Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

BACHELOR THESIS

Methods of Public Property Sales in the Czech Republic

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Academic Year: **2012/2013**

Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature. He confirms that this thesis is written for purposes to achieve the Bachelor's degree at IES FSV UK only.

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Prague, May 13, 2013

Signature

Acknowledgments

The author is grateful especially to Jiří Skuhrovec for all the patient comments and useful guidance. He is also grateful to Jozef Baruník, Zdeňka Niklasová, Petr Uhlíř, and other people who helped.

Abstract

The aim of this work is to compare common methods of public property sales in the Czech Republic - it compares sales through public auction with sealed-bid auction. Public auctions with more regulated publicity standards show much lower rate of failed auction, which might make them preferable method of sale. Revenue of both methods is found to be similar, which fits the auction theory predictions, despite demonstrated bias in official price estimates and institutional frictions. The difference between the methods is reflected in the fact that the revenues from the sales through sealed-bid auctions have lower variance than the sales through public auctions.

JEL Classification	C01, C12 , C13, D44, D73, D83
Keywords	auction, public auction, sale, public property, Czech republic, auction theory

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Abstrakt

Cílem této práce je srovnat běžné metody prodeje veřejného majetku v České republice – práce srovnává prodej veřejnou dražbou a prodej obálkovou metodou. Veřejné dražby, které mají striktněji danou povinnost zveřejňovat dražební vyhlášky, vykazují mnohem nižší míru neúspěšných dražeb, což by je mohlo dělat vhodnější metodou prodeje. Výsledné ceny obou metod jsou podobné, což potvrzuje teoretické predikce a to navzdory prezentovanému vychýlení v oficiálních odhadních cenách a institucionálním frikcím. Rozdíl mezi oběma metodami se projevuje v nižším rozptylu výsledných cen při prodeji veřejnou dražbou.

Klasifikace	C01, C12 , C13, D44, D73, D83
Klíčová slova	aukce, veřejná dražba, prodej, veřejný majetek, Česká republika, teorie aukcí

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Acronyms

ARK ČR	Association of Real Estate Offices Czech Republic
CSU	Czech Statistical Office
MMR	Ministry of Regional Development of the Czech Republic
OLS	Ordinary least squares
SIPV	Symmetric independent private values

Bachelor Thesis Proposal

Methods of public property sales in the Czech Republic

Název v anglickém jazyce:	Methods of public property sales in the Czech Republic
Název v českém jazyce:	Metody prodeje veřejného majetku v ČR
Klíčová slova:	aukce, veřejná dražba, prodej, veřejný majetek, Česká republika, teorie aukcí
Klíčová slova anglicky:	auction, public auction, sale, public propery, Czech republic, auction theory
Akademický rok vypsání:	2011/2012
Typ práce:	bakalářská práce
Jazyk práce:	angličtina
Ústav:	Institut ekonomických studií (23-IES)
Vedoucí / školitel:	PhDr. Ing. Jiří Skuhrovec
Řešitel:	Vítězslav Titl - zadáno vedoucím/školitelem
Datum přihlášení:	10.05.2012
Datum zadání:	10.05.2012

Seznam odborné literatury

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Předběžná náplň práce

Cílem této práce je porovnat efektivitu a další aspekty různých způsobů zpeněžování veřejného majetku v České republice. Používané metody prodeje budou podrobeny analýze z hlediska mikroekonomické teorie aukcí. Dále bude práce zaměřena na srovnání prodeje majetku veřejnou dražbou a prodej nejvyšší nabídce. Své závěry založím na empirické analýze dat sesbíraných od českých úřadů na základě Zákona o svobodném přístupu k informacím a na datech poskytnutých společností JH Partners s.r.o.

Metody práce:
Institucionální analýza veřejných dražeb a dalších metod zpeněžování veřejného majetku.
Sběr dat pomocí Zákona o svobodném přístupu k informacím a vytvoření vhodné databáze setříděním těchto dat a dat poskytnutých společností JH Partners, s.r.o. pomocí databázového systému MySQL.
Testování statistických hypotéz.

