

Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies



MASTER'S THESIS

**Public procurement of mobile network
operators services**

Author: **Bc. Zdeněk Polák**

Supervisor: **PhDr. Ing. Jiří Skuhrovec**

Academic Year: **2014/2015**

Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

The author grants to Charles University permission to reproduce and to distribute copies of this thesis document in whole or in part.

Prague, January 5, 2015

Signature

Acknowledgments

I would especially like to thank PhDr. Ing. Jiří Skuhrovec for supervising this thesis and providing me with priceless advice and comments.

I also thank Andrea Čapkovičová for patience and moral support.

Abstract

This thesis deals with public procurement of mobile network operators services and analysis of institutional and procedural characteristics under which public authorities are able to reach lower prices than regular retail customers. The applied model attempts to explain a variation in final price of high consumption mobile services consumer basket. The variation is explained as a function of estimated price of consumer basket, year of tender, length of contract, supplier, governance structure of public authority, number of bidders and use of electronic auction.

The results indicate that usage of electronic auction brings lower final price of mobile services by 8.6 %, T-Mobile is more expensive than O2 and Vodafone on average by 8 % and each additional bidder decreases the final price on average by 6.1 %. We found that there exists statistically significant difference in the final price with respect to type of public authority. The final price of mobile services is decreasing in time, on average by 9 % per year. Together with insignificance of the variable measuring length of contract, it follows that long term contracts are not cost-efficient.

JEL Classification	H57, C21, D44, L96
Keywords	public procurement, mobile services, electronic auction
Author's e-mail	zdenekpolak@hotmail.com
Supervisor's e-mail	jskuhrovec@gmail.com

Abstrakt

Tato diplomová práce se zabývá veřejnými zakázkami na služby mobilních operátorů a analýzou institucionálních a procedurálních znaků, které umožňují veřejným zadavatelům dosahovat nižší ceny, než dosahují běžní spotřebitelé. Aplikovaný model vysvětluje variabilitu v konečné ceně spotřebního koše s vysokou spotřebou mobilních služeb. Variabilita je vysvětlována jako funkce odhadované ceny spotřebního koše, roku veřejné zakázky, délky smlouvy, dodavatele, struktury řízení veřejného zadavatele, počtu účastníků a použití elektronické aukce.

Výsledky naznačují, že při použití elektronické aukce klesá konečná cena mobilních služeb o 8.6 %, T-Mobile je dražší než O2 a Vodafone v průměru o 8 % a každý další účastník veřejné zakázky snižuje konečnou cenu v průměru o 6.1 %. Zjistili jsme, že

existuje statisticky signifikantní rozdíl v konečné ceně mobilních služeb s ohledem na typ veřejného zadavatele. Konečná cena mobilních služeb klesá v čase průměrně o 9 % za rok. Společně se statistickou nevýznamností proměnné udávající délku smlouvy vyplývá, že dlouhodobé smlouvy nejsou nákladově efektivní.

Klasifikace	H57, C21, D44, L96
Klíčová slova	veřejné zakázky, služby mobilních operátorů, elektronická aukce
E-mail autora	zdenekpolak@hotmail.com
E-mail vedoucího práce	jskuhrovec@gmail.com

Contents

List of Tables	vii
List of Figures.....	viii
Acronyms.....	ix
Master's Thesis Proposal.....	x
1 Introduction.....	1
2 Literature Review	3
2.1 Auction theory	3
2.2 Procedural and institutional characteristics	6
2.3 Collusion.....	7
2.4 Transaction costs	8
3 Public Procurement in the Czech Republic.....	10
3.1 Legal framework.....	10
3.2 Process of public procurement.....	12
3.3 Definition of MNOs services in public procurement	14
3.4 Public procurement statistics	14
3.5 Statistics of tenders won by MNOs	15
4 Czech Mobile Market	19
4.1 O2	19
4.2 T-Mobile	20
4.3 Vodafone.....	20
4.4 Mobile termination rates.....	20
4.5 Price development	21
4.6 International comparison	23

4.7	Oligopoly	24
5	Methodology	26
5.1	Ministry of Regional Development	26
5.2	Czech Telecommunication Office	27
5.3	OECD	30
6	Dataset.....	32
6.1	Dataset statistics.....	34
7	Model and Hypotheses.....	39
8	Results and Discussion	42
8.1	Benchmark analysis	42
8.2	Regression analysis.....	45
8.3	Discussion of results	52
9	Conclusion	55
	Bibliography	57
	Appendix A: OLS Assumptions.....	61

List of Tables

<i>Table 1: Examples of transaction costs connected with administration of award procedure</i>	8
<i>Table 2: Volume and number of won tenders with respect to MNO</i>	17
<i>Table 3: Structure of baskets (units per year)</i>	28
<i>Table 4: Destination of calling</i>	28
<i>Table 5: Duration of calling (in minutes)</i>	28
<i>Table 6: SMS and MMS destination</i>	29
<i>Table 7: Time (applicable for calls, SMS, MMS)</i>	29
<i>Table 8: Structure of baskets (units per year)</i>	31
<i>Table 9: Summary statistics of non-dummy variables</i>	34
<i>Table 10: Savings against Market Price</i>	42

List of Figures

<i>Figure 1: Process of public procurement</i>	13
<i>Figure 2: Volume of public tender market (in CZK billion)</i>	15
<i>Figure 3: Volume and number of won tenders with respect to MNO</i>	16
<i>Figure 4: Volume of tenders with respect to type of procedure</i>	17
<i>Figure 5: Volume of tenders with respect to number of bidders</i>	18
<i>Figure 6: Number of mobile customers as of 30 September 2014</i>	19
<i>Figure 7: Termination rate (CZK per minute)</i>	21
<i>Figure 8: Price of consumer basket with VAT – Low consumption</i>	21
<i>Figure 9: Price of consumer basket with VAT – Medium consumption</i>	22
<i>Figure 10: Price of consumer basket with VAT – High consumption</i>	22
<i>Figure 11: Average minute price</i>	23
<i>Figure 12: OECD Mobile Voice Price Benchmarking, 100 calls basket</i>	24
<i>Figure 13: Number of examined public tenders with respect to winner</i>	34
<i>Figure 14: Volume of examined public tenders with respect to winner</i>	35
<i>Figure 15: Number of examined public tenders with respect to winner and year</i>	35
<i>Figure 16: Usage of electronic auction in examined tenders</i>	36
<i>Figure 17: Number of bidders</i>	36
<i>Figure 18: Number of won tenders by each MNO with respect to number of bidders in a tender</i>	37
<i>Figure 19: Type of procedures in examined tenders</i>	37
<i>Figure 20: Type of public authorities in examined tenders</i>	38
<i>Figure 21: Size of public authorities in examined tenders</i>	38
<i>Figure 22: Number of tenders with respect to savings against Market Price</i>	43
<i>Figure 23: Tenders won by O2</i>	43
<i>Figure 24: Tenders won by T-Mobile</i>	44
<i>Figure 25: Tenders won by Vodafone</i>	44

Acronyms

CAE Centre for Applied Economics

CPV Common Procurement Vocabulary

CTO Czech Telecommunication Office

ISVZ Public Contract Information System

MNO Mobile network operator

MRD Ministry of Regional Development

MVNO Mobile virtual network operator

OECD Organisation for Economic Co-operation and Development

Master's Thesis Proposal

Author: Bc. Zdeněk Polák
Supervisor: PhDr. Ing. Jiří Skuhrovec
Defense Planned: February 2015

Proposed Topic:

Public procurement of mobile network operators services

Topic Characteristics:

Czech mobile market is considered oligopolistic and highly uncompetitive, both characteristics being clearly understood by general public as well as official authorities (for reference see Czech Telecommunication Office (2012)). However, institutional customers are able to reach lower prices than other customers due to the higher volume of purchased services. Even higher savings are achieved by the use of electronic auction awarding procedure.

The aim of my thesis is to examine bidding behaviour of mobile network operators accompanied by the analysis of institutional characteristics under which institutional customers are able to reach lower prices. As a source of data I will use the Czech informational system of public procurement (www.isvzus.cz).

Hypotheses:

1. Public authorities reach lower average prices than average market prices published by Czech Telecommunication Office.
2. Usage of electronic auction yields lower award price than other awarding procedures.
3. Institutional characteristics of contracting authority predefine terms and conditions of mobile service contract.

Methodology:

The thesis background will be built on the review of auction theory and principal-agent dilemma concept. They both deal with the characteristics of public procurement that I will use for explaining the bidding behaviour of mobile network operators and bargaining behaviour of an institutional contracting authority. Based on the findings, I will be able to apply the theory on the practical example of Czech mobile network operators market for public authorities.

I will use case study approach in the empirical part. I am going to ask public authorities for contracts of mobile service operators services in line with Act. no. 106/1999 Coll., on Free Access to Information in the time period from 2008 to 2012. Since April 2012, contracts of public authorities exceeding 500 thousand CZK are compulsorily published on the profile of contracting authority. First, I will categorize public authorities according to their institutional characteristics. By doing so, I will be able to compare categories of public authorities with respect to terms and conditions of mobile services contracts. Furthermore, I will be able to analyse their bargaining behaviour as being described in the theoretical background. I will examine unit price of mobile services and I will test above mentioned hypotheses by standard econometric approach. Dependent variable will be the price of one unit of mobile

services and explanatory variables will be the characteristics of the procurement and awarding procedure. Finally, I will raise conclusions for every group about the public procurement practice in mobile network operators services in the Czech Republic.

Outline:

1. Introduction
 - a. Motivation of the study
 - b. Existing research gap
 - c. The aim of the study
2. Theoretical analysis
 - a. Literature review - auction theory and principal-agent dilemma concept
 - b. Legislation and characteristics of public procurement in the Czech Republic
 - c. Market of Czech mobile network operators services
 - d. Implications of theoretical background of public procurement on Czech mobile network operators market
3. Empirical analysis
 - a. Methodology
 - b. Data description
 - c. Results
 - C1. Categories of public authorities according to their institutional characteristics
 - C2. Terms and conditions of mobile service contracts in identified categories
 - C3. Analysis of bargaining behaviour of public authorities
 - d. Discussion
4. Conclusions

Core Bibliography:

1. Czech Telecommunication Office (2012): Měsíční monitorovací zpráva č. 11/2012 Českého telekomunikačního úřadu.
2. Hlaváček J. (1987): Homo se securans, Politická ekonomie 34.
3. Klemperer, P. (2004): Auctions: theory and practice. Princeton University Press.
4. Kornai, J. (1986): The soft Budget Constraint. Kyklos.
5. Krishna, V. (2010): Auction theory. Elsevier.
6. Niskanen, W. A. (1968): The Peculiar Economics of Bureaucracy. American Economic review.
7. Niskanen, W. A. (1975): Bureaucrats and Politicians. American Economic review.
8. Pavel, J. (2009): Veřejné zakázky v České republice. Studie Národohospodářského ústavu Josefa Hlávky.
9. Reimarová, H. (2011): Transaction Costs in Public Procurement (Diploma thesis). Charles University in Prague.
10. Soudek, J., Skuhrovec, J. (2013): Public procurement of homogeneous goods: The Czech Republic case study. IES Working Paper, No. 05/2013.
11. Soudry, O. (2004): Promoting Economy: Electronic Reverse Auctions under the EC Directives on Public Procurement. Journal of Public Procurement. Vol. 4, No. 3, pp. 340-374.

Author

Supervisor

1 Introduction

Czech mobile market is considered oligopolistic and highly uncompetitive, both characteristics being clearly understood by general public as well as official authorities (CTO, 2012). However, public authorities are able to reach lower prices than regular retail customers due to the higher volume of purchased services and even higher savings are achieved by the use of electronic auction awarding procedure (Matura, 2013).

The public procurement market in the Czech Republic comprises more than 25 % of annual GDP and it represents one of the largest in Europe (OECD, 2011). Although public procurement of mobile network operators services constitutes only small part of the whole public procurement market, we believe that the findings of this thesis might be applicable also for public procurement of other commodities.

The objective of this thesis is to examine bidding behaviour of mobile network operators (MNO), accompanied by the analysis of institutional and procedural characteristics under which public authorities are able to reach lower prices. We test 9 hypotheses that stem from public procurement literature:

H1: Public authorities reach lower final price than market price published by Czech Telecommunication Office.

H2: Usage of electronic auction yields lower final price.

H3: There is no statistically significant difference in the final price with respect to the winning MNO.

H4: Number of bidders decreases the final price.

H5: Estimated price increases the final price.

H6: Term length decreases the final price.

H7: Governance structure of public authority affects the final price.

H8: Size of public authority measured by number of employees decreases the final price.

H9: The final price of mobile services is decreasing in time.

The contribution of this thesis lies in the fact that recent public procurement research in the Czech Republic has usually described the procurement system as a whole. The most similar work to ours has been done by Soudek and Skuhrovec (2013) who analyzed public procurement of electricity and natural gas. However, nobody up to

now has focused on the specifics of the public procurement of mobile network operators services. We believe that the results will help to understand bidding behaviour of mobile network operators and institutional and procedural characteristics which play role in the bargaining process. Moreover, the very specific contribution of the thesis lies in the characteristics of the topic – the Czech Republic and MNOs behaviour in the bargaining process. Therefore, the topic is unique and the results of this thesis may even stimulate wider public discussion.

This thesis is structured in the following way. After the introduction follows section two which provides literature review and covers relevant parts of auction theory and research on public procurement. Section three and four cover brief description of public procurement in the Czech Republic and Czech mobile market. Fifth section presents methodology of measuring the efficiency of public procurement of MNOs services. Sixth section describes the used dataset and seventh section introduces the model and hypotheses. Eighth section presents and discusses the results. Section nine summarizes our findings.

2 Literature Review

This section covers relevant parts of auction theory as well as findings derived from the research on public procurement. To our knowledge, there has not been conducted any research focused directly on public procurement of MNOs services. Therefore, we introduce findings of research which addressed public procurement of other commodities or particular institutional characteristics of public procurement in this section.

Public purchases are different from standard economic transactions between two private entities in number of characteristics which has impact on the procedure and result of the purchases. Pavel (2007) specifies these differences as follows:

- Purchasing agent is not the final consumer of the procurement which influences the motivation of purchasing agent. If the purchase does not end well (wrong good, high price) it does not affect the utility of the purchasing agent directly.
- Usually, more persons are deciding about the purchase than in private transactions. This leads to compromises and slow decision making.
- Volume and value of public purchases are usually higher than by private transactions. On one hand, higher volume and value create space for economies of scale. On the other hand, it creates also incentives for corruption behaviour.
- Decision making process is standardized and formalized in law. Thus, the awarding procedure is more complicated than private transactions.

2.1 Auction theory

Auction theory is relevant for public procurement because competitive bidding procedures have form of various types of auctions. In the usual form of an auction, the seller is seeking to sell a good to a buyer who is willing to pay the highest price. This situation is equal to the case when the buyer is seeking to purchase a good from a seller who is willing to accept the lowest price. Public procurement corresponds to the latter case in which bidders compete among themselves for a contract with the public authority.

There are four types of auctions commonly analyzed in the literature (Klemperer, 1999): first-price sealed-bid auction, the second-price sealed-bid auction, the Dutch auction and the English auction. In the following paragraphs, the auction types are described from the public procurement point of view when bidders compete to sell a good to a single buyer who seeks the lowest possible price.

In the *first-price sealed-bid auction*, each bidder submits a single bid without knowing the bids of other bidders. Winner of the auction is the bidder who submitted the lowest price. This type of auction is the most widely used competitive bidding procedure in public procurement.

Second-price sealed-bid auction differs from first-price sealed-bid auction in the price which is to be paid by the public authority. The winner of the auction is still the bidder who submitted the lowest price but the price to be paid is the second lowest submitted price. The logic behind this auction mechanism is that bidders have no incentives to submit a bid above their real evaluation of the costs of the procured good.

Before *Dutch auction* can start, public authority needs to set the initial price of the tendered good well below the evaluation of the good. The price then increases until the first bidder expresses the intention to sell for the reached price level. Bidder's strategy in a Dutch auction will therefore be to make a bid once the price increases above his evaluation but is still lower than his expectation of other bidder's evaluations.

In the *English auction*, public authority sets the initial price of the tendered good above the evaluation of the good. Bidders then submit their bids repetitively in decreasing manner until remains only the bidder who is willing to sell the good for the lowest final price. In the public procurement environment, this auction mechanism is called *reverse electronic auction* because the bids are ascending in the standard English auction while the bids are descending in the reverse electronic auction.

