričková, and M. Grega, 'Contracting, outsourcing, procurement: Selected factors limiting their success in the CEE region.', in *Proceedings of 18th Annual Conference of the International Research Society for Public Management*, 2014.
- [38] M. Palanský and J. Skuhrovec, 'Collaborative purchasing: Foreign best practices and lessons learned for czech republic.', *Center for Applied Economics, Prague.*, 2016.
- [39] J. M. Wooldridge, 'Cluster-Sample Methods in Applied Econometrics', *The American Economic Review*, vol. 93, no. 2, pp. 133–138, 2003.
- [40] J. Křížová and Brojáč, Jan, 'Centrální nákupy (Centralizované zadávání veřejných zakázek) - Právní úpravav ČR, EZ a ve vybraných státech Evropy', *Parlamentní Institut*, parliament study 5.355, 2015.
- [41] McCue Clifford P., 'Centralized vs. decentralized purchasing: current trends in governmental procurement practices', *Journal of Public Budgeting, Accounting & Financial Management*, vol. 12, no. 3, pp. 400–420, Jan. 2000.

- [42] OECD, 'Centralised Purchasing Systems in the European Union', SIGMA Papers 47, Apr. 2011.
- [43] OECD, 'Central Public Procurement Structures and Capacity in Member States of the European Union', SIGMA Papers 40, Jan. 2007.
- [44] Kožíšek, Jakub, 'Bidding patterns in public procurement auctions', Bachelor thesis, Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, 2015.
- [45] P. Prucek, 'Barriers to entry in public procurement: Evidence from the Czech Republic', Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, Prague, 2015.
- [46] L. S. Aiken, S. A. Mistler, S. Coxe, and S. G. West, 'Analyzing count variables in individuals and groups: Single level and multilevel models', *Group Processes & Intergroup Relations*, vol. 18, pp. 290–314, Apr. 2015.
- [47] Ministry of Regional Development, 'Analysis of Options for Centralised Public Procurement. Retrieved from', 2011.
- [48] B. R. Moulton, 'An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units', *The Review of Economics and Statistics*, vol. 72, no. 2, pp. 334–338, 1990.
- [49] B. Brezovnik, Ž. J. Oplotnik, and B. Vojinović, '(De)Centralization of Public Procurement at the Local Level in the EU', *Transylvanian Review of Administrative Sciences*, vol. 11, no. 46, pp. 37–52, 2015.

List of appendices

Appendix 1: Summary of number of tenders with information about centralized procurement

Appendix 2: Summary of number of tenders (2016 and 2017) with certain not missing variables

Appendix 3: Summary of country specific variables used in our analysis

Appendix 4: Modelling number of bidders, OLS results

Appendix 5: Modelling probability of SME as a bidder, OLS results

Appendices

Appendix 1: Summary of number of tenders with information about centralized procurement

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
AT	0	0	0	0	0	0	0	0	0	0	512	974
BE	0	0	0	0	0	0	0	0	3	0	81	886
CY	0	0	0	0	0	0	0	0	0	0	0	0
CZ	0	0	0	0	0	0	6	17	70	342	9150	17224
DE	0	0	0	0	0	1	0	6	0	49	4472	13216
DK	0	0	0	0	0	0	0	0	2	1	1470	2632
EE	0	0	0	0	0	0	0	0	0	0	0	590
ES	0	0	0	0	0	0	0	0	0	9	1131	5181
FI	0	0	0	0	0	0	2	0	0	0	450	871
FR	0	0	0	0	0	0	0	1	132	974	8158	18169
GR	0	0	0	0	0	0	0	0	0	0	4	8
HU	0	0	0	0	0	0	0	0	0	0	263	582
IE	0	0	0	0	0	0	0	0	0	0	27	78
IT	0	0	0	0	0	1	0	0	0	3	456	1468
LT	0	0	0	0	0	0	0	0	0	0	1	218
LU	0	0	0	0	0	0	0	0	0	0	23	116
LV	0	0	0	0	0	0	0	0	0	0	5	1054
NL	0	0	0	0	0	0	0	0	1	2	727	4097
PL	0	0	0	0	0	0	0	0	0	13	3122	35970
PT	0	0	7137	43411	42391	48272	53253	58085	80750	93676	98336	62669
SE	0	0	0	0	0	0	0	0	0	0	502	4351
SI	0	0	0	0	0	1	4	37	306	1321	4387	36281
SK	0	0	0	0	0	3	0	4	10	388	3868	5368
UK	0	0	0	0	0	0	0	16	0	31	648	2239
RO	0	0	0	0	0	0	0	0	0	0	4	6
BG	0	0	0	0	0	0	0	0	0	0	1	2
HR	0	0	0	0	0	0	0	0	0	0	0	2846
ML	0	0	0	0	0	0	0	0	0	0	0	0

(Source: own construction base on Datlab data)

Appendix 2: Summary of number of tenders (2016 and 2017) with certain not missing variables