Předpokládaná struktura:

1. Úvod
2. Teorie aukcí
3. Současná česká legislativa upravující veřejné dražby
4. Veřejné dražby z pohledu teorie aukcí
5. Empirické srovnání veřejné dražby a prodeje
6. Závěr

Předběžná náplň práce v anglickém jazyce

The aim of the thesis is to compare efficiency and other aspects of different methods of public property sales in the Czech Republic. Commonly used methods will be analyzed in terms of microeconomic auction theory. Further the thesis will be focused on the comparison of the public auctions and sales. The conclusions will be based on empirical analysis of the data provided by JH Partners, s.r.o. and the data collected by applying the law "Zákon o svobodném přístupu k informacím".

Methodology:
Institutional analysis of public auctions and other methods of public property sale.
Collecting data by applying the law "Zákon o svobodném přístupu k informacím" and ordering this data and data provided by JH Partners, s.r.o. using MySQL database system to make suitable dataset.
Testing statistical hypothesis.

Outline:
1. Introduction
2. Microeconomics Auction Theory
3. Current Auction Legislation in the Czech Republic
4. Public Auctions in Terms of Auction Theory
5. Empirical Comparison of Public Auctions and Sales
6. Conclusion

1 Introduction

An auction has become a very successful and popular sale mechanism in last decades. For example, art auctions are very frequent. However in recent years, many governments have also started to sell its property through auctions. For instance, mobile telephony frequencies or timber in U.S. are well known cases. The first "big auction" was the UK auction of UMTS[1] frequencies. There were many participants in the auction and the government raised a lot of money. It was simply a success. On the other hand, the similar auction in the Netherlands was not so successful. The amount of raised money was significantly smaller. The newcomers were not interested in the auction, et cetera. Taking into account these two opposite experiences, we can see that the success of the auction probably depends at least partially on auction design. (Janssen, 2004) The question that immediately arises is what auction mechanism can be successful under what circumstances.

The aim of this work is to compare methods that are used to sell immovable public property in the Czech Republic and to find out which method generates higher revenue. There are two kinds of auctions which are used to sell public property. The first one is regulated form which is called a *public auction*. The second method is *first-price sealed-bid auction*.

In the first part of this work, the current legislative framework that is linked to public property sales is presented. In the second part, *public auction* and other methods of sale are discussed in terms of auction theory. Then this theory is applied on the methods of public property sales used in the Czech Republic. Thirdly, there is a description of the data-set used for empirical comparison of these methods. Fourthly, the results of the empirical comparison of the revenues and other aspects are presented. At the end of work, the conclusion based on the results from the previous section is discussed.

[1] UMTS means Universal Mobile Telecommunications System. It is a third generation technology developed by 3rd Generation Partnership Project and it is used by mobile phones. (Universal Mobile Telecommunications System Anon., 2013)

2 The legal framework linked to the public property sales in the Czech Republic

2.1 Definition of a public property

Before the legal methods of public property transfers are discussed, definitions of property, and especially public property should be introduced. Property, according to Czech legislative, can be understood as some object of civil relationship. So called object of civil relationship[2] can commonly be things or possibly rights. For purpose of this work it is crucial that public subjects own so-called public property and they have right to dispose of the property. (Havlan and Janeček, 2009) The description of the legal ways of disposing of public property follows.

2.2 Legal ways of disposing of public property

Generally, it is presumed that general private law is applied on the ways of disposing of public property. The disposing is based on private law acts such as a contract. Transfers of public property are regulated generally by three laws. These laws are The Act No. 219/2000 Coll., on the property of the Czech Republic and the representation of the Czech Republic in legal relations, The Act No.128/2000 Coll., on Municipalities (the Municipal Arrangement) and The Act No.129/2000 Coll., on Self-governmental Regions[3]. Due to the purpose of this work, these transfers have been divided into transfers of state property and transfers of territorial self-governmental unit property. The transfers of immovable properties will be discussed only. (Havlan, Janeček, 2009)

[2] According to section 118 of The Act NO. 40/1964 Coll., The Civil Code (1) Things and, if their nature admits so, rights or other property values can be subject to civil legal relationships. (2) Also flats and non-residential premises may be subject to civil legal relationships.

[3] The last two acts are related to territorial self-governmental unit property transfers.

2.3 State property transfers

State is a legal entity[4] which exclusively owns state property. On the other hand, "state organizational units" are not legal entities and they do not have any property. They manage the state property only. "State organizational units" are, for example, ministries and other administrative authorities, the Constitutional Court, The Office of the Government of the Czech Republic, et cetera.[5] The Office for Government Representation in Property Affairs is one of the other administrative authorities which is important to be pointed out, firstly because of the amount of property which is managed by this office, and secondly because it is named directly in Act No. 219/2000 Coll.