Auctions are analyzed as games of incomplete information that are evaluated based on the efficiency and the revenue (in the public procurement case the cost). The efficient auction puts goods into the hands of those who value them the most. The costs criterion is met when the cost for the buyer is minimal.

Vickrey (1961) and then more generally Riley and Samuelson (1981) and Myerson (1981) proved a revenue equivalence theorem which states that under the

assumptions of risk neutrality, independence of valuations and symmetry among bidders all auction mechanisms generate on average the same expected revenue for the seller. It means that under the mentioned assumptions all auction mechanisms generate on average the same expected cost for the buyer in the public procurement auctions.

Although the revenue equivalence theorem proves the equivalence of all auction mechanisms, the assumptions under which it holds are often violated. Thus, there is not one auction mechanism that would fit all situations. The auction mechanisms have different outcomes under various assumptions. Thus, for different situations are suitable different auction mechanisms. Czech legislation allows for the first-price sealed-bid auction and reverse electronic auction, with first-price sealed-bid auction being the default mechanism and electronic auction being used rather rarely. This thesis is investigating the effect of usage of electronic auction in the tenders for mobile services.

Positive effect of usage of electronic auctions in public procurement is often mentioned in the literature. According to Soudry (2004) electronic auctions have the potential to decrease costs of contracting, to increase transparency and to achieve better economic outcomes as a result of increased competition. This was confirmed by many authors, e.g. Shalev and Asbjornsen (2010), Soudek and Skuhrovec (2013), Beblavá et al. (2013).

Soudry (2004) describes the mechanism of electronic auction in the following way: “In a reverse electronic auction, all suppliers view the auction site (usually via the internet) and follow the progress of the tender as the auction proceeds. Suppliers are required to submit bids and are provided with information on prices submitted by their competitors as well. As the auction proceeds, suppliers are allowed to amend their bids on an on-going basis in competition with other tenderers and to change factors such as the price offered or non-price aspects. Once the time limit is over, the price and non-price aspects are combined to give an overall ranking of bids. The bid that is mostly favorable is then selected.” (p.344)

Shalev and Asbjornsen (2010) reviewed private sector focused literature and identified the most relevant factors for success of electronic auctions in the public sector. They found positive correlation between electronic auction success and competition among suppliers. Additionally, they found negative correlation between electronic auction success and purchase complexity and positive correlation between electronic auction success and purchase specification. In other words, electronic auctions should be used for simple, easily specified purchases.

Soudek and Skuhrovec (2013) examined institutional and procedural characteristics which are affecting the final price of procurement of homogenous goods, specifically electricity and natural gas. They found that contracting authorities can reach a lower price of the public procurement by bringing a more competitive environment into the procedure. This can be ensured by the use of an electronic auction which strengthens the competition by allowing the bidders to adjust their bids. On average, the final unit price of the electricity and natural gas was lower by 6 % and 17 %, respectively. Large difference between the electricity and gas electronic auction savings was either caused by difference in individual markets or small dataset in the case of gas public procurement.

Positive effect of the usage of electronic auctions was observed also by Beblavá et al. (2013) who examined data from 32 procurement bodies and 725 procurements in the Slovak public sector. They found that electronic auctions generate savings in the amount of 10 - 12 %. However, the savings were defined in relation to initial price which might lead to exaggerated conclusions. The initial price was set either based on price from previous period, or price submitted by bidders before the start of electronic auction as starting price, or price determined by project engineer. All of the methods for determination of initial price are only estimates and thus the resulting effect of electronic auction might be overstated. We investigate the effect of electronic auction by means of dummy variable in OLS regression which measures the direct effect of usage of electronic auction on the final price.

2.2 Procedural and institutional characteristics

Public procurement literature often investigates the impact of procedural and institutional characteristics on the price of public procurement. Procedural characteristics include, e.g. usage of electronic auction which is debated above, number of bidders and type of used procedure. Institutional characteristics are for instance governance structure of public authority, size of public authority and type of supplier. We describe findings of Pavel (2008), Soudek and Skuhrovec (2013) and Bandeira et al. (2009), which are particularly relevant for this thesis from the geographical point of view or by examined subject.

Pavel (2008) examined 62 tenders for infrastructure transport construction works in the Czech Republic and he concluded that final price (expressed as a percentage of estimated price) is influenced by number of bidders and type of procedure. He concluded that every additional bidder decreased the final price on average by 4.4 % of the estimated price. The usage of award procedure different from open procedure

increased the final price on average by 19.8 % of estimated price. However, the methodology used in Pavel (2008) suffers from similar problem as the methodology of Beblavá et al. (2013). The expression of savings as the percentage of estimated price is not accurate because the estimated price is almost never close to the reality.

Soudek and Skuhrovec (2013) found statistically significant effect of open procedure, number of bidders and time on final price of public procurement in the Czech Republic. Open procedure decreased the final price of electricity public procurement on average by 7 %. They explained it by the fact that open procedure provided a competitive environment and other types of procedures restricted the competition. Every additional bidder in electricity tender decreased the final price on average by 1 %. The finding in the case of gas tenders was even more profound, the final unit price drops on average by 4 % with every additional bidder. In the case of electricity, the final price of public procurement decreases in time. This finding is explained by the increasing competitiveness on the market in time. Contrary to Bandeira et al. (2009), they did not find any statistically significant differences in the final unit price with respect to the different types of contracting authorities.

Bandeira et al. (2009) examined public procurement of standardized goods in Italy. They found that semi-autonomous bodies (universities and health authorities) paid the lowest prices. Compared to these, the average town government paid 13% more. The difference increased further for regional governments (21%), social security institutions (22%), while the average ministry topped the list with 40% higher prices. They concluded that the more autonomous the public authority was the more concerned about the price was.

2.3 Collusion

There are 2 factors which play role in the occurrence of collusion. First, collusion is more likely to occur in markets with small number of participants (Stigler, 1964). It is easier to communicate and enforce the agreement within a smaller group of members. Second, the presence of the same group of bidders in similar and repeated biddings also increases the probability of collusion (Gupta, 2001). Repeated interaction among bidders makes the profit of deviating in a single bidding much smaller than the expected profit from collusion in the subsequent periods. Both factors are present in public procurement of MNOs services, thus we provide brief summary of literature on outcome of auctions in relation to collusion and cartel.

Robinson (1985) shows that cartels are generally stable if the buyer uses English auctions but not if the buyer uses first-price sealed-bid auctions. The reason behind it

is that it is possible to monitor bids of each bidder during the English auction while bids in first-price sealed-bid auctions are secret until the announcement of the winner and it is not possible to react on the defective lower bid which makes it profitable to submit slightly lower bid than was agreed in the cartel. Thus, on one hand, electronic auction has the advantage of increased transparency, but on the other hand, it may help a cartel to enforce collusion among its members.

Empirical evidence for collusion in public procurement is available for instance in the highway construction (Porter and Zona, 1993) or milk industry (Pesendorfer, 2000).

2.4 Transaction costs

Transaction costs constitute not negligible part of public procurement costs for parties on both sides of the transaction as can be seen in Table 1 (Pavel, 2007).

Table 1: Examples of transaction costs connected with administration of award procedure

	Ex-Ante	Continuous	Ex-Post
Public sector	<ul style="list-style-type: none"> • Announcement and administration of public competition • Remuneration of independent experts • Legal analysis of contracts 	<ul style="list-style-type: none"> • Monitoring of fulfilment of the contract 	<ul style="list-style-type: none"> • Renewal of the award procedure • Costs connected with delay in execution of the public contract • Legal dispute
Private sector	<ul style="list-style-type: none"> • Preparation of offer • Obtaining of qualification requirements • Payment of deposit 	<ul style="list-style-type: none"> • Communication with the contracting entity 	<ul style="list-style-type: none"> • Legal dispute

Source: Pavel (2007, p.58)

Additional costs incurred by the usage of electronic auction were analyzed by PwC (2011), which authors had questioned about 5,500 contracting authorities and 1,800 businesses. According to PwC (2011), electronic auction increases the person day costs by approximately 6 person-days compared to average tender (that is about

CZK 12,000). This finding is in conflict with Soudry (2004) who claims that electronic auction has the potential to decrease the costs of contracting, e.g. by reducing many administrative difficulties and the costs associated with the traditional open procedure.

Reimarova (2012) evaluated the administration of public procurement award procedures from the point of view of economic rationality. She found that contractors do not hire external companies for administration of award procedure because of lower price. Price of the administration is significantly higher by outsourced procedure (8 % of the contracts' value) than in the case of in-house administration (4 % of the contracts' value). Additionally, the results suggested that more bidders compete by in-house administrated contracts than by the outsourced one. Award procedure was further evaluated in terms of efficiency expressed by the number of formal errors in the procedure. As a result, the probability of errors was found to be slightly lower by the outsourced administration of award procedure in case of small contractors. On the contrary, the probability of formal errors in the case of in-house administration is lower than in case of outsourced administration with large contractors.

3 Public Procurement in the Czech Republic

3.1 Legal framework

Public procurement is subject to a complex regulation in the Act No. 137/2006 Coll. (Act), on Public Contracts, which incorporated the relevant legal regulations of the European Union. This Act has been subject to frequent changes. There have been more than twenty amendments since the act had come into force.

Public tenders can be divided based on the character of the contracting authority, subject of public tender, expected price for subject of public tender and type of award procedure. Relevant for this thesis is division based on the award procedure.

Division based on the character of contracting authority:

- Public contracting authority
- Subsidized contracting authority
- Sector contracting authority

Division based on subject of public tender:

- Public supply tender
- Public service tender
- Public works tender

Division based on expected price (exclusive VAT) for subject of public tender:

- Above-the-threshold tender
- Below-the-threshold public tender
- Small-scale public tender

Division based on type of award procedure:

- **Open procedure:** Open procedure is the most transparent type of procedure. After the announcement of a tender, suppliers can submit their bids. The

suppliers have to comply with qualification criteria and the public authority awards the tender to the supplier which meets the best the evaluation criteria.

- **Restricted procedure:** Before 1 April 2012, the public authority could restrict the number of suppliers in the tender which were afterwards asked to submit their bids. After the amendment which came into force on 1 April 2012, the restriction on the number of suppliers can be applied only in the case of tenders in the field of defence and security or tenders announced by sector contracting authorities.
- **Negotiated procedure with publication:** Negotiated procedure with publication is commenced with announcement based on which suppliers submit their bids and prove fulfilment of qualification criteria. Then, public authority negotiates with suppliers the final form of bid. Before 1 April 2012, the public authority could restrict the number of suppliers in the tender which were afterwards asked to submit their bids. After the amendment which came into force on 1 April 2012, the restriction on the number of suppliers can be applied only in case of tenders in the field of defence and security or tenders announced by sector contracting authorities. Application of this procedure is restricted after the fulfilment of certain conditions.
- **Negotiated procedure without publication:** Negotiated procedure without publication is similar to negotiated procedure with publication, except the final form of bid is negotiated before the submitting of bids. Application of this procedure is restricted after the fulfilment of certain conditions.
- **Competitive dialogue:** Competitive dialogue is used for awarding of particularly complicated tenders. First, the public authority discusses with suppliers suitable solution. Only after finding of solution, suppliers are asked to submit bids.
- **Simplified below-the-threshold procedure:** Simplified below-the-threshold procedure is reserved only for public contracting authorities. First, the public authority sends invitation to tender to at least five suppliers. The selection of suppliers is fully at discretion of the public authority. The announcement about the tender is published only on the profile of contracting authority and does not have to be published in The Public Contract Information System (ISVZ).

Following a vivid public debate regarding loopholes in the public procurement regulation, a major amendment came into force on 1 April 2012. The most significant changes are:

- Contracts exceeding CZK 500 thousand are compulsorily published on the profile of contracting authority for all tenders which commenced after 1.4.2012;
- Decrease in the limit for small-scale public tenders which are subject to less strict regulation;
- Introduction of a new category “Significant public tender”. Expected price of procurement is at least CZK 50 million in case of territorial self-governing units (municipalities and regions) or at least CZK 300 million in case of other public authorities. It has to be approved by the government in the case of state or by the municipal council in the case of municipalities;
- There have to be at least two bidders in the tender. Otherwise the tender shall be cancelled;
- Stricter rules for publishing of tenders and public contracts have been introduced;
- The options of disqualification a tender participant for an alleged lack of economic or technical qualification have been limited;
- A preliminary announcement of the tender shall be published one month before beginning of the tendering procedure;
- The practice of reducing the number of tender participants by means of a ballot, which was allowed previously, has been banned.

The oversight over public tenders is being carried out by Office for the Protection of Competition (OPC). OPC has wide range of options at its disposal, including imposing fines, cancelling the open tender or annulling of the contract.

3.2 Process of public procurement

Process and decision making of public procurement was described in detail by Reimarova (2012). The process has six stages as can be seen in Figure 1.

1. **Need:** The process starts with the need to purchase certain goods or services. This step is realized within the organization of the contracting authority.

2. **Form:** Need is materialized into formal public procurement documentation which specifies requirements and qualifications of who shall deliver it.
3. **Announcement:** Public procurement is announced in a way required by law.
4. **Evaluation of bids:** Bids are received by contracting authority. Bids are evaluated according to selected criteria in the public procurement documentation and the winner is selected.
5. **Announcement 2:** The winner is announced and the winning price is published.
6. **Contract:** Contract is closed with the winner and it starts to be fulfilled.

Figure 1: Process of public procurement

Award Procedure	Need	<ul style="list-style-type: none"> • Assessment of needs of the contracting authority to purchase certain goods or services. • Realized within the organism of the contracting authority (preferentially bottom-up).
	Form	<ul style="list-style-type: none"> • In this phase, the contracting authority materializes its identified needs into a formal PP documentation which sets requirements on what shall be purchased and who shall deliver it.
	Announcement (1)	<ul style="list-style-type: none"> • The PP is announced in a way required by law. • Bidders may start to prepare their offers and compete. • Office for the Protection of Competition control (upon bidders' request), public control.
	Evaluation of bids	<ul style="list-style-type: none"> • The bids are received by the contracting authority, which evaluates them and selects the winner of the public contract based on criteria stated in the PP documentation. • Possible control by the Office for the Protection of Competition.
	Announcement (2)	<ul style="list-style-type: none"> • The contracting authority announces the winner and publishes the winning price. • This enables ex-post control of the procedure. • Possible ex post control - both public and by the Office for the Protection of Competition.
	Contract	<ul style="list-style-type: none"> • The public contract is awarded to the winner and starts to be fulfilled. • Potential changes solved between the contracting authority and winner.

Source: Reimarova (2012, p.9)

3.3 Definition of MNOs services in public procurement

Public procurement of every good and every service can be classified according to Common Procurement Vocabulary (CPV). (European Commission, n.d.) The CPV is based on a tree structure comprising codes of up to nine digits associated with a wording that describes the supplies, works or services forming the subject of the contract:

- The first two digits identify the divisions (XX000000-Y);
- The first three digits identify the groups (XXX00000-Y);
- The first four digits identify the classes (XXXX0000-Y);
- The first five digits identify the categories (XXXXX000-Y).

Each of the last three digits gives a greater degree of precision within each category. A ninth digit serves to verify the previous digits. The use of the CPV is mandatory in the European Union since 1 February 2006. We used the CPV code for the identification and selection of tenders for MNOs services in to the sample.