Country	Centralized procurement	Final bid price (EUR)	Estimated price (EUR)	Procedure type	CPV category	Bidders employees count	Total tenders
AT	1486	1832	197	2360	2396	1675	2396
BE	967	1631	312	2057	2105	1208	2105
BG	3	7	2	6	7	6	7
CY	0	8	5	8	8	7	8
CZ	26374	39797	24381	40531	41514	38059	41514
DE	17688	17117	2548	28619	29548	24970	29548
DK	4102	3831	421	4695	4863	3361	4863
EE	590	15701	4652	21770	21955	17144	21955
ES	6312	50529	32279	53268	53526	50060	53526
FI	1321	1412	183	1551	1579	1356	1579
FR	26327	26832	1637	30485	31232	17050	31232
GR	12	18	8	20	20	17	20
HR	2846	11615	9788	11722	11928	11605	11928
HU	845	1170	1592	2429	2653	2322	2653
IE	105	64	9	121	121	89	121
IT	1924	4630	2540	4732	4901	4401	4901
LT	219	6498	822	7789	7806	7749	7806
LU	139	202	42	228	230	161	230
LV	1059	1494	425	3390	5473	5033	5473
NL	4824	6180	1021	13877	14080	12723	14080
PL	39092	71811	32188	80758	81388	23419	81388
PT	161005	104549	24002	837	161216	153598	161216
RO	10	6132	5226	7020	7039	7008	7039
SE	4853	5154	992	12918	12943	12679	12943
SI	40668	39238	1792	40534	41616	40075	41616
SK	9236	12330	11211	14000	14155	13126	14155
UK	2887	3382	941	7458	7553	3796	7553
ML	0	0	0	0	0	0	0

(Source: own construction based on Datlab database)

Appendix 3: Summary of country specific variables used in our analysis

Country	WGI Corruption (2017)	WGI Government effcivness (2017)	Share of SME (2016)
AT	1.55	1.51	68.86%
BE	1.64	1.33	69.18%
BG	-0.17	0.30	74.82%
CY	0.83	0.96	-
CZ	0.54	1.05	67.32%
DE	1.84	1.73	63.45%
DK	2.23	1.88	-
EE	1.27	1.10	78.60%
ES	0.52	1.83	72.26%
FI	2.24	1.41	65.92%
FR	1.40	0.23	63.34%
GR	-0.09	0.50	-
HR	0.20	0.46	69.42%
HU	0.10	1.33	69.61%
IE	1.58	0.54	-
IT	0.08	1.69	78.63%
LT	0.71	1.08	75.55%
LU	2.10	1.01	67.35%
LV	0.43	0.96	79.06%
ML	0.72	1.83	78.29%
NL	1.91	0.70	65.43%
PL	0.74	1.21	68.19%
PT	0.93	-0.17	-
RO	-0.02	1.77	65.36%
SE	2.19	1.12	65.02%
SI	0.82	1.13	72.93%
SK	0.23	0.90	71.71%
UK	1.90	1.60	53.57%

(Source: own construction based on World bank and Eurostat)

Appendix 4: Modelling number of bidders, OLS results

	Model 1 (OLS st. error)	Model 1 (Clustered st.error)	Model 1 (OLS st. Error)	Model 2 (Clustered st. Error)
(Intercept)	0.2695*** (0.0146)	0.2695. (0.1523)	0.1889*** (0.0149)	0.1889 (0.1537)
Energetics	0.2891*** (0.0153)	0.2891** (0.0929)	0.2919*** (0.0152)	0.2919** (0.093)
IT and Telecommunication	0.0628*** (0.0114)	0.0628 (0.0762)	0.056*** (0.0113)	0.056 (0.0775)
Office equipment	0.2073*** (0.0135)	0.2073* (0.0812)	0.1934*** (0.0134)	0.1934* (0.0855)
Medical equipment	-0.0247** (0.0094)	-0.0247 (0.0851)	0.0088 (0.0095)	0.0088 (0.0818)
MEAT	0.0079 (0.0058)	0.0079 (0.0759)	0.0066 (0.0058)	0.0066 (0.0743)
Central procurement	0.0972*** (0.0134)	0.0972 (0.1585)	0.635*** (0.0269)	0.635*** (0.1398)
Final bid price (EUR mil.)	0.0007*** (0.0002)	0.0007** (0.0002)	0.0007*** (0.0002)	0.0007** (0.0002)
Government effectiveness	0.3465*** (0.0146)	0.3465** (0.1341)	0.3692*** (0.0146)	0.3692** (0.1338)
Corruption	0.0385*** (0.0094)	0.0385 (0.066)	0.0832*** (0.0096)	0.0832 (0.0636)
Central procurement*Corruption			-0.4154*** (0.018)	-0.4154** (0.1465)
Observations	66,104	66,104	66,104	66,104
R ²	0.0662	0.0662	0.0736	0.0736
Adjusted R ²	0.0660	0.0660	0.0735	0.0735

(Note: ***, **, *, . stand for significance at 0.001, 0.01, 0.05, 0.1 respectively; standard errors are in the brackets)

Appendix 5: Modelling SME as a bidder, OLS results

	(1) OLS st. error	(1) Clustered st. Error
(Intercept)	-1.3786*** (0.0524)	-1.3786** (0.4246)
Energetics	-0.1188*** (0.0101)	-0.1188. (0.064)
IT and Telecommunication	-0.0533*** (0.0076)	-0.0533 (0.0433)
Office equipment	0.1079*** (0.0089)	0.1079* (0.0517)
Medical equipment	0.0269*** (0.0065)	0.0269 (0.038)
MEAT	-0.0421*** (0.0048)	-0.0421. (0.0234)
Central procurement	-0.0225* (0.0096)	-0.0225 (0.0438)
Final bid price (EUR mil.)	-0.0003* (0.0001)	-0.0003* (0.0001)
Governance	0.1866*** (0.0108)	0.1866* (0.0847)
Corruption	0.09*** (0.0067)	0.09* (0.0369)
SME share	2.6912*** (0.0711)	2.6912*** (0.5222)
Observations	37,834	37,834
R ²	0.0780	0.0780
Adjusted R ²	0.0777	0.0777

(Note: ***, **, *, . stand for significancy at 0.001, 0.01, 0.05, 0.1 respectively; standard errors are in the brackets)