According to the Act named above, The Office of the Government of the Czech Republic has to offer its property firstly to other organizational units of state and if no unit wants the property, it can sell the property if one of the two following conditions is fulfilled. Firstly, if the organizational unit does not need it in order to fulfill its purposes. Or secondly, the organization can achieve more economical functioning by sale.

2.4 Territorial self-governmental units property transfers

The Act No.128/2000 Coll., on Municipalities (the Municipal Arrangement) is the main legal regulation of municipalities. It states that municipalities are public-law corporations, they own property, and take care about all-round development of the area.

Property transfers are treated by sections 39, and 85 of this act. It requires declarations of intent to sell property to be disclosed on so-called "official board" of the municipality 15 days in advance. The declaration can also be disclosed in the way which is locally usual. The opening price on the announcement should be at least usual price. The deviation from the usual price has to be explained. Every declaration of intent to sell has to be approved by the council of the municipality.[6]

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[4] According to the section 21 of The Act NO. 40/1964 Coll. The Civil Code "If the state takes part in civil legal relationships, it shall be considered a legal entity."

[5] According to The Act No. 219/2000 Coll., on the property of the Czech Republic and the representation of the Czech Republic in legal relations.

[6] The Act No.128/2000 Coll., on Municipalities (the Municipal Arrangement)

The Act No.129/2000 Coll., on Self-governmental Regions is the main legal regulation of regions. It states again that regions are public-law corporations which are managing their own property. Property transfers are treated by sections 18, and 36 of the act. The rules are very similar. The only important difference[7] is that declarations of intent to sell property have to be disclosed on so-called official board of the region 30 days in advance not only 15 days.

2.5 Methods of sale

Both self-governmental territorial units and the state can sell its property through either *public auctions* or through *first-price sealed-bid auction*. *Public auction* is a method of sale regulated by The Act 26/2000 Coll., on Public Auctions. It is an English auction[8] that has to satisfy a few conditions. For the purposes of this work is relevant that the auction deposit[9] can be maximally 30% of the opening bid, while it cannot be higher than 1.5 million CZK plus 10% of the amount exceeding 5 million CZK. If the property sold is an immovable property, the auction announcement has to be disclosed on the *Centralni adresa*[10] and on locally common place[11] for disclosing auction announcement at least 30 days before the auction is to begin. The auction announcement has to contain extensive information[12] about the property sold. The last but not least feature of a *public auction* is that the value of the property has to be estimated as so-called "usual price" by a judicial expert[13].

The second method can be any method of sale that fulfills the laws mentioned above. However, the most common one is *first-price sealed auction*. In this method, the price estimation is also required but it needs not to be done a judicial expert. This price estimation is done by a valuer[14]. The price offer has to be at least the estimated

[7] This difference can be important because earlier publication can attract more bidders and consequently it can raise the revenue.

[8] An English auction is described in the Section 3.3.

[9] Auction deposit is the amount of money that is required if one wants to participate in the auction.

[10] *Centralni adresa* is a web portal about public auctions and procurements available at http://www.centralniadresa.cz/cadr/.

[11] Locally common place can be for example local newspaper.

[12] Compulsory content of the announcement is precisely defined in the act.

[13] It is necessary in case of immovable property not generally. The process of price estimation is further described in the following section of the work.

[14] The difference between a valuer and a judicial expert is discussed in the next section of the work.

price[15]; however, it can be reduced after an unsuccessful sale. This rule can possibly play crucial role, because it may be incentive for the seller to underestimate the property (i.e. force the valuer to lower the price estimation); however, the Ministry of Finance of the Czech Republic has to approve the price estimation which makes underestimation more difficult. Further as it was mentioned earlier, the requirement about disclosing of intent of sale on official board has to be fulfilled.