MNOs services are defined in CPV as follows:

- 64200000-8 - Telecommunication services
 - 64210000-1 – Telephone services and data transmission
 - 64212000-5 – Mobile telephone services
 - 64212100-6 - Short message services (SMS)
 - 64212200-7 - Enhanced Messaging Service (EMS)
 - 64212300-8 - Multimedia Messaging Service (MMS)
 - 64212400-9 - WAP services
 - 64212500-0 - GPRS services
 - 64212600-1 - EDGE services
 - 64212700-2 – UMTS services
 - 64212800-3 – Services of payphone operators
 - 64212900-4 – Services of prepaid cards operators

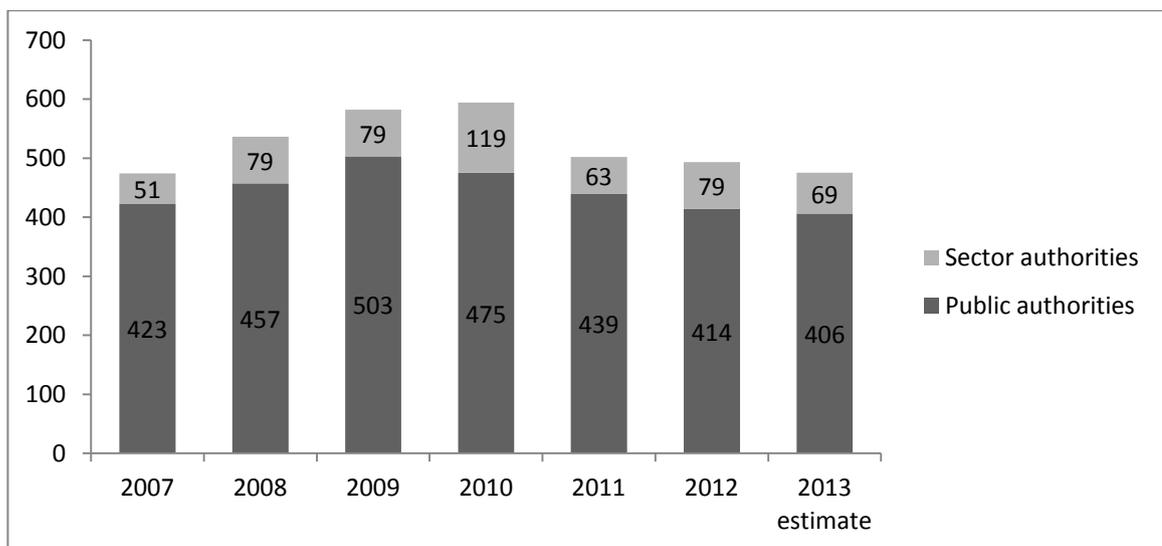
3.4 Public procurement statistics

The Czech public procurement market comprises more than 25 % of annual GDP and represents one of the largest in Europe (OECD, 2011). According to the OECD study, the Czech Republic had the second biggest expenditures on public tenders (taking into account general government procurement and state owned utilities) when being represented as the percentage of GDP among OECD members in 2008.

The current volume of public tenders in the Czech Republic is not clear and different sources provide varying estimates. MRD (2014) estimates the volume of public tender market generally between CZK 450 and 600 billion annually as can be seen in Figure 2. These figures are usually based on assumptions regarding the relation of public tenders to GDP. The precise value is not available due to the missing control of expenditures on public contracts, in particular the nonexistence of data on the small scale public contracts (Skuhrovec, 2011).

The Public Contract Information System (ISVZ) is supposed to publish 66% of all public tenders in terms of volume (MRD, 2014). The remaining public tenders are exceptions and small scale public tenders, which do not have to be published in ISVZ.

Figure 2: Volume of public tender market (in CZK billion)



Source: own processing based on MRD (2014)

3.5 Statistics of tenders won by MNOs

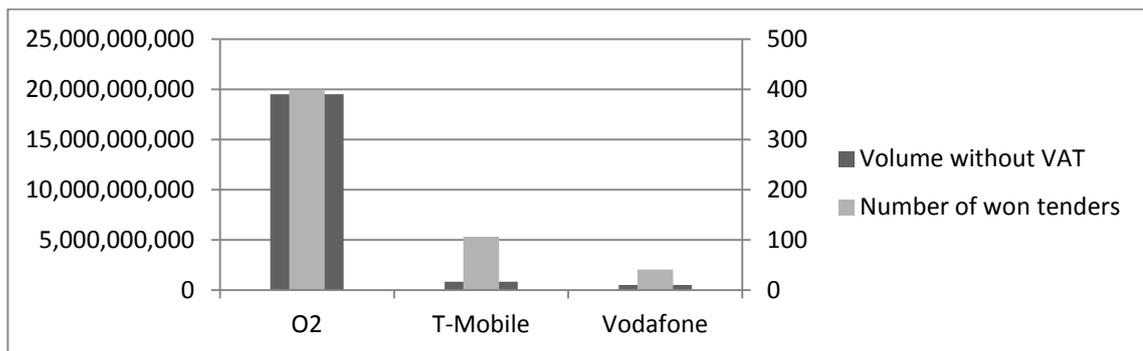
To provide at least rough picture about the volume of public procurement of MNOs services, we used database presented on the website www.vsechnyzakazky.cz. The database includes data on all awarded tenders in the period from 1 January 2007 downloaded from websites isvzus.cz a zakazky.praha.eu. We used the data as they were on the website on 2 January 2015. Data on the website are not processed or cleaned in any way and thus include also errors and inaccuracies. One supplier can thus be included in the database under more than one name. We filtered the data

according to suppliers using the key words O2, Telefónica and Telefonica for O2, and T-Mobile and Vodafone for T-Mobile and Vodafone. We point out that all presented figures are highly overstated (particularly in case of O2) because all MNOs provide also other services than just mobile services.

When we sum up the volume of tenders for all MNOs, we get approximately CZK 20,813 million in the period 2007-2014. It makes annually approximately CZK 2,602 million.

The largest volume of tenders is won by O2 as can be seen in Figure 3. O2 won 399 tenders worth more than CZK 19 billion in the period 2007-2014. O2 even belonged among the 20 largest suppliers in 2013 in terms of volume (MRD, 2014) and ranked twelfth in total. We ascribe it to the fact that O2 is historically the traditional Czech telecommunication provider and thus it has extraordinary relationships with the public authorities. T-Mobile won 106 tenders worth more than CZK 813 million and Vodafone won 41 tenders worth more than CZK 510 million in the period 2007 - 2014. We can see in Table 2 that volume of average tender won by Vodafone is substantially higher than the volume of the average tender won by T-Mobile, which indicates that Vodafone is winning larger tenders than T-Mobile. The volume of won tenders by T-Mobile and Vodafone is rather small in comparison with O2 and thus we present the exact figures in Table 2.

Figure 3: Volume and number of won tenders with respect to MNO



Source: own processing based on www.vsechnyzakazky.cz

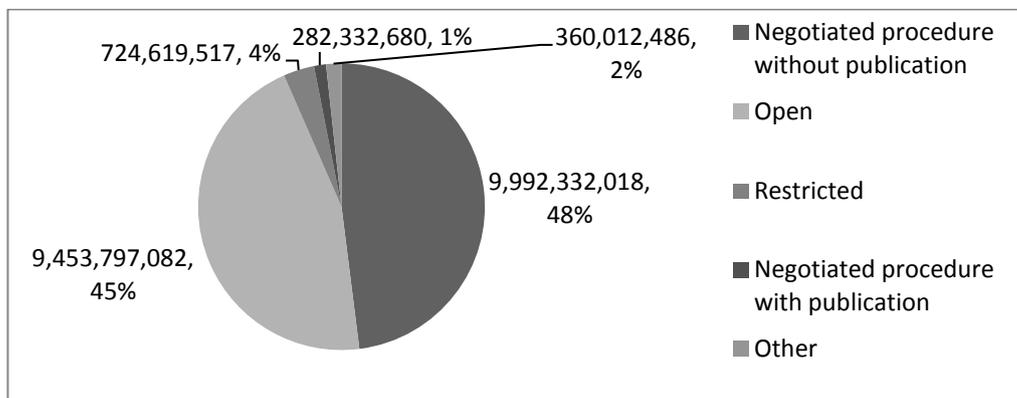
Table 2: Volume and number of won tenders with respect to MNO

	O2	T-Mobile	Vodafone
Number of won tenders		399	106
Volume without VAT	19,489,425,587	813,372,142	510,296,054
Volume of average tender	48,845,678	7,673,322	12,446,245

Source: own processing based on www.vsechnyzakazky.cz

We can see in the Figure 4 that the most often used procedure in total in terms of volume is negotiated procedure without publication, which holds also for O2. The most often used procedure in terms of volume in case of tenders won by T-Mobile and Vodafone is open procedure. More than 80 % of tenders won by T-Mobile and even 90 % of tenders won by Vodafone are awarded by the means of open procedure.

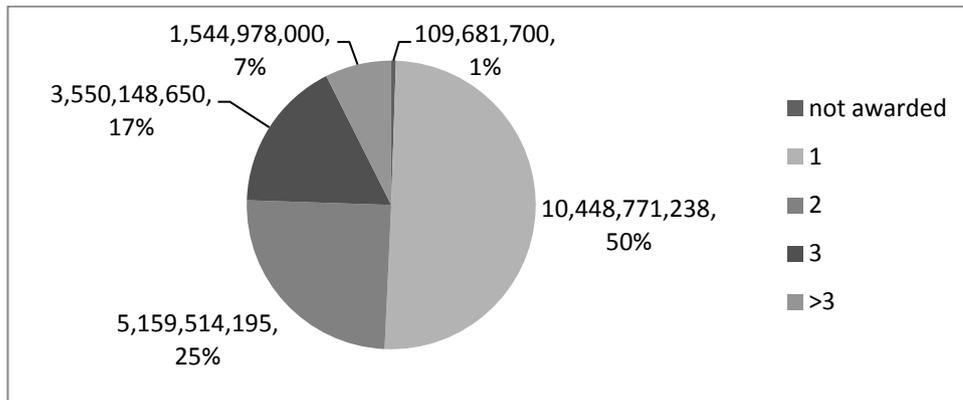
Figure 4: Volume of tenders with respect to type of procedure



Source: own processing based on www.vsechnyzakazky.cz

Figure 5 shows that half of all tenders in terms of volume had only 1 bidder. Quarter of all tenders in terms of volume had 2 bidders. The picture changes again when we look at the individual level of MNOs. The finding that half of all tenders in terms of volume had only 1 bidder holds for O2. T-Mobile won most tenders in terms of volume when there were 2 bidders (32 % of tenders in terms of volume) and Vodafone won most tenders in terms of volume when there were 3 bidders (45 % of tenders in terms of volume). O2 is either providing services to public authorities which no other supplier can provide or the competition is restricted in 50 % of tenders won by O2.

Figure 5: Volume of tenders with respect to number of bidders



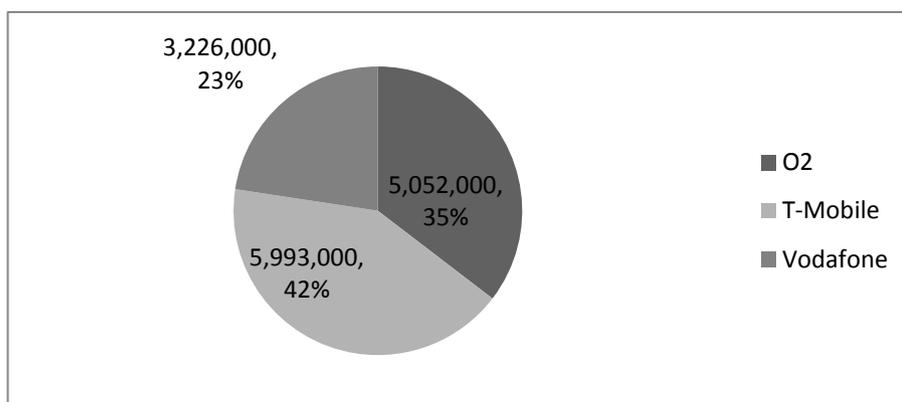
Source: own processing based on www.vsechnyzakazky.cz

4 Czech Mobile Market

The Czech mobile market is consisting of three major MNOs and one unorthodox MNO. Major MNOs include O2 Czech Republic a.s. operating under brand O2, T-Mobile Czech Republic a.s. operating under brand T-Mobile and Vodafone Czech Republic a.s. operating under brand Vodafone. Unorthodox MNO is Air Telecom a.s. operating under brand U:fon whose network is not compatible with ordinary mobile phones and special devices are needed. This complication led U:fon to focus on mobile internet and U:fon never achieved considerable market position. Only the three major MNOs will be considered in the following text because Air Telecom has not win any public tender. Telecommunication operator GTS is also not considered relevant for this thesis. Although the firm took part in one examined tender, it did not win it. GTS announced cooperation with T-Mobile in the field of mobile services in 2013 and it was acquired by T-Mobile in 2014.

To illustrate market share of MNOs, we present number of mobile customers of each MNO in Figure 6. T-Mobile is the largest MNO in the Czech Republic in terms of number of mobile customers as of 30 September 2014 with 42 % market share. The market share of O2 is 35 %. Vodafone is the smallest MNO with market share 23 %.

Figure 6: Number of mobile customers as of 30 September 2014



Source: own processing based on O2 (2014), T-Mobile (2014), Vodafone (2014)

4.1 O2

O2 was the first mobile operator in the Czech Republic, starting an analogue NMT 450 network operated under the Eurotel brand in 1991 and then launching a GSM network in 1996. It was founded by state enterprise Správa pošt a telekomunikací

Praha s.p. (later ČESKÝ TELECOM, a.s.) and ATLANTIC West B.V. (joint-venture of AT&T Wireless Services Inc. and Verizon Communications Inc.). ČESKÝ TELECOM, a.s. became the sole owner of the company in 2003. Telefónica, S.A. privatised 51.1% share in the company in 2005 and remained the majority owner until 2013 when it sold a 65.9% stake in O2 to PPF Group.

4.2 T-Mobile

T-Mobile launched services in 1996 under the brand Paegas. It was founded by České Radiokomunikace, a.s. and CMobil B.V. whose majority owner was Deutsche Telekom. The brand was changed from Paegas to T-Mobile in 2003 when CMobil B.V. gained majority in the company from České Radiokomunikace, a.s. Since 2014, CMobil B.V. has been the sole owner of T-Mobile.

4.3 Vodafone

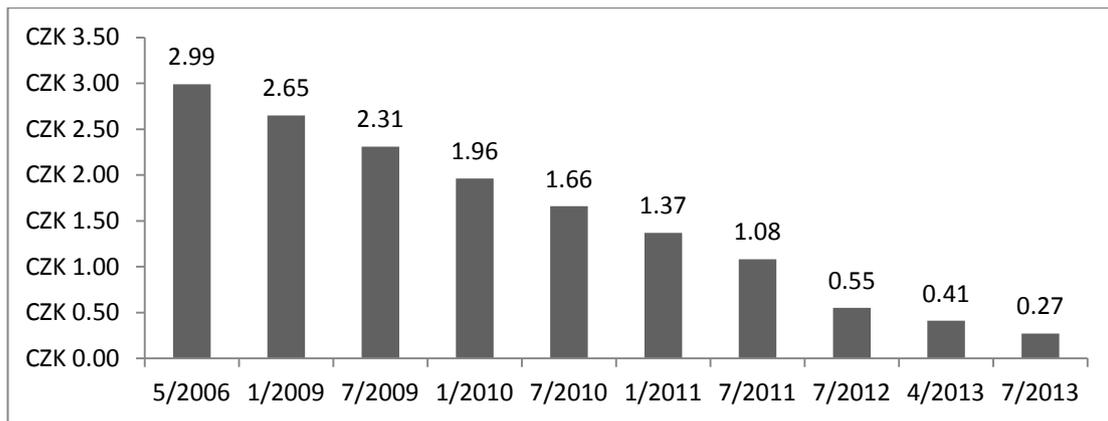
Vodafone launched services in 2000 under the brand Oskar after it was awarded a licence in 1999. It was founded by TIW Czech N.V., IPB, a.s. and Priority Telecom. In 2005, Vodafone bought 100% stake in the company and the brand name was changed from Oskar to Vodafone in 2006.

4.4 Mobile termination rates

MNOs charge each other for calls fee called mobile termination rate. In the Czech Republic, the mobile termination rate is paid by the MNO in whose network the call was originated to MNO in whose network the call was terminated. It represents the cost of MNO and it determines also the final price of calling. It might be considered as the lowest offer price the public authorities might get because otherwise it would be considered exceptionally low offer price according to § 77 of Act No. 137/2006 Coll., on Public Contracts and the offer would have to be discarded. Exceptionally low offer price clause treats the phenomenon known as the ‘winner’s curse’ in the auction theory (Thaler, 1988). In the environment of public tenders, the winner’s curse represents situation when the tender is awarded to the bidder who submitted the most underestimated bid. It happens when true value of the item is uncertain and bidders’ knowledge about it is limited. Awarding the contract to the cheapest bid with exceptionally low offer price entails the risk that due to wrong estimations or misunderstanding of some aspects of the tender bidders’ ability to perform the contract in accordance with the requirements of the bid is in question. We present

historical development of mobile termination rate value in the Czech Republic in Figure 7.

Figure 7: Mobile termination rate in the Czech Republic (CZK per minute)



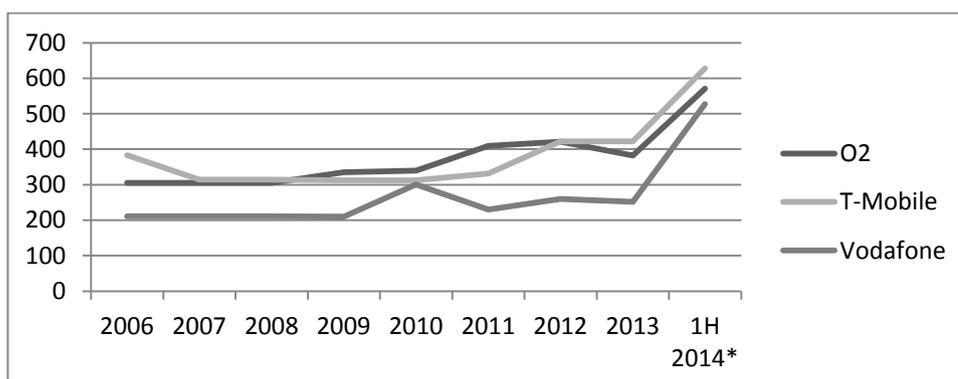
Source: own processing based on CTO

4.5 Price development

In this subsection, we compare prices of the major three MNOs for the period from 2006 to the last reported data for first half of 2014. In 2014, Czech Telecommunication Office (CTO) updated the consumer baskets to reflect change in consumer behaviour. The baskets were enriched with mobile data element and also the structure of baskets was changed.

Vodafone is the cheapest MNO in case of low consumption consumer basket as can be seen in Figure 8. It holds for the whole observed period. The ranking of O2 and T-Mobile is changing in time but currently O2 is cheaper than T-Mobile.

Figure 8: Price of consumer basket with VAT – Low consumption

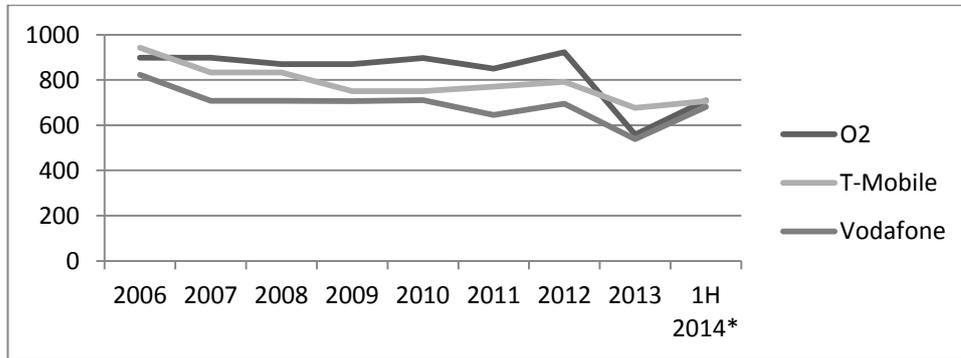


*change in methodology

Source: own processing based on CTO website

Vodafone is also the cheapest MNO in case of medium consumption consumer basket (see Figure 9). Nevertheless, all 3 MNOs converged in 2014 to the same price as the consumer basket was updated.

Figure 9: Price of consumer basket with VAT – Medium consumption

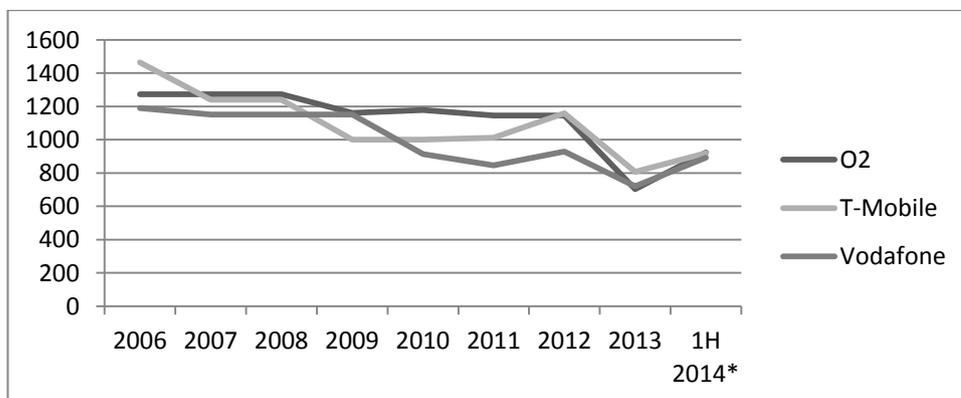


*change in methodology

Source: own processing based on CTO website

In case of high consumption consumer basket, the cheapest MNO changes during the period (see Figure 10). It was Vodafone for most of the time except 2009 when the cheapest MNO was T-Mobile and first 2013 when the cheapest MNO was O2. Neglecting the year 2014 when the consumer baskets were updated, we can see from the Figures 8-10 that price of medium and high consumption is decreasing in time while price of low consumption is rather increasing in time. We classify public authorities as customers with high consumption and thus we expect the price to decline in time as well.

Figure 10: Price of consumer basket with VAT – High consumption

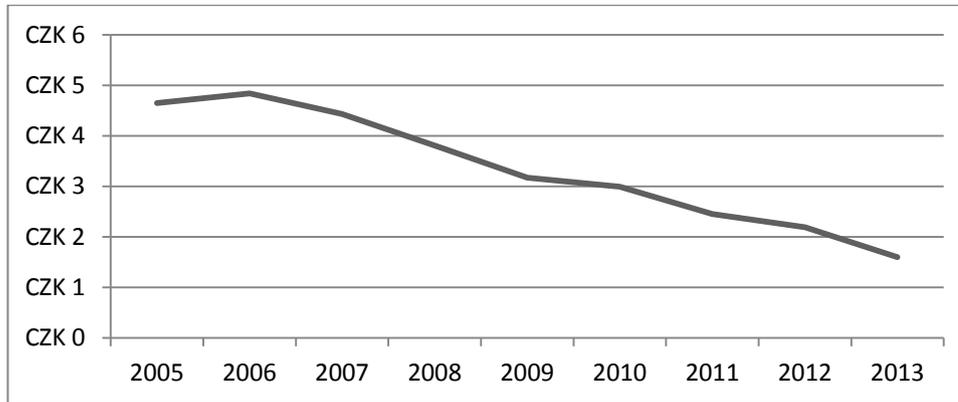


*change in methodology

Source: own processing based on CTO website

Average price of minute of calling is clearly decreasing in time as can be seen in Figure 11. Average price for minute of calling was CZK 4.65 in 2005 while it was CZK 1.78 in 2013.

Figure 11: Average minute price



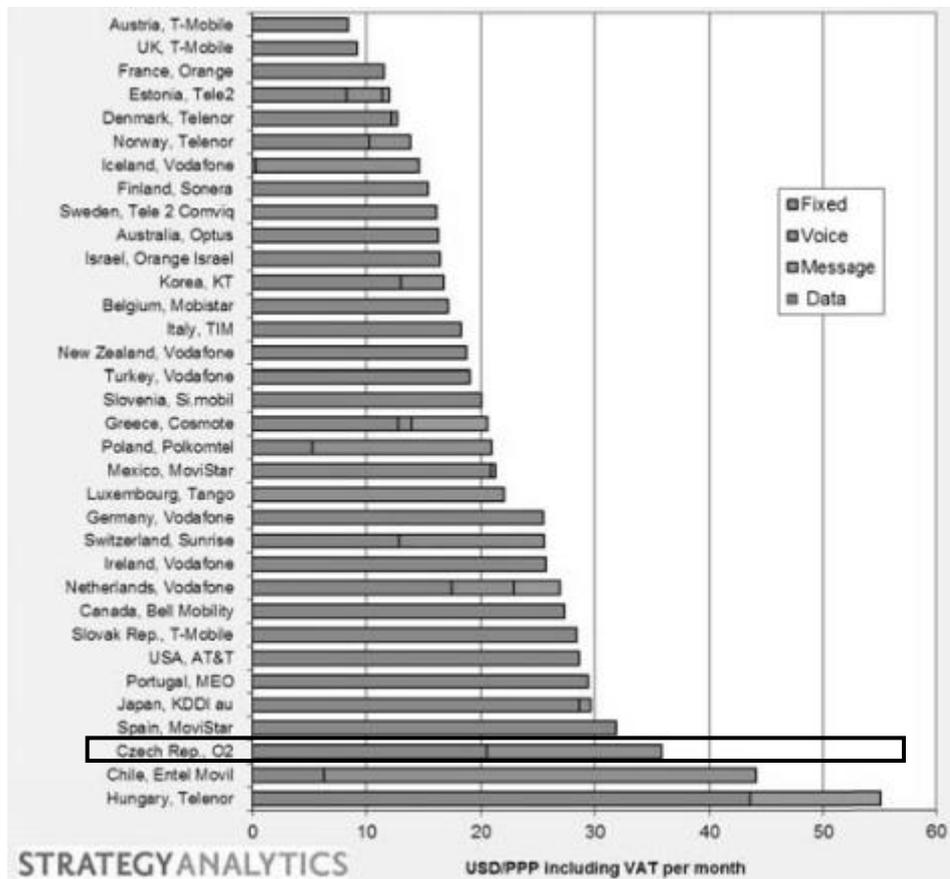
Source: own processing based on CTO website

4.6 International comparison

The most recent international comparison of mobile prices was published in August 2014 by Strategy Analytics (Teligen). (CTO, 2014) The comparison was drawn up based on OECD methodology (OECD, n.d.). The two biggest MNOs in each OECD country were included in the comparison. Retail and corporate tariffs of O2 and T-Mobile as of May 2014 were used to calculate the lowest price of consumer basket. The consumer basket specified as 100 calls basket, which includes 100 calls and 140 SMS per month, is the closest from the analyzed consumer baskets to the consumer basket used in this thesis (we use consumer basket which includes 140 calls, 140 SMS and 0.25 MMS per month). We present results for this consumer basket which are adjusted for purchasing power parity.

We can see in the Figure 12 that Czech Republic belongs to the most expensive countries. Only in Chile and in Hungary is the consumer basket more expensive. The lowest price of the 100 calls basket in the Czech Republic in May 2014 was USD 35.85. Compared to the results of the same international comparison from May 2013, the price increased by USD 0.8 and the rank is worse by one place. When the price was not adjusted for purchasing power parity, Czech Republic ranked 22nd (out of 34 OECD countries) and the 100 calls basket cost USD 26.53.

Figure 12: OECD Mobile Voice Price Benchmarking, 100 calls basket



Source: CTO (2014)

4.7 Oligopoly

Mobile industry is an easy oligopoly candidate due to small number of firms caused by high entry costs and limited spectrum range.

Final price of mobile services is mainly influenced by the level of competition. Two remarkable events happened in this respect in the last years. First, MNOs enabled access to their networks to mobile virtual network operators (MVNO) which should increase the competition on the market. Second, O2 and T-Mobile agreed on sharing of their networks which should decrease competition between these two incumbents. Before these two events took place, CTO published Analysis of the relevant market no. 8: Access and call origination in public mobile telephone networks (CTO, 2012). There, CTO labelled the relevant market as not effectively competitive market because companies present in the market are companies with collective significant market power.

CTO (2012) describes that the situation on the market has two possible outcomes:

- **Collusion:** Maintenance of status quo, MNOs retain the same level of revenues and profit.
- **Competition:** One of the MNOs breaks the collusion aiming to gain higher market share. The competition comes in two steps:
 1. **Break:** One of the MNOs considerably decreases prices under the level of the rest of MNOs in attempt to gain higher market share and maximize profit. The price decrease has to be close to marginal costs to attract enough clients before the rest of MNOs can react.
 2. **Price war:** The rest of MNOs reacts in the same manner to maintain the market share. Eventually, revenues and prices will equal marginal costs.

CTO showed in the analysis that MNOs are economically motivated to tacit collusion¹. It is concluded that oligopoly is stable and it is the most profitable strategy particularly because elasticity of demand for MNOs services is lower than 1 and MNOs have similar marginal costs. MNOs are most likely reaching the monopolistic profitability already and breaking of the cartel would not bring an advantage against the current situation to any of MNOs.

¹ “Under conditions of oligopoly, the pricing and output actions of one firm have a significant impact upon that of its rivals. Firms may after some period of repeated actions become conscious or aware of this fact and without an explicit agreement coordinate their behaviour as if they were engaged in collusive behaviour or a cartel to fix prices and restrict output. The fear that departure from such behaviour may lead to costly price cutting, lower profits and market share instability may further create incentives for firms to maintain such an implicit arrangement amongst themselves.” (OECD, 1993, p.26)

5 Methodology

This section describes the common approaches which might be applied for the analysis of price efficiency of public procurement of mobile services. We introduce the approaches in general and describe approaches for analysis of price efficiency of mobile services and explain the selection of the most suitable one.

First, we discuss the methodology applied by Pavel (2008). Pavel (2008) examined 62 tenders on infrastructure engineering works. The dependent variable was final price expressed as a percentage of estimated price. However, using this approach might be misleading because the estimated price is rarely accurate. Therefore, we discuss methodologies created directly for measuring of the efficiency of public procurement of MNOs services.

Measuring of the efficiency of public procurement of MNOs services is complex issue. Methodologies of Ministry of Regional Development (MRD), Czech Telecommunication Office (CTO) and OECD are introduced in the following subsections.

5.1 Ministry of Regional Development

In 2013, MRD published Methodology for evaluating effectiveness of telecommunication services procurement in which it assesses various methods (MRD, 2013).

First, method of historical comparison of prices is assessed. This method compares unit prices of certain commodity in two time periods with the same range (usually one year). MRD (2013) concludes that this method is not suitable for evaluating effectiveness of telecommunication services procurement due to fast development of telecommunication services and difficult comparability.

Second, method of benchmark prices is evaluated. This method compares purchase price of certain good with a benchmark price. The benchmark price is either public list price published on the website of telecommunication services provider or mean value of offer price in the particular tender. MRD (2013) again concludes that this method is not suitable for evaluating effectiveness of telecommunication services procurement. The reasons for this are that it is not comparable to compare offers for

public authorities with list prices for retail clients and that it is not possible to know percentage share of individual services in telecommunication solution which is different in the case of each public authority.

Third, method of consumer baskets is discussed. The consumer baskets method is examining price development in time for selected characteristic packages of services. This method is found suitable for evaluating effectiveness of telecommunication services procurement due to existing OECD consumer baskets, high precision and easy implementation. Each telecommunication solution can be expressed as

$$\text{Telecommunication solution} = \sum_{k=1}^n n_k * CB_k$$

n_k – number of the k-th consumer basket in the telecommunication solution

CB_k – predefined services represented by the k-th consumer basket in the telecommunication solution.

Total price of the telecommunication services can be then expressed as

$$\text{Total price of telecommunication services} = \sum_{k=1}^n n_k * PCB_k$$

n_k – number of the k-th consumer basket in the telecommunication solution

PCB_k – price of the k-th consumer basket in respective time period.

Thus, we are using consumer baskets method to be able to compare the tenders among each other. Next subsection describes the consumer basket used in the empirical part of this thesis.

5.2 Czech Telecommunication Office

CTO publishes on its website number of indicators which can be used to evaluate the efficiency of public procurement of MNOs services (CTO, n.d.).

Average price for 1 minute of call is the simplest method. Total voice services revenues are divided by the total amount of dialled minutes in this method. Average price of all three major MNOs is weighted by the amount of dialled minutes in network of each operator. Both personal tariffs and tailor-made tariffs for firms are included in this indicator. Firms are able to reach lower prices than ordinary consumer which significantly decreases the value of the indicator.

Another indicator published by CTO is price of consumer baskets. The baskets are set to reflect different volumes of consumption of calling, SMS and MMS. There are 3 consumer baskets: low consumption, medium consumption and high consumption. The calling units in the baskets are differentiated according to calling to fixed, own mobile network, other mobile networks and calling to the voice mail. Time (peak time, off-peak time, weekend) and duration of the call are also taken into account. The baskets should correspond to the structure of consumer groups in the Czech Republic given the data provided by MNOs. We present the description of consumer baskets in Tables 3-7.