2.6 The price estimation

The price estimation which is required has to be done as the estimation of a *"usual price"*. The *"usual price"* is defined in the section one of section 2 of The Act No. 151/1997 Coll., on Valuation of Property and it *"means the price that would be obtained when selling identical or similar asset or when rendering identical or similar services in usual commercial relations in the Czech Republic as of the day of valuation."*

In case of any *public auction*, an expert report of *"usual price*" has to be made by so-called judicial expert. A judicial expert is appointed by the Minister of Justice of the Czech Republic. (The Act No. 36/1967 Coll., on judicial experts and translators, section 3, s. 1) If an export report was not truthful or incomplete, a judicial expert could be imprisoned for maximally two years. (The Act No. 140/1961 Coll., the Criminal Code, section 346, s. 1) On the other hand in case of other methods of sale, the estimation of a *"usual price"* takes the form of price estimation done by a valuer. A valuer is licensed trade according to The Trade Licensing Act (No. 455/1991 Coll.). A valuer is not appointed by anyone. The appropriate education[16] is requested only.

2.6.1 On the difference between a judicial expert and a valuer

The important conclusion is that an expert report and price estimation is not the same thing. An export report is done by a judicial expert who is criminally responsible and has to prove special knowledge and skills. On the contrary, price estimation is done by a valuer who is a common licensed trader. Therefore, it may be reasonable to expect that an expert report should be generally more difficult to manipulate. This may be important aspect of price estimation process to consider.

[15] This holds in case of state property sales and it cannot be violated only if a special law does not specify otherwise.

[16] It can be either technical education or economics.

2.7 Pricing maps

Due to the fact that the price estimation of property sold through *public auctions* is done by a judicial expert and the price estimation of property sold through *first-price sealed-bid auctions* is done by a valuer, it would be useful to have price estimation method that is common for both methods of sale. In this work, a pricing map will be used for this purpose. A pricing map is done by local authority according to The Property Valuation Act 151/1997 Coll., it shows prices for particular construction sites in the city. It is an unbiased benchmark of property value in given locality and time. In particular, it is not affected by a need to satisfy legal conditions or possible corrupt behavior. The prices in pricing maps are based on prices that were sent to the local authority by the seller in the time of sale. Therefore, the prices are similar to the *"usual price"*.

Unfortunately, the pricing maps made by local authorities shows only prices of construction sites. As pricing map for buildings and flats, the pricing map made by ARK ČR will be used. These prices are based on realized prices collected from ARK ČR members. The brief description and list of links to online pricing maps that were used is in Appendix A.

2.7.1 Collecting of administrative prices from pricing maps

An administrative price of a particular construction site, flat or building states price per square meter. So in order to collect the administrative prices of the properties in the data-set, the areas of flats or building were manually search in the auction announcements or in the database of Czech Office for Surveying, Mapping and Cadastre[17]. Then the price was determined as *area * administrative price per square meter*. If the property was composed of a building (or a flat) and also a land, the total price of the property was obtained as a sum of the price of the building (or the flat) and the price of the land.

The administrative prices may have larger variance, because they do not take into account the unique characteristics of the property; however, they are not biased which will be very important in the empirical analysis.

[17] The database is available at http://nahlizenidokn.cuzk.cz/VyberParcelu.aspx (in Czech only).

2.8 Summary of the legal framework linked to the public property sales

To summarize the legal framework up, it is possible to say that there are basically two methods of public property sales in the Czech Republic. Firstly, it is *public auction* which is rigorous form of English auction. And secondly, it is *first-price sealed-bid auction*. In the first one, the estimated price takes the form of an expert report and it is more regulated way of estimating price done by officially appointed judicial experts. In the next section of this work, these two forms are compared in terms of auction theory.

3 Auction theory and the methods of public property sales

3.1 Auction

Menezes and Monteiro (2005, p. 9) defined the auction "as a market clearing mechanism, to equate demand and supply". The other known methods of sale are fixed price sale and bargaining.

In this work, the introduction to this theory will be made and then the specific parts of auction theory, that are linked to the public property sales in the Czech Republic, will be discussed. However firstly, it is useful to go through the possible goals of auctions and particularly through goals of public property auctions.

3.2 Auctions and their goals

If an auction and other method of sale are compared in theoretical literature, an auction appears to be more efficient, fast, transparent, and, if the auction is well designed, the revenue would be fair. However, there are some issues that make auction less attractive. For example in open auctions, there is a possibility of collusion (details are discussed later). On the other hand in sealed-bid auction, officials can help some bidders illegally and tell them already submitted bids which makes sealed-bid auction less attractive. (Janssen, 2004, p. 9)

Governments can have different goals to achieve while selling public property. Janssen (2004, p. 3) suggested six possible goals. Three of them refer to the outcome, while the rest refers to the process of the allocation.