Table 3: Structure of baskets (units per year)

	Calls	SMS	MMS
Low consumption	360	400	2
Medium consumption	1000	1000	2
High consumption	1680	1680	3

Table 4: Destination of calling

	Calling to			
	Fixed	Own mobile network	Other mobile network	Voice mail
Low consumption	8 %	67 %	24 %	1 %
Medium consumption	7 %	65 %	27 %	1 %
High consumption	6 %	56 %	37 %	1 %

Table 5: Duration of calling (in minutes)

	Calling to				
	Fixed	Own mobile network	Other mobile network	mobile	Voice mail
Low consumption	1.5	1.6	1.4		0.8
Medium consumption	1.8	1.9	1.7		0.8
High consumption	1.7	1.9	1.8		0.8

Table 6: SMS and MMS destination

	Own mobile network	Other mobile network
Low consumption	55 %	45 %
Medium consumption	55 %	45 %
High consumption	55 %	45 %

Table 7: Time (applicable for calls, SMS, MMS)

	Peak	Off-peak	Weekend
Low consumption	66 %	14 %	20 %
Medium consumption	66 %	16 %	18 %
High consumption	76 %	12 %	12 %

MNOs can use different patterns of billing dialled calls. The fairest option is per second billing when customer is paying only for the time of the actual call. MNOs are using also per minute billing when customer is billed for the whole minute even though the call lasted less than one minute. Billing is also reflected in the calculation of consumer basket price. Billed duration of the call (BD) is equal to the actual duration of the call (D) plus half of the billed unit (U) minus one.

$$BD = D + \frac{U - 1}{2}$$

There is taken the actual duration of the call and added $(60-1)/2$ in case of per minute billing. There is billed the actual duration of the call in case of per second billing.

Discounts on calling and sending SMS to selected phone numbers are reflected in the following way:

$$V_2 = V_1 \times [\log(10 \times N \times 1.5) / (\log(10 \times V))] \times S$$

V_2 – Amount of minutes and SMS assigned to selected discounted phone numbers

V_1 – Total amount of minutes and SMS defined by the consumer basket

N – Number of selected discounted phone numbers

V – Total amount of minutes and SMS for all calls and SMS in the basket

S – Percentage of discount in case of the selected discounted phone numbers

All price list pre-paid and post-paid tariffs which are accessible to all customers are considered for the calculation of the price of the consumer baskets. Hence, student and firm tariffs are not considered. Tariff with the lowest price including VAT is selected in case of each MNO and for each of the three levels of consumption. Prices

of consumer baskets as defined by CTO are not fully comparable with the prices from contracts with public institutions because there are not included firm tariffs which are closer to the parameters of contracts with public institutions. However, there is not publicly available any better benchmark and thus we selected the price of the high consumption consumer basket reported by CTO as the benchmark for comparison with prices reached by public authorities.

We decided to use above described CTO methodology for our investigation because of its clarity, availability and annual reporting. In 2014, CTO consumer baskets were updated to reflect change in consumer behaviour. The baskets were enriched with mobile data element and also the structure of baskets was changed. We did not use this updated basket to keep the methodology consistent throughout the sample which means that we used the above described old methodology also for year 2014.

5.3 OECD

The OECD examines price of MNOs services using consumer basket methodology (OECD, n.d.). The mobile baskets include a pre-determined number of calls, SMS and MMS messages over the period of one year (see Table 8). The ratio of on-network (own mobile network) and off-network (other network) calls is determined through discussions with operators. Operators also provide the OECD with data on SMS and MMS patterns. The methodology assumes that calls are billed by the second. Operators rounding up to the nearest minute require more minutes to fulfil the baskets. We did not use this consumer baskets definition because the prices are not publicly available.

Table 8: Structure of baskets (units per year)

	Calls	SMS	MMS	Total minutes
30 calls basket	30	100	100	50
100 calls basket	100	140	140	188
300 calls basket	300	225	225	569
900 calls basket	900	350	350	1 787
40 calls prepaid basket	40	60	60	75
400 messages basket		400		

6 Dataset

We use a dataset provided by Centre for Applied Economics (CAE). The dataset provided by CAE included all tenders classified as telecommunication services according to CPV classification system in the period from 8.8.2006 to 2.10.2014. We needed a contract for each tender in order to calculate the price of consumer basket and contracts exceeding CZK 500 thousand are compulsorily published on the profile of contracting authority for all tenders which commenced after 1.4.2012. After this restriction, 314 tenders remained in our sample. The final sample of 59 tenders resulted from the exclusion of tenders for different telecommunication services, exclusion of tenders for which the contract was not published on the profile of contracting authority and exclusion of tenders which contracts had blackened price information.

To be able to compare price efficiency of tenders between each other, we needed to calculate the price of high consumption consumer basket as defined by CTO. We had to manually find the respective contract on the profile of contracting authority and then calculate the price of high consumption consumer basket based on the content of each contract.

The final dataset includes variables which are described as follows:

- **Final price of consumer basket:** Final price of high consumption consumer basket defined by CTO in CZK. The final price was calculated for every tender based on the content of respective contract. We decided to use the high consumption consumer basket because public authorities are customers with high demand.
- **Market price of consumer basket:** Price of high consumption basket reported by CTO² for each MNO. We subtracted VAT from the market price of consumer basket because the final price of consumer basket is also without VAT.

² <http://www.ctu.cz/ctu-informuje/srovnavaci-prehled-cen-a-podminek/cenovy-barometr.html>

-
- **Estimated price of consumer basket:** Estimated price of consumer basket was calculated as a proportion of award price of consumer basket to total price of contract times the total estimated price. The aim of this computation was to approximate the estimated price of consumer basket as the components and calculation of total estimated price are not publicly available. It is the only variable for which we have only 40 observations because the estimated price is not published for every tender.
 - **Year:** Categorical variable expressing the year in which the tender took place.
 - **Bidders:** Number of bidders in the tender.
 - **Term:** Number of months for which the resulting contract was closed.
 - **Supplier:** 3 dummy variables for O2, T-Mobile and Vodafone.
 - **E-auction:** Dummy variable (1 for tender with use of electronic auction, 0 otherwise).
 - **Procedure:** 6 dummies for 6 types of procedures (open procedure, negotiated procedure with publication, negotiated procedure without publication, simplified below-the-threshold procedure, restricted procedure, exceptional procedure).
 - **Authority:** 3 dummies for 3 types of public authorities with respect to governance structure (Centralized for state-funded institutions and state authorities, Semi-centralized for municipalities and regions, Decentralized for public companies and universities and research). The types of public authorities were set to reflect the groups in Bandeira et al. (2009).
 - **Size:** 3 dummies used to approximate the size of the public authority by the number of employees (Small-sized: 10-499 employees, Medium-sized: 500-1999 employees, Large-sized: 2000-9999 employees). The ranges for the number of employees were arbitrarily selected so that each category had approximately the same number of observations and the ranges were logically reflecting the purpose.

Table 9: Summary statistics of non-dummy variables

Variable	Min	Max	Mean	Std. Dev.
Award price of consumer basket	CZK 62.15	CZK 427.65	CZK 180.80	CZK 77.27
Market price of consumer basket	CZK 703	CZK 1,159	CZK 880.54	CZK 153.79
Estimated price of consumer basket	CZK 97.15	CZK 1400.20	CZK 492.21	CZK 302.20
Year	1	3	2.10	0.71
Bidders	1	4	2.34	0.78
Term	3	48	31.34	12.61

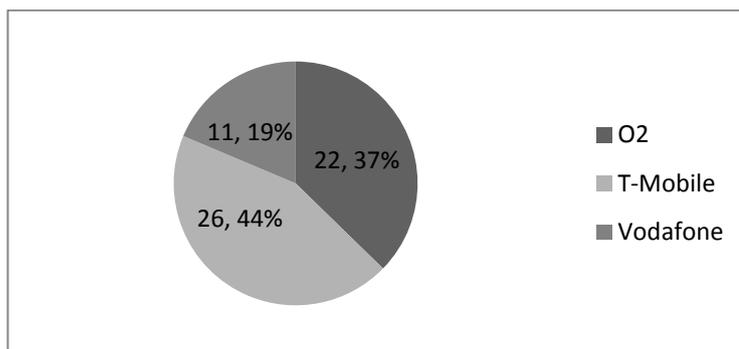
Source: own processing based on CAE

6.1 Dataset statistics

This subsection provides the descriptive statistics of the examined dataset and already this exercise reveals number of interesting facts.

As can be seen in Figure 13, T-Mobile won most of the examined tenders (26). O2 won 22 tenders and Vodafone won only 11 tenders.

Figure 13: Number of examined public tenders with respect to winner

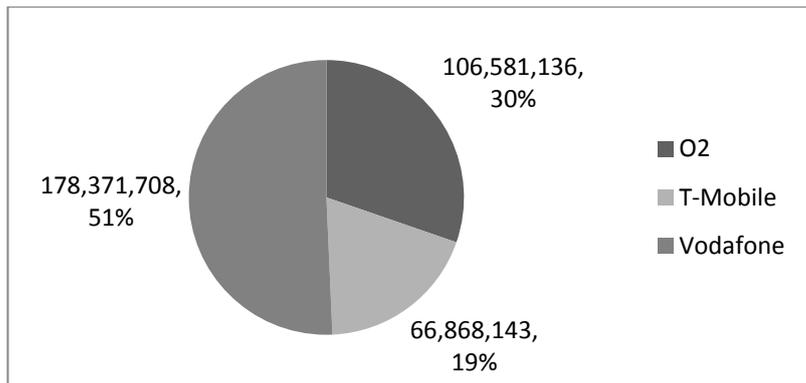


Source: own processing based on CAE

Nevertheless, the ranking of MNOs is completely opposite when looking at the volume of tenders which each MNO won (see Figure 14). Vodafone won the fewest tenders but the volume of won tenders is the highest and more than two times higher than the volume of tenders won by T-Mobile which won the most tenders. O2 won

tenders worth slightly more than CZK 100,000,000 and T-Mobile won tenders in the amount of CZK 66,868,143.

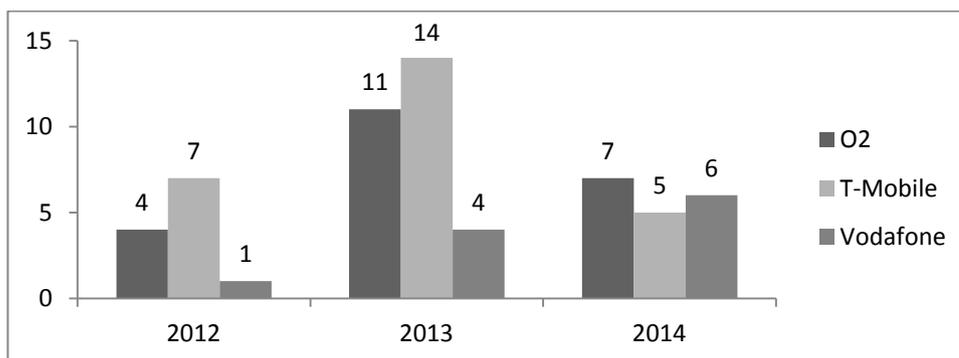
Figure 14: Volume of examined public tenders with respect to winner



Source: Own processing based on CAE

Looking at the dataset from the perspective of years and the respective number of won tenders by each MNO, we can see clear growing trend in the case of Vodafone (see Figure 15). The trend in the case of O2 and T-Mobile is unclear because our dataset starts from 1.4.2012 and the last tender in the dataset was awarded on 2.10.2014. The Figure 15 also shows that almost half of the examined tenders were awarded in 2013, 20 % of tenders were awarded in 2012 and 31 % were awarded in 2014.

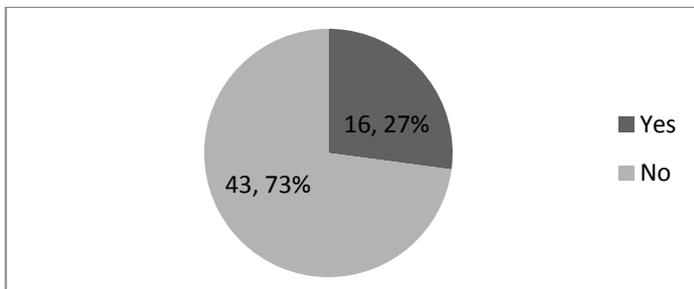
Figure 15: Number of examined public tenders with respect to winner and year



Source: Own processing based on CAE

The usage of electronic auction in the examined tenders was rather rare as can be seen in Figure 16. Electronic auction was used only in 27 % of examined tenders.

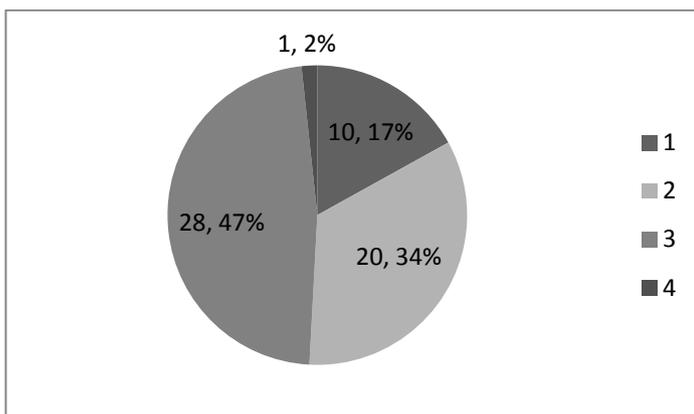
Figure 16: Usage of electronic auction in examined tenders



Source: Own processing based on CAE

All 3 major MNOs competed in almost half of the examined tenders (see Figure 17). The fourth bidder in the only tender with 4 bidders was GTS Czech but did not win the tender. Tenders with only 1 bidder counted for 17 % and 34 % of tenders had 2 bidders.

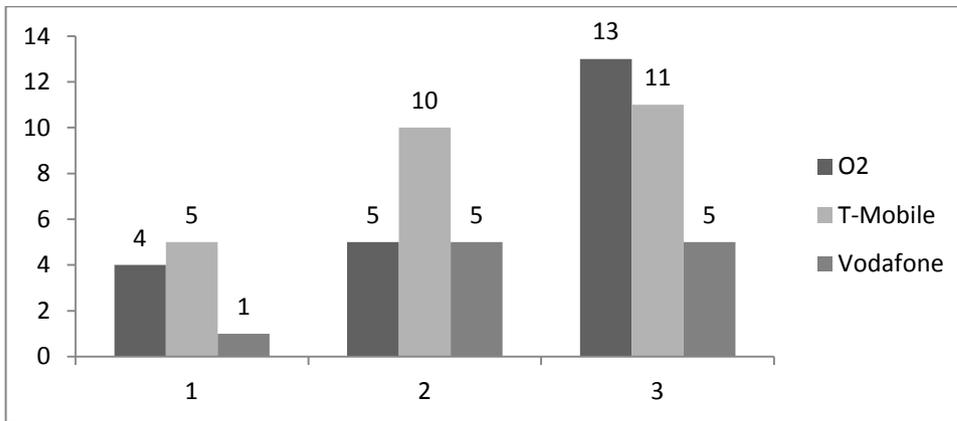
Figure 17: Number of bidders



Source: Own processing based on CAE

Figure 18 reveals that Vodafone won only 1 tender where it was the only bidder. Either Vodafone is not invited in these tenders or Vodafone does not take part in tenders with more specialized conditions. Anyhow, the tenders with only 1 bidder were won either by O2 or T-Mobile. The strongest MNO in tenders where took part all 3 major MNOs is O2 which won 13 of such tenders and also volume of these 13 tenders is higher than volume of tenders with 3 bidders won by T-Mobile or Vodafone.

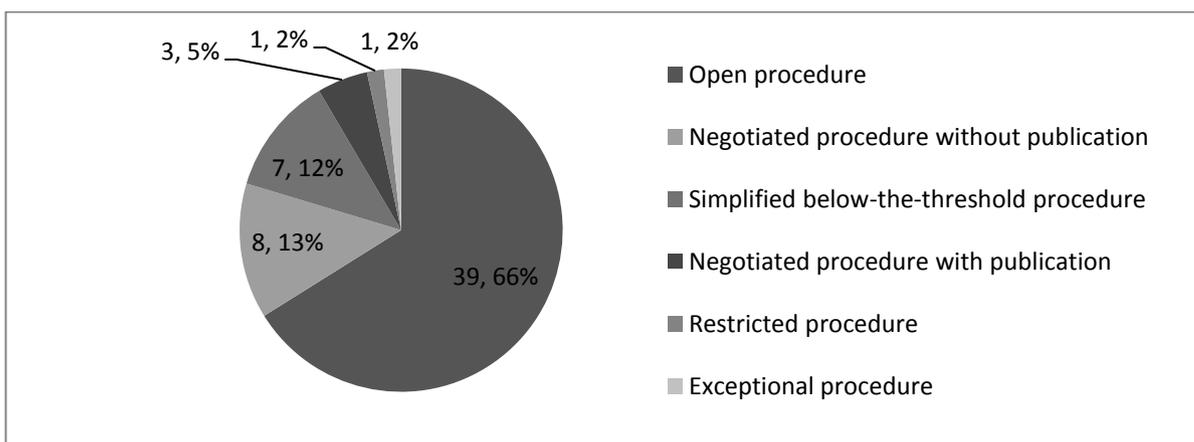
Figure 18: Number of won tenders by each MNO with respect to number of bidders in a tender



Source: Own processing based on CAE

Most of the examined tenders (66 %) were awarded by the means of open procedure which is the most transparent procedure (see Figure 19). Negotiated procedure without publication, much less transparent procedure, was used in 13 % of examined tenders. Simplified below-the-threshold procedure was used in 12 % of examined tenders and negotiated procedure with publication was used in 5 % of examined tenders. Restricted procedure and exceptional procedure were both used in the case of 1 observation.

Figure 19: Type of procedures in examined tenders

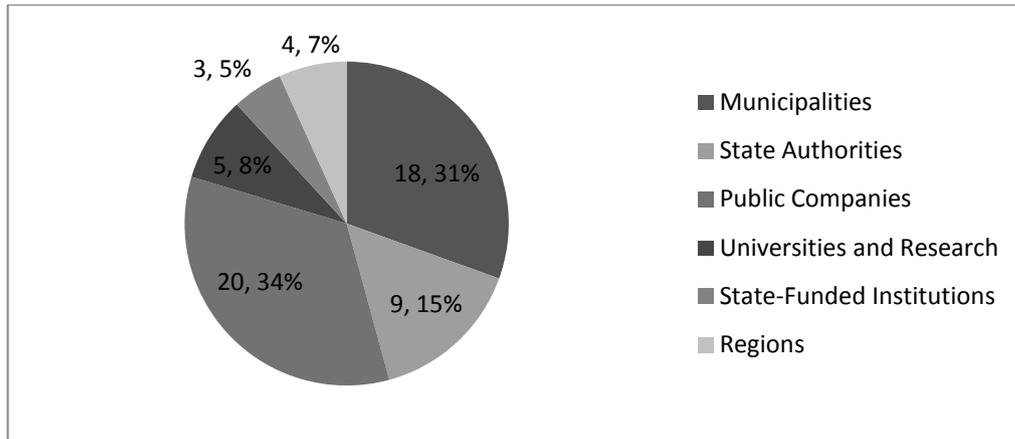


Source: Own processing based on CAE

The two most represented types of public authorities in the examined tenders are public companies and municipalities, forming 34 % and 31 %, respectively (see

Figure 20). State authorities form 15 % of the sample, universities and research 8 %, regions 7 % and state-funded institutions 5 %.

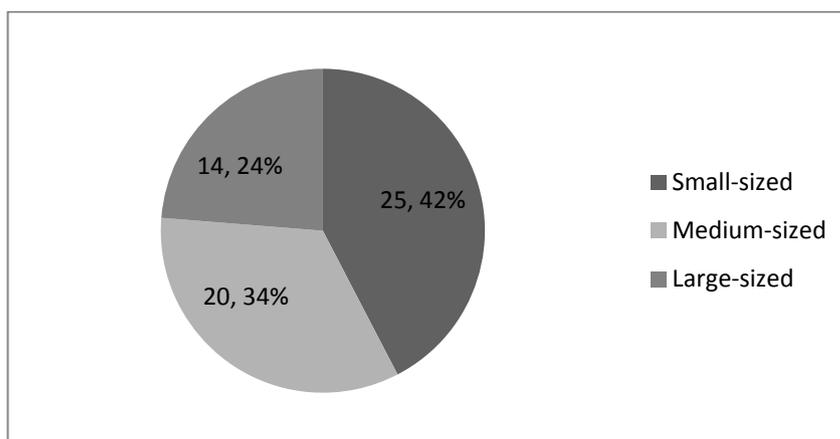
Figure 20: Type of public authorities in examined tenders



Source: Own processing based on CAE

Figure 21 show that more than 40% of public authorities in the examined tenders were small-sized (10-499 employees). Approximately the third of public authorities in the examined tenders were medium-sized public authorities (500-1999 employees). The least represented size of public authorities in the examined tenders was large-sized public authorities (2000-9999 employees). We point out that the ranges for the number of employees were arbitrarily selected so that each category had approximately the same number of observations and the ranges were logically reflecting the purpose.

Figure 21: Size of public authorities in examined tenders



Source: Own processing based on CAE

7 Model and Hypotheses

The aim of this thesis is to examine bidding behaviour of MNOs, accompanied by the analysis of institutional characteristics under which public authorities are able to reach lower price for mobile services. Hence, we investigate following hypotheses:

H1: Public authorities reach lower final price than market price published by Czech Telecommunication Office.

- We expect that public authorities are able to reach lower average prices than average market prices because of higher volume of demanded services and because the market prices are calculated from the price list prices. Thus, the average market price should represent the upper margin and all final prices should be below the market price.

H2: Usage of electronic auction yields lower final price.

- Within the environment of public procurement, the positive effect of electronic auction is well documented. According to Soudry (2004) electronic auctions have the potential to decrease costs of contracting, to increase transparency and to achieve better economic outcomes as a result of increased competition. This was confirmed by, e.g. Shalev and Asbjornsen (2010), Soudek and Skuhrovec (2013), Beblavá et al. (2013). We expect that public procurement of MNOs services is no exception and the usage of electronic auction is decreasing the final price of the procurement.

H3: There is no statistically significant difference in the final price with respect to the winning MNO.

- We expect that on average the final price is not affected by the fact who is the winner of the tender. If the final price would be affected, the cheapest MNO would win almost all of the tenders when participating.

H4: Number of bidders decreases the final price.

- We expect that when more bidders are participating in a tender then there is higher competition and the pressure on the final price is higher. Soudek and Skuhrovec (2012) found that every additional bidder decreases the final price

on average by 1 % in case of electricity tenders and by 4 % in case of natural gas tenders.

H5: Estimated price increases the final price.

- This hypothesis follows the paper by Soudek and Skuhrovec (2013) who found that estimated price predicts final price in case of electricity and natural gas tenders.

H6: Term length decreases the final price.

- It is common business practice that the longer the contract is the lower the final price is. Consequently, the longer the contract is the safer the customer is for the supplier. Supplier can thus count with longer revenues and it can give up part of the mark-up. We expect this effect to be present also in the case of public procurement of MNOs services.

H7: Governance structure of public authority affects the final price.

- Bandeira et al. (2009) who investigated public procurement of standardized goods in Italy found that universities and health authorities pay the lowest prices (comparable with our decentralized public authorities), the average town government pays 13 % more, regional governments 21 % more, social security institutions 22 % more, while the average ministry pays 40% higher prices (comparable with our centralized public authorities). We expect less pronounced but similar effect also in the case of public procurement of MNOs services.

H8: Size of public authority measured by number of employees decreases the final price.

- We expect that larger public authorities demand higher amount of services and thus reach lower final price through economies of scale.

H9: The final price of mobile services is decreasing in time.

- As we have shown in section 4.5 the market price of high consumption basket is decreasing in time. We expect that the final price of mobile services is decreasing in time as well.

The influence of the type of procurement procedure on the final price is not tested because it is correlated with the usage of electronic auction. In our sample, the electronic auction is used only in some open procedures and in one case in simplified below-the-threshold procedure.

For the purpose of statistical comparison, the final price is expressed as a price of consumer basket. We use natural logarithmic form of the final price of consumer basket as a dependent variable because we are interested in relative changes of the final price with respect to independent variables.

We specify following model to test the hypotheses:

Equation 1: Regression equation

$$\begin{aligned} \log(\text{final price of consumer basket}) &= \alpha + \beta_1 \log(\text{estimated price of consumer basket}) + \beta_2 \text{year} \\ &+ \beta_3 \text{DUMMYsupplier} + \beta_4 \text{DUMMYe-auction} + \beta_5 \text{bidders} \\ &+ \beta_6 \text{term} + \beta_7 \text{DUMMYauthority} + \beta_8 \text{DUMMYsize} + \varepsilon \end{aligned}$$

8 Results and Discussion

8.1 Benchmark analysis

In the benchmark analysis, we compare the final price of consumer basket in each tender with the market price of consumer basket as reported by CTO. The aim of the benchmark analysis is to show that public customers are able to reach better prices than regular retail customers.

The average saving against the market price was 81.79% and maximal and minimal savings were 94.15% and 39.17%, respectively (see Table 10 and Figure 22). The savings seem high but we have to take into account that the market price of consumer basket is calculated from the price list prices. This analysis confirmed the hypothesis that public authorities as customers with high consumption are able to reach individual price and contract conditions. Every tender was awarded to winner who submitted lower price than the market price.

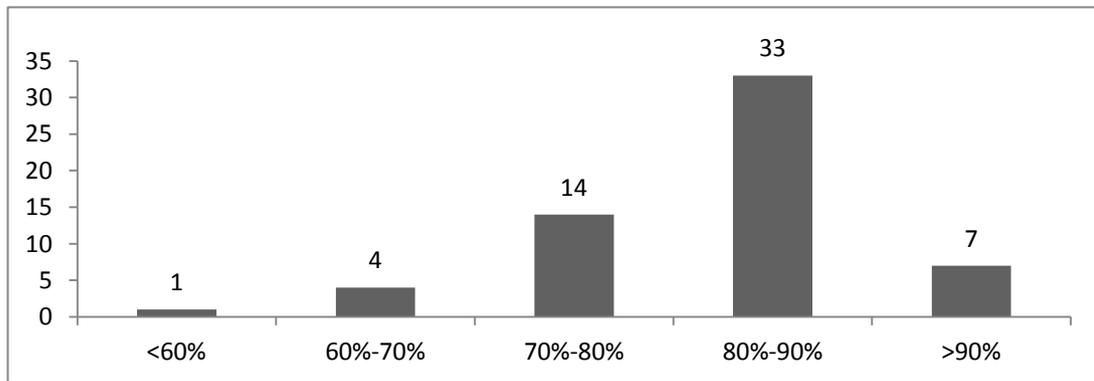
We point out that the selected benchmark is not perfectly suitable for comparison with prices achieved by public authorities but it is the best available. It would be better to compare the prices achieved by public authorities with prices paid by corporations for mobile services. However, such information is not publicly available and thus we satisfied with the market price of consumer basket as reported by CTO.

Table 10: Savings against Market Price

Average Savings	Median Savings	Max Savings	Min Savings
81.79%	84.04%	94.15%	39.17%

Source: Own processing based on CAE

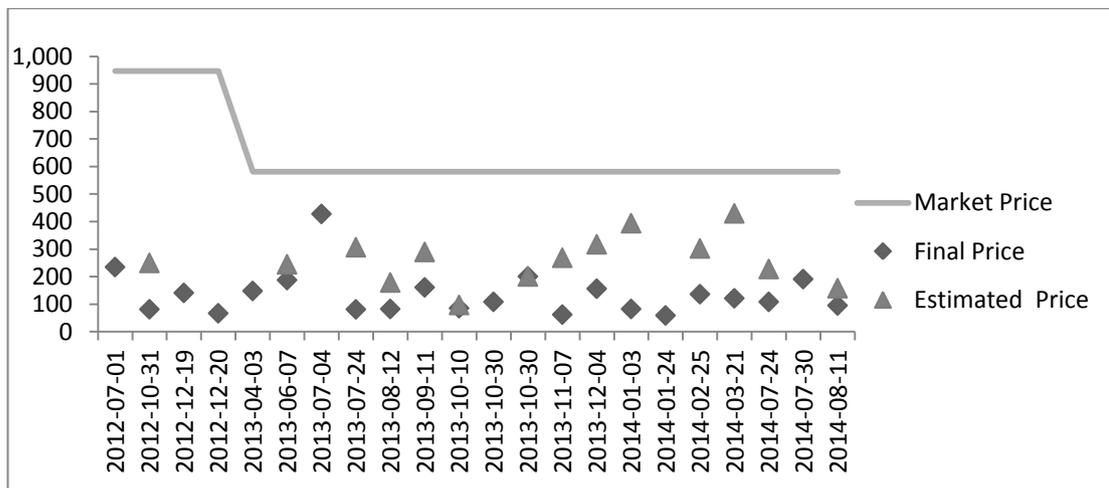
Figure 22: Number of tenders with respect to savings against Market Price



Source: Own processing based on CAE

The average final price of high consumption consumer basket in the O2 subsample is CZK 137 (with standard deviation 80), the average estimated price is CZK 262 (standard deviation 86) and average market price is CZK 647 (standard deviation 141). Figure 23 presents how the tenders won by O2 are distributed in time.

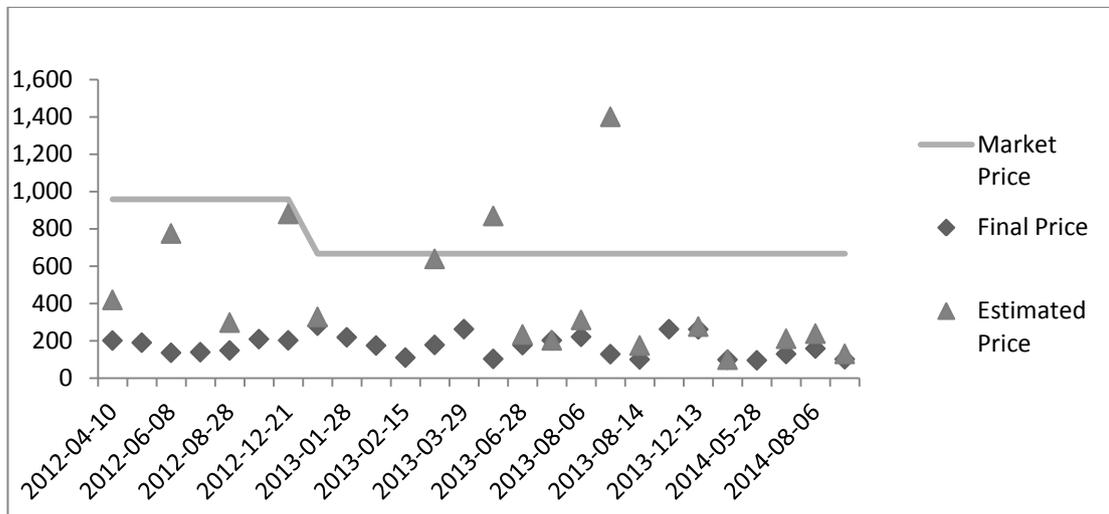
Figure 23: Tenders won by O2



Source: own processing based on CAE

The average final price of the T-Mobile subsample is CZK 172 (with standard deviation 56), the average estimated price is CZK 440 (standard deviation 343) and average market price is CZK 745 (standard deviation 129). Figure 24 presents how the tenders won by T-Mobile are distributed in time.