1. Efficient operation of the after market
2. Market that provides publicly desirable goods
3. Revenues
4. Value-maximizing allocation process
5. Transparent selection process
6. Efficient allocation process

When a government or self-governmental territorial unit wants to sell its unneeded property, it can influence both what is sold and to whom it is sold. (Janssen, 2004) Under specific circumstances the shape of aftermarket can be important[18]. However, the amount of unneeded immovable public property sold in auctions[19] is very small in comparison with the whole market; therefore, it is not likely to influence the aftermarket very much.

The second goal is linked to paternalistic role of the governments. Politicians may want to determine which goods should be available at the market. Nevertheless in this work, it is assumed that a government would not sell anything that is not desired by a government to be at the market. However, a government may want, for example, to help all people to have their own accommodation. Anyway governments use other tools such as subsidies[20] to solve affordability of housing issue. Due to these reasons this goal will not be considered further.

The third goal is very straightforward and important as well. Because the majority of the public property sold in auctions is redundant and useless property, it is reasonable to assume that revenue is one of the most important goals to achieve.

The last three goals are focused on the process not too much on the outcome. Whether these three goals are satisfied is discussed in the following sections about auction theory. A brief description of these three goals is following.

Firstly, a value-maximizing process means that the bidder with the highest value will win. The question that immediately arises is why the market cannot handle itself because it is possible to argue that the seller can resell the property. However, Krishna (2009) pointed out that this argument is not very strong for two reasons. Firstly, there would probably be only a small number or participants, and the transaction could be inefficient because it can easily happen under circumstances of incomplete information. Secondly, the resale could involve additional transaction costs which can consequently make the resale pointless.

[18] For instance in case of mobile frequencies mentioned in the introduction of the work.

[19] The ongoing auctions (as specified in the Data section of this work) were considered.

[20] This method of housing subsidy program was used for instance in U.S.

Fifth goal is transparency of selection process. It means a process in which the winner is selected in an unambiguous manner. (Janssen, 2004, p. 3) This last criterion has become especially important for public property sales over the last years. This criterion will be discussed a little in the section about corruption in auctions**.**

3.3 Common auction mechanisms

There are generally two groups of auction mechanisms: sealed-bid auctions and open auctions. In the open auctions, all bids are publicly observable in real time and bidders act simultaneously, and independently. In the sealed-bid auctions, bidders do not know the bids of other bidders and they bid[21] independently and only once. (Janssen, 2004)

Open auctions can be divided into ascending auctions which are called English auctions, and descending auctions which are commonly called Dutch auctions. In the ascending auctions, bidders start to bid at a low price and they increase their bids in time. In the descending auctions, "bidding starts at a high price that continuously declines until one of the bidders stops the process by acquiring the object". (Menezes and Monteiro, 2005, p. 10)

The two kinds of sealed-bid auctions differ in the way how the price is determined. In the *first-price sealed-bid auction*, the winner pays the highest bid, i. e., his or her own bid. In the second-price sealed-bid auction, the winner pays the second highest price, i. e. the bid of the first unsuccessful bidder. The second-price sealed-bid auction is also called Vickrey auction. (Menezes and Monteiro, 2005) The following paragraphs are, inter alia, focused on the issue how this difference in the determination of the price can influence bidder's behavior.

These were the four basic auction mechanisms. However, there are also other mechanisms. For instance, Anglo-Dutch auction which is combination of English auction and first-price sealed-bid auction. It is an ascending auction until certain number of remaining bidders is reached. And then the first-price sealed-bid auction is conducted. (Damme and Börgers, 2004) These are definitely not all possible mechanisms, however, for the purpose of this work the English one and first-price sealed-bid auction are essential only.

[21] In the Czech environment, envelopes bids are used often for submitting.

3.4 An equivalence among auction mechanisms in general

There are many theorems about auction mechanisms and equivalence between them. Firstly, the outline of the equivalences will be made in the following paragraphs, and in the next section it will be done in detail.