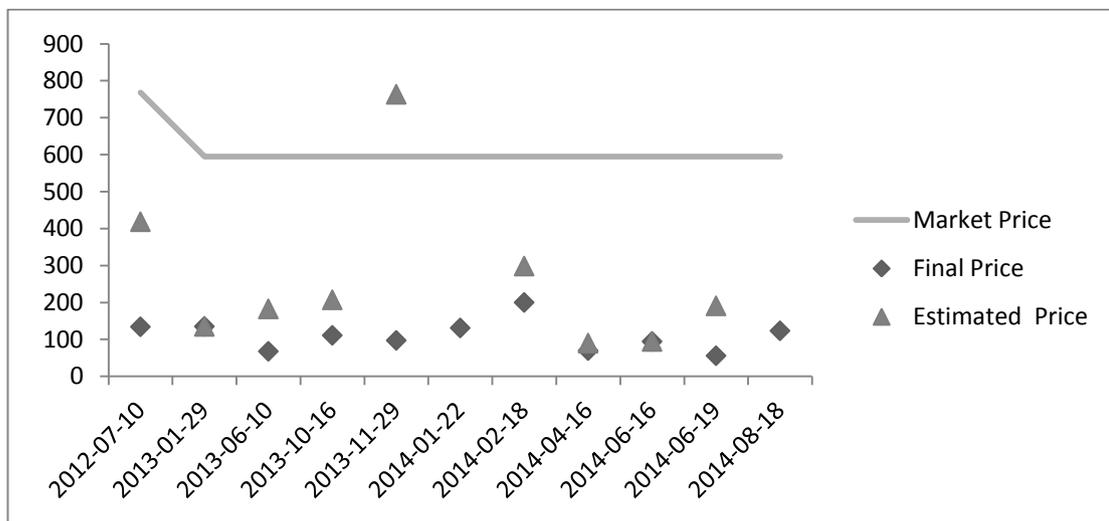
Figure 24: Tenders won by T-Mobile



Source: own processing based on CAE

The average final price of the Vodafone subsample is CZK 111 (with standard deviation 39), the average estimated price is CZK 264 (standard deviation 201) and average market price is CZK 611 (standard deviation 50). Figure 25 presents how the tenders won by Vodafone are distributed in time.

Figure 25: Tenders won by Vodafone



Source: own processing based on CAE

8.2 Regression analysis

This subsection presents the results of 3 OLS regressions. The dependent variable in all 3 regressions is final price of mobile services consumer basket with high consumption as defined by CTO. Model 1 is calculated using 59 observations and all variables except Estimated Price because there are less than 59 observations for this variable. Model 2 was created from Model 1 by omitting of insignificant regressors. The influence of Estimated Price is investigated in Model 3. Only 40 observations are used in Model 3 because Estimated Price is not reported in documentation to every tender.

We test following assumptions to ensure that the estimated coefficients are the best linear unbiased estimators:

1. Homoskedasticity of residuals
2. Normality of residuals
3. Absence of multicollinearity

Model 1 – Full Model

Model 1 is calculated using 59 observations and all variables except Estimated Price because there are less than 59 observations for this variable. The influence of Estimated Price is investigated in Model 3.

The assumptions of OLS regressions are met (see Appendix A for details):

- We can't reject the null hypothesis of heteroskedasticity not present using Breusch Pagan test with p-value equal to 0.297 and White's test with p-value equal to 0.328.
- We can't reject the null hypothesis of normality of residuals with p-value equal to 0.803.
- Variance Inflation Factors do not indicate a collinearity problem as the values for all variables are lower than 10.

Furthermore, we can't reject the null hypothesis that the specification of the model is adequate using RESET test with p-value equal to 0.621. We reject the null hypothesis that all coefficients are equal to zero based on F-test with p-value lower than 0.001.

Model 1 explains 54.8 % of variability in the dependent variable *log Final Price*.

Model 1: OLS, using observations 1-59
Dependent variable: log_Final_Price

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	2.54432	0.105391	24.1416	<0.00001	***
Year	-0.0932564	0.0289366	-3.2228	0.00228	***
T-Mobile	0.0822486	0.0443517	1.8545	0.06982	*
Vodafone	0.00993468	0.0597159	0.1664	0.86857	
E-auction	-0.0840432	0.0462047	-1.8189	0.07516	*
Bidders	-0.0647944	0.0290908	-2.2273	0.03065	**
Term	0.000246574	0.00183065	0.1347	0.89342	
Centralized	-0.167142	0.0573584	-2.9140	0.00541	***
Semi-centralized	-0.105866	0.0565715	-1.8714	0.06740	*
Small-sized	0.0342452	0.0568998	0.6019	0.55011	
Medium-sized	-0.0983708	0.0545583	-1.8030	0.07766	*
Mean dependent var	2.127493	S.D. dependent var		0.191881	
Sum squared resid	0.964468	S.E. of regression		0.141750	
R-squared	0.548357	Adjusted R-squared		0.454265	
F(10, 48)	5.827874	P-value(F)		0.000011	
Log-likelihood	37.63725	Akaike criterion		-53.27450	
Schwarz criterion	-30.42159	Hannan-Quinn		-44.35365	

Dropped dummies: O2, Decentralized, Large-sized
Source: own processing based on CAE

Equation 2: Model 1 equation

$$\begin{aligned} \log(\text{final price of consumer basket}) &= 2.54 - 0.09\text{year} + 0.08\text{T-Mobile} + 0.01\text{Vodafone} \\ &- 0.08\text{e-auction} - 0.06\text{bidders} + 0.0002\text{term} - 0.16\text{centralized} \\ &- 0.10\text{semi-centralized} + 0.03\text{small-sized} - 0.10\text{medium-sized} \end{aligned}$$

Here, we interpret only the estimates of insignificant coefficients. Estimates of significant coefficients are interpreted in the subsection Model 2. Model 1 indicates that coefficients for variables Vodafone, Term and Small-sized are not significant on the 10% level of significance.

The insignificance of Vodafone coefficient suggests that the final price of mobile services is not significantly different if the tender is won by O2 or Vodafone. Additionally, the value of the coefficient is very low. Thus, we omit this variable in the Model 2, because it does not provide any value to the model. On the contrary, the T-Mobile coefficient is significant and positive. It indicates that T-Mobile is on average more expensive than O2 by 8.2 %.

The insignificance of Term coefficient suggests that the length of contract does not determine the final price. Surprisingly, the coefficient is even slightly positive. We can interpret it in the way that it does not make difference (save any money) whether the contract is closed for 24 months or 48 months and taking into account that the price of mobile services is decreasing in time (by 9.3 % every year) it seems to be advantageous to close the contract only for such an amount of time to compensate for the transaction costs connected with every tender.

The insignificance of variable Small-sized which is proxy for public authorities with number of employees between 10 and 499 suggests that the final price of mobile services is not significantly affected by the fact whether the public authority has large number of employees or small number of employees. We assume that the forces which lead to this conclusion are different but the resulting effect is the same. The coefficient is positive and it indicates that public authorities with number of employees from 10 to 499 are reaching higher final price of mobile services by 3.4 % than public authorities with number of employees from 2000 to 9999. It makes sense that larger public authorities are able to reach higher economies of scale. However, the value of the coefficient is rather small and we would assume the mark-up for small public authorities to be higher. Hence, we assume that while small public authorities do not reach the high discounts due to low amount of demanded services, large public authorities simply do not ask for the discount. Large public authorities can be also more bureaucratic according to Bandeira et al. (2009). Surprisingly, medium-sized public authorities with 500-1999 employees are able to get the discount. The model indicates that medium-sized public authorities with 500-1999 employees are able to achieve final price lower on average by 9.8 % than large public authorities.

Model 2 – Reduced Model

Model 2 was created from Model 1 by omitting of insignificant regressors. Coefficient of determination R^2 decreased only slightly and Adjusted R^2 is even higher than in Model 1 due to lower number of regressors. Model 2 is again calculated using 59 observations.

The assumptions of OLS regressions are met (see Appendix A for details):

- We can't reject the null hypothesis of heteroskedasticity not present using Breusch Pagan test with p-value equal to 0.391 and White's test with p-value equal to 0.332.
- We can't reject the null hypothesis of normality of residuals with p-value equal to 0.736.
- Variance Inflation Factors do not indicate a collinearity problem as the values for all variables are lower than 10.

Furthermore, we can't reject the null hypothesis that the specification of the model is adequate using RESET test with p-value equal to 0.548. We reject the null hypothesis that all coefficients are equal to zero based on F-test with p-value lower than 0.001.

Model 2 explains 54.4 % of variability in the dependent variable *log Final Price*.

Model 2: OLS, using observations 1-59
Dependent variable: *log_Final_Price*

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	2.55395	0.0991172	25.7670	<0.00001	***
Year	-0.0900205	0.0273588	-3.2904	0.00182	***
T-Mobile	0.080111	0.0386974	2.0702	0.04352	**
E-auction	-0.0862603	0.0428403	-2.0135	0.04935	**
Bidders	-0.0612265	0.0267049	-2.2927	0.02602	**
Centralized	-0.154242	0.0508346	-3.0342	0.00379	***
Semi-centralized	-0.0921317	0.0479298	-1.9222	0.06017	*
Medium-sized	-0.118705	0.0432883	-2.7422	0.00840	***
Mean dependent var	2.127493	S.D. dependent var		0.191881	
Sum squared resid	0.974456	S.E. of regression		0.138228	
R-squared	0.543680	Adjusted R-squared		0.481048	
F(7, 51)	8.680532	P-value(F)		5.63e-07	
Log-likelihood	37.33332	Akaike criterion		-58.66663	
Schwarz criterion	-42.04634	Hannan-Quinn		-52.17874	

Dropped dummies: O2, Vodafone, Decentralized, Small-sized, Large-sized

Source: own processing based on CAE

Equation 3: Model 2 equation

$$\begin{aligned}
 &\log(\text{final price of consumer basket}) \\
 &= 2.55 - 0.09\text{year} + 0.08\text{T-Mobile} - 0.09\text{e-auction} \\
 &\quad - 0.06\text{bidders} - 0.15\text{centralized} - 0.09\text{semi-centralized} \\
 &\quad - 0.12\text{medium-sized}
 \end{aligned}$$

The final price of mobile services is decreasing in time, on average by 9 % per year. This is expected result due to the fact that market price of mobile services is decreasing in time as well. Together with insignificance of the term variable, it follows that long term contracts are not cost-efficient.

The final price of tenders won by T-Mobile is on average higher by 8 % than the final price of tenders won by O2 and Vodafone. This might be caused by the fact that T-Mobile is winning rather small tenders and thus it can win the tender with higher price. Within our dataset, the average volume of a tender won by T-Mobile is CZK 2,571,852 while the average volumes of tenders won by O2 and Vodafone are CZK 5,455,316 and CZK 16,215,610, respectively. T-Mobile is thus winning the most tenders but the volume of the tenders is smaller and we assume that T-Mobile applies higher mark-up.

The usage of electronic auction decreases the final price on average by 8.6 %. This result is in line with many research papers which acclaim positive contribution of electronic auction. The benefit of electronic auction is often cited even in the mass media but the usage is still rather rare. In our dataset, the electronic auction was used only in 16 out of 59 tenders. PwC (2011) quantified the cost of execution of electronic auction at CZK 12,000. If the electronic auction decreases the price of mobile services by 8.6 % then it should be used in every tender on mobile services with value higher than CZK 139,535. There are only 2 tenders in our dataset with value lower than CZK 139,535.

Each additional bidder decreases the final price on average by 6.1 %. Here applies the same argumentation as in the case of the electronic auction. The positive effect of higher number of bidders in a tender which brings higher competition is widely reported and well known. In the case of mobile services, there are only 4 applicable bidders and thus public authorities should always invite in the tender all of them.

In comparison with decentralized public authorities (Public Companies, Universities and Research Institutions), centralized public authorities (State Authorities, State-Funded Institutions) and semi-centralized public authorities (Regions, Municipalities) reach on average lower final price by 15.4 % and 9.2 %, respectively. This result is interesting in the light of findings of Bandeira et al. (2009) who found opposite effect in the case of Italian public procurement of standardized goods. They found that

universities and health authorities pay the lowest prices (comparable with our decentralized public authorities which pay the highest price), the average town government pays 13% more, regional governments (21%), social security institutions (22%), while the average ministry pays 40% higher prices (comparable with our centralized public authorities which pay the lowest price).

The final price is lower on average by 11.9 % if the public authority is medium sized with 500-1999 employees. This result is clear in comparison with small sized public authorities – economies of scale in case of larger public authorities enable lower price. In case of large sized public authorities, there is explanation hidden in the dataset. Most of the large sized public authorities in the dataset are Public Companies and Universities and Research Institutions (10 out of 15 observations for large sized public authorities). As was mentioned in previous paragraph, these public authorities pay the highest price and this is the reason for the counterintuitive result. To rule out multicollinearity, the Variance Inflation Factors do not indicate multicollinearity and the variables Centralized, Semi-centralized and Medium-sized are jointly significant using F-test on 1% level of significance with p-value 0.001 (we reject the null hypothesis that the variables Centralized, Semi-centralized and Medium-sized are jointly equal to 0).

Model 3 – Examination of Estimated Price

Model 3 examines the effect of variable Estimated Price on the final price of mobile services. Only 40 observations are used in this model because Estimated Price is not reported in documentation to every tender. We present here already the model with omitted insignificant regressors.

The assumptions of OLS regressions are met (see Appendix A for details):

- We can't reject the null hypothesis of heteroskedasticity not present using Breusch Pagan test with p-value equal to 0.964 and White's test with p-value equal to 0.803.
- We can't reject the null hypothesis of normality of residuals with p-value equal to 0.643.
- Variance Inflation Factors do not indicate a collinearity problem as the values for all variables are lower than 10.

Furthermore, we can't reject the null hypothesis that the specification of the model is adequate using RESET test with p-value equal to 0.323. We reject the null hypothesis that all coefficients are equal to zero based on F-test with p-value lower than 0.001. Model 3 explains 51.6 % of variability in the dependent variable *log Final Price*.

Model 3: OLS, using observations 1-40
Dependent variable: *log_Final_Price*

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	2.20143	0.27204	8.0923	<0.00001	***
log_Estimated_Price	0.0428096	0.0891608	0.4801	0.63420	
Year	-0.0769434	0.0373431	-2.0604	0.04707	**
T-Mobile	0.131942	0.0446583	2.9545	0.00565	***
Centralized	-0.224359	0.0556875	-4.0289	0.00030	***
Semi-centralized	-0.0929982	0.0517513	-1.7970	0.08122	*
Mean dependent var	2.097774	S.D. dependent var		0.176596	
Sum squared resid	0.589157	S.E. of regression		0.131636	
R-squared	0.515599	Adjusted R-squared		0.444363	
F(5, 34)	7.237945	P-value(F)		0.000104	
Log-likelihood	27.60131	Akaike criterion		-43.20263	
Schwarz criterion	-33.06935	Hannan-Quinn		-39.53875	

Dropped dummies: O2, Vodafone, Decentralized

Source: own processing based on CAE

Equation 4: Model 3 equation

$$\begin{aligned}
 \log(\text{final price of consumer basket}) & \\
 &= 2.20 + 0.04 \log(\text{estimated price of consumer basket}) \\
 &- 0.08\text{year} + 0.13\text{T-Mobile} - 0.22\text{centralized} \\
 &- 0.09\text{semi-centralized} + \varepsilon
 \end{aligned}$$

The logarithmic form of dependent variable and variable Estimated Price enables to interpret the Estimated Price coefficient as the elasticity of Final Price with respect to Estimated Price. We can see that the coefficient is low and insignificant. The interpretation would be that 1 % change in Estimated Price causes on average 0.04 % change in Final Price. Given the insignificance and low value of the coefficient, we conclude that Estimated Price does not affect the Final Price.

8.3 Discussion of results

This section discusses the results in connection with the stated hypotheses.

H1: Public authorities reach lower final price than market price published by Czech Telecommunication Office.

- Based on the benchmark analysis, we can't reject this hypothesis and the results are so strong that we dare to say that the hypothesis was confirmed. Public authorities are able to reach average savings against the market price in the amount of 81.79% and maximal and minimal savings within our dataset were 94.15% and 39.17% respectively. Every tender within our dataset was awarded to winner who submitted price lower than market price. This result suggests that public authorities should not measure the savings in comparison to the market price calculated from price lists but they can for instance share the information among each other to gain notion about the reachable prices.

H2: Usage of electronic auction yields lower final price.

- Usage of electronic auction brings lower final price of mobile services by 8.6 %. Therefore, we can't reject this hypothesis. Our finding is in line with number of research papers as mentioned in the literature review (e.g., Shalev and Asbjornsen (2010), Soudek and Skuhrovec (2013), Beblavá et al. (2013)). Compared to first-price sealed-bid auction, electronic auction enables bidders to adjust their bids and therefore the competition ends only after no one is willing to bid lower price. Our finding also indirectly rejects the possibility of cartel among MNOs. Robinson (1985) showed that electronic auction as a form of English auction may help a cartel to enforce collusion among its members by the possibility to monitor bids of other bidders. Nevertheless, we found that it is not the case of public procurement of MNOs services because the usage of electronic auction decreases the final price. If there would be a cartel, we would assume the final price of tenders with the usage of electronic auction to be higher than in tenders without electronic auction. Based on our findings, we recommend using electronic auction as often as possible due to relatively low cost (compared to the volume of tenders) and high savings.

H3: There is no statistically significant difference in the final price with respect to the winning MNO.

- There is no statistically significant difference in the final price between O2 and Vodafone, but T-Mobile is more expensive than these two mobile operators on average by 8 %. Therefore, we reject this hypothesis. This might be caused by the fact that T-Mobile is winning relatively smaller tenders in comparison with O2 and Vodafone as we have shown in section 3.5 and thus it can win the tender with higher price. Within our dataset, the average volume of a tender won by T-Mobile is CZK 2,571,852 while the average volumes of tenders won by O2 and Vodafone are CZK 5,455,316 and CZK 16,215,610, respectively. T-Mobile is thus winning the most tenders but the volume of the tenders is smaller and we assume that T-Mobile is able to apply higher mark-up.

H4: Number of bidders decreases the final price.

- Each additional bidder decreases the final price on average by 6.1 %. Therefore, we can't reject this hypothesis. The positive effect of higher number of bidders in a tender which brings higher competition is widely reported and well known. In the case of MNOs services, there are only 4 applicable bidders and thus public authorities should invite into the tender all of them.

H5: Estimated price increases the final price.

- We did not find statistically significant effect of estimated price on final price of mobile services. Therefore, we reject this hypothesis. We also can't confirm finding of Soudek and Skuhrovec (2013) who found that estimated price predicts final price in the case of homogenous goods.

H6: Term length decreases the final price.

- We did not find statistically significant effect of the term length of a contract on final price of mobile services and the coefficient is even positive eventhough the amount of the coefficient is very small. Therefore, we reject this hypothesis. However this hypothesis seemed plausible, our dataset did not support it. Thus, it seems to be advantageous to close the contract only for such an amount of time to compensate for the transaction costs connected

with every tender and potentially switching costs related to the change of the supplier.

H7: Governance structure of public authority affects the final price.

- In comparison with decentralized public authorities (Public Companies, Universities and Research Institutions), centralized public authorities (State Authorities, State-Funded Institutions) and semi-centralized public authorities (Regions, Municipalities) reach on average lower final price by 15.4 % and 9.2 %, respectively. Therefore, we can't reject this hypothesis. This result is interesting in the light of findings of Bandeira et al. (2009) who found opposite effect in case of Italian public procurement of standardized goods. They found that universities and health authorities pay the lowest prices (comparable with our decentralized public authorities which pay the highest price), the average town government pays 13 % more, regional governments 21 %, social security institutions 22 % more, while the average ministry pays 40 % higher prices (comparable with our centralized public authorities which pay the lowest price).

H8: Size of public authority measured by number of employees decreases the final price.

- Conclusion to this hypothesis is ambiguous. There is no statistically significant difference in the final price between small sized public authorities and large sized public authorities, but in case of medium sized public authorities the final price is lower on average by 11.9 %. We can find the explanation in the dataset. Most of the large sized public authorities in the dataset are Public Companies and Universities and Research Institutions (10 out of 15 observations for large sized public authorities). As was mentioned in paragraph for Hypothesis 7, these public authorities pay the highest price and this is the reason for the counterintuitive result.

H9: The final price of mobile services is decreasing in time.

- The final price of mobile services is decreasing in time, on average by 9 % per year. Therefore, we can't reject this hypothesis. Together with insignificance of the term variable, it follows that long term contracts are not cost-efficient.

9 Conclusion

The aim of this thesis was to examine bidding behaviour of mobile network operators, accompanied by the analysis of institutional and procedural characteristics under which public authorities are able to reach lower prices than regular retail customers.

We used the consumer basket methodology in order to compare tenders among each other. We calculated the final price of consumer basket from contracts related to each tender and investigated the factors affecting the final price. This enabled us to provide uniquely focused measure of public procurement of mobile network operators services in terms of price efficiency, which could contribute to public debate.

First, we analyzed the bidding behavior of mobile network operators from the point of view of number of bidders in a tender and the winner of a tender with respect to volume of the tender. O2 wins large amount of tenders when it is the only bidder. On the contrary, the most tenders won by Vodafone are tenders when all 3 mobile network operators were bidding. We also found that T-Mobile wins relatively smaller tenders in comparison with O2 and Vodafone and that Vodafone wins high volume tenders.

Second, we used benchmark analysis to investigate how compared final price reached by public authorities with market price. The benchmark analysis revealed that the final price of high consumption basket is on average lower than market price of high consumption basket by 82 %.

Third, we ran 3 regressions to determine the effect of institutional and procedural characteristics on the final price of high consumption basket.

The usage of electronic auction diminished final price of mobile services by 8.6 %. Based on our findings, the usage of electronic auction in tenders is rather rare and thus we recommend using electronic auction as often as possible due to relatively low cost (compared to the volume of tenders) and high savings.

T-Mobile was more expensive than other 2 MNOs on average by 8 %. This might be caused by the fact that T-Mobile won rather small tenders and thus it could win the tender with higher price.

Each additional bidder decreased the final price on average by 6.1 %. In case of MNOs services, there are only 4 applicable bidders and thus public authorities should invite into the tender all of them.

We did not find statistically significant effect of the term length of a contract on final price of mobile services. Thus, it seems to be advantageous to close the contract only for such an amount of time to compensate for the transaction costs connected with every tender.

We found that there exists statistically significant difference in the final price with respect to type of public authority. In comparison with decentralized public authorities (Public Companies, Universities and Research Institutions), centralized public authorities (State Authorities, State-Funded Institutions) and semi-centralized public authorities (Regions, Municipalities) reached on average lower final price by 15.4 % and 9.2 %, respectively.

The final price of mobile services is decreasing in time, on average by 9 % per year. Together with insignificance of the variable measuring length of contract, it follows that long term contracts are not cost-efficient.

Limitation of this thesis is relatively small dataset and thus we suggest further research to verify our results on larger dataset. The dataset can be enlarged either by adding more tenders or covering longer time period. Further research might also focus on public procurement of MNOs services in other countries and compare it with our findings.

Bibliography

Bandeira, O., Prat, A., Valetti, T. (2009): Active and Passive Waste in Government Spending: Evidence from a Policy Experiment, *American Economic Review*.

Beblava, E., Klatík, P., Beblavy, M. (2013): Ekonomické efekty elektronických aukcí na Slovensku (Economic Effects of Electronic Auctions in Slovakia). *Ekonomický časopis*, Vol 61, No. 10, 2013.

CTO (n.d.). Metodika ČTÚ. CTU.cz. Retrieved 30 June 2014, from <http://www.ctu.cz/ctu-informuje/srovnavaci-prehled-cen-a-podminek/metodika-ctu.html>

CTO (2012): Analýzu trhu č. A/8/XX.2012-Y, trh č. 8 – přístup a původ volání (originace) ve veřejných mobilních telefonních sítích.

CTO (2014): Měsíční monitorovací zpráva č. 8/2014 Českého telekomunikačního úřadu – srpen 2014. Retrieved 3 January 2015, from http://www.ctu.cz/cs/download/monitorovaci_zpravy/monitorovaci_zprava_08-2014_srpen.pdf

Domberger, S., Hall, C., Li, E. A. L. (1995): The determinants of price and quality in competitively tendered contracts. *The Economic Journal*, 1454-1470.

European Commission (n.d.): CPV. Retrieved 29 December 2014, from http://simap.europa.eu/codes-and-nomenclatures/codes-cpv/codes-cpv_en.htm

Government of the Czech Republic (2011): Hodnocení dopadů regulace k novele zákona č. 137/2006 Sb., o veřejných zakázkách, ve znění pozdějších předpisů. Retrieved 30 June 2014, from <http://www.psp.cz/sqw/text/orig2.sqw?idd=71342>

Government of the Czech Republic (2012): Strategie vlády v boji s korupcí na období let 2013 a 2014. Retrieved 30 June 2014, from <http://www.vlada.cz/assets/protikorupcni-strategie-vlady/na-leta-2013-2014/Strategie-2013-a-2014.pdf>

Gupta, S. (2001): The Effect of Bid Rigging on Prices: A Study of The Highway Construction Industry. *Review of Industrial Organization*, 19 (4): 453-467.

Hlaváček J. (1987): Homo se assecurans, *Politická ekonomie* 34.

Klemperer, P. (1999): Auction theory: A guide to the literature. *Journal of economic surveys*, 13(3), 227-286.

Klemperer, P. (2004): *Auctions: theory and practice*. Princeton University Press.

Kornai, J. (1986): The soft Budget Constraint. *Kyklos*.

Krishna, V. (2010): *Auction theory*. Elsevier.

Matura, J. (2013): Proč jsme volali draze? Třeba proto, že úřady volají skoro zadarmo. Retrieved 1 January 2015, from http://mobil.idnes.cz/urady-volaji-skoro-zadarmo-dd4-/mobilni-operatori.aspx?c=A130410_133552_mobilni-operatori_jm

MRD (2013): Metodika pro vyhodnocování efektivnosti nákupu telekomunikačních služeb.

MRD (2014): Výroční zpráva o stavu veřejných zakázek v České republice za rok 2013.

Myerson, R. B. (1981): Optimal auction design. *Mathematics of operations research*, 6(1), 58-73.

Nikolovova, P., Palguta, J., Pertold, F., Vozár, M. (2012). Veřejné zakázky v ČR: Co říkají data o chování zadavatelů?. IDEA.

Niskanen, W. A. (1968): The Peculiar Economics of Bureaucracy. *American Economic review*.

Niskanen, W. A. (1975): Bureaucrats and Politicians. *American Economic review*.

O2 (2014): Společnosti O2 se daří snižovat náklady, klíčovou oblastí růstu zůstává Slovensko. Retrieved 3 January 2015, from <http://www.o2.cz/spolecnost/tiskove-zpravy/390672-Spolecnosti-O2-se-dari-snizovat-naklady-klicovou-oblasti-rustu-zustava-Slovensko.html>

OECD (n.d.): OECD telecommunication price baskets. Retrieved 30 June 2014, from <http://www.oecd.org/sti/broadband/price-baskets.htm>

OECD (1993): Glossary of Industrial Organisation Economics and Competition Law, compiled by R. S. Khemani and D. M. Shapiro, commissioned by the Directorate for Financial, Fiscal and Enterprise Affairs, OECD, 1993.

OECD (2011): Government at a Glance 2011. Retrieved 30 June 2014, from http://www.oecd-ilibrary.org/governance/government-at-a-glance-2011_gov_glance-2011-en

Pavel, J. (2007): Ekonomické aspekty veřejných zakázek. Praha: VŠE, Nakladatelství Oeconomica, 2007. 110 s. ISBN 978-80-245-1260-0.

Pavel, J. (2008): Vliv počtu nabízejících na cenu stavebních zakázek v oblasti dopravní infrastruktury 2004 - 2007, Transparency International Česká republika.

Pavel, J. (2009): Veřejné zakázky v České republice. Studie Národohospodářského ústavu Josefa Hlávky.

Pavel, J., Sičáková-Beblavá, E. (2013): Do E-Auctions Really Improve the Efficiency of Public Procurement? The Case of the Slovak Municipalities. Prague Economic Papers, 2013(1), 111-124.

Porter, H. R., Zona, J. D. (1993): "Detection of Bid Rigging in Procurement Auctions." The Journal of Political Economy, 101 (3): 518-538.

PwC, London Economics and Ecorys (2011): Public procurement in Europe, Cost and effectiveness, A study on procurement regulativ prepared for the European Commission.

Reimarová, H. (2012): Transaction Costs in Public Procurement (Rigorous Thesis). Charles University in Prague.

Riley, J. G., Samuelson, W. F. (1981): Optimal auctions. The American Economic Review, 381-392.

Robinson, S. M. (1985): Collusion and the Choice of Auction. Rand Journal of Economics, 16 (1): 141-145.

Shalev, M. E., and Asbjornsen, S. (2010): Electronic reverse auctions and the public sector—Factors of success. *Journal of public procurement*, 10(3), 428-452.

Skuhrovec, J. (2011): Kolik se utratí za veřejné zakázky? To u nás nikdo neví. Retrieved 30 June 2014, from <http://blog.aktualne.centrum.cz/blogy/jiri-skuhrovec.php?itemid=12218>

Soudek, J., Skuhrovec, J. (2013): Public procurement of homogeneous goods: The Czech Republic case study. IES Working Paper, No. 05/2013.

Soudry, O. (2004): Promoting Economy: Electronic Reverse Auctions under the EC Directives on Public Procurement. *Journal of Public Procurement*. Vol. 4, No. 3, pp. 340-374.

Stigler, G. J. (1964): A Theory of Oligopoly. *Journal of Political Economy*, 72 (1): 44-61.

T-Mobile (2014): Q3 2014: T-MOBILE POTVRZUJE SVOU VEDOUČÍ POZICI. Retrieved 3 January 2015, from <http://t-press.cz/cs/tiskove-materialy/tiskove-zpravy-t-mobile/q3-2014-t-mobile-potvrzuje-svou-vedouci-pozici.html>

Thaler, R. H. (1988): Anomalies: The winner's curse. *The Journal of Economic Perspectives*, 2(1), 191-202.

Transparency International (2005): Veřejné zakázky v České Republice: Korupce nebo transparentnost?

Vickrey, W. (1961): Counterspeculation, auctions, and competitive sealed tenders. *The Journal of finance*, 16(1), 8-37.

Vodafone (2014): Vodafone announces results for the six months ended 30 September 2014. Retrieved 3 January 2015, from http://www.vodafone.com/content/dam/vodafone/investors/financial_results_feeds/half_year_30september2014/dl_halfyear2014.pdf

Appendix A: OLS Assumptions

Model 1

Breusch-Pagan test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: LM = 11.8213

with p-value = $P(\text{Chi-square}(10) > 11.8213) = 0.297193$

White's test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: LM = 14.6783

with p-value = $P(\text{Chi-square}(13) > 14.6783) = 0.327861$

Test for normality of residual -

Null hypothesis: error is normally distributed

Test statistic: Chi-square(2) = 0.440016

with p-value = 0.802512

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: $F(2, 46) = 0.481744$

with p-value = $P(F(2, 46) > 0.481744) = 0.620786$

Variance Inflation Factors

Minimum possible value = 1.0

Values > 10.0 may indicate a collinearity problem

T-Mobile	1.424
Vodafone	1.588
E-auction	1.239
Bidders	1.483
Term	1.538
Centralised	1.565
Semi-centralised	2.197
Small-sized	2.321
Medium-sized	1.958

Model 2

Breusch-Pagan test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: $LM = 7.37593$

with p-value = $P(\text{Chi-square}(7) > 7.37593) = 0.390815$

White's test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: $LM = 31.7352$

with p-value = $P(\text{Chi-square}(29) > 31.7352) = 0.331615$

Test for normality of residual -

Null hypothesis: error is normally distributed

Test statistic: $\text{Chi-square}(2) = 0.613112$

with p-value = 0.735977

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: $F(2, 49) = 0.608202$

with p-value = $P(F(2, 49) > 0.608202) = 0.548386$

Variance Inflation Factors

Minimum possible value = 1.0

Values > 10.0 may indicate a collinearity problem

Year	1.151
T-Mobile	1.14
E-auction	1.12
Bidders	1.315
Centralised	1.293
Semi-centralise	1.659
Medium-sized	1.297

Model 3

Breusch-Pagan test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: LM = 0.977339

with p-value = $P(\text{Chi-square}(5) > 0.977339) = 0.964373$

White's test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: LM = 11.1051

with p-value = $P(\text{Chi-square}(16) > 11.1051) = 0.802953$

Test for normality of residual –

Null hypothesis: error is normally distributed

Test statistic: Chi-square(2) = 0.882682

with p-value = 0.643173

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: $F(2, 32) = 1.1704$

with p-value = $P(F(2, 32) > 1.1704) = 0.323172$

Variance Inflation Factors

Minimum possible value = 1.0

Values > 10.0 may indicate a collinearity problem

Year	1.43
T-Mobile	1.125
log_Estimated_Price	1.383
Centralised	1.427
Semi-centralised	1.449