One of commonly known equivalences is the strategic equivalence between Dutch auction and first-price sealed-bid auction. It holds basically because, in Dutch auction, bidders have to choose the price (while current price is falling during the auction) at which he or she will stop the auction and pay this price. This is the same mechanism as in first-price sealed-bid auction, i.e. the winner determines the price which is equal to his or her bid. Therefore, it is said that these two auction mechanisms are strategically equivalent. (Milgrom and Weber, 1982)

There is also relationship between second-price sealed-bid auction and English auction. However, it is weaker than strategic equivalence. The reason is that the English one allows other bidders to see when other bidders drop-out which can be useful information. Anyway, if bidders knew their own valuation of the object sold, they would optimally bid their values and pay the value of the second strongest bidder. (Janssen, 2004)

More precise description of bidding behavior is following. Because of the aim of the work, the description is focused on single object auctions only.

3.5 Bidding behavior at a single object auction

In order to compare auction mechanisms or to choose which one is optimal under what circumstances, it is necessary to understand bidding behavior. To do that, let us assume that bidders know their valuation of the object. Let v_i be the value of the object for bidder i. Let p be the realized price. Then the net gain for winning bidder is defined as follows.

Definition 3.1. Net gain is equal to $v_i - p$ if bidder i win, otherwise it is equal 0.

In English auction, optimal strategy for bidder i is to stay in the auction until v_i is reached. Following this strategy one can make a positive profit[22]. To conclude, it is important to point out that under these circumstances the bidder that assigns the

[22] If the strongest bidder value's v_i was not reached then the net gain would be positive.

highest value to the object will win. And therefore, the outcome of the auction is efficient. (Damme and Börgers, 2004)

The behavior of the bidders in second-price sealed-bid auction would be very similar. Again the outcome of the auction is equal to the value of the bidder with the second highest valuation to the object. It is because the highest bid determines the winner only.

Considering Dutch and first-price sealed-bid auctions, the situation is very different. To achieve positive surplus, one has to bid less than his value. The question is how much less. The answer depends on how much risk the bidder is willing to take. A risk-taker would wait and make much more profit if he wins, because as a bidder waits the price falls down and bidder's net gain rises. However, the probability of losing the auction also rises. On the other hand in Dutch auction, if risk-neutral bidders, who know the values of all others, are assumed, it is possible to conclude that the outcome of the auction will be the same as in English auction. Because the bidder with the highest value can wait until the second highest value is reached. (Damme and Börgers, 2004)

3.6 Revenue equivalence theorem

Assumption of risk-neutral bidders proved to be useful for the following analysis. In order to derive equivalence of auction mechanisms formally, five assumptions were made.

Assumption 3.1. Single object is sold.

Assumption 3.2 (symmetric bidders). Bidders are not distinguishable.

Assumption 3.3 (private information). All bidders know their valuations and do not know valuations of others.

Assumption 3.4 (risk-neutrality). All bidders are risk-neutral.

Assumption 3.5 (i.i.d. and continuity). Bidders' valuations are independent, identically distributed and continous random variables.

A model satisfying Assumptions 3.1 - 3.5 is called Symmetric independent private values (SIPV). For instance, in Menezes and Monteiro (2005) there is proof of so-called Revenue Equivalence Theorem which says that English, Dutch, first-price and second-price sealed-bid auctions generate the same expected revenue under SIPV.

This theorem is very important theoretical result, because it predicts that if these five assumptions were satisfied, *public auction* and *first-price sealed-bid auction* would generate the same revenue. In the following paragraphs, a few possible violations of the assumptions will be presented.

3.7 Asymmetry of bidders

In the above paragraph, it was assumed that all the bidders valuations to be drawn from the same distribution. In this paragraph, the situation in which some bidders are stronger than others is discussed. This phenomenon is called asymmetry of bidders and it is a realistic expectation, because the bidders can have different opportunity cost[23]. Hence, the bidders will not have the same distribution function from which their valuations are drawn[24]. (Maskin and Riley, 1998) To describe the situation of asymmetric bidders in different auction mechanisms, let us assume two bidders with valuations from uniform distributions U[0,1] (the weaker bidder), and U[2,3] (the stronger bidder), respectively. In English auction, and in second-price sealed-bid auction, the behaviour of bidders would be the same as normally. Consequently, the stronger one would win and pay the other bidder's value. On the other hand in first-price sealed-bid or in Dutch auction, the weaker bidder would bid his own value since recognizing he has no chance of winning the auction[25]. The stronger one would bid the maximal value of the weaker bidder and will win. The revenue, in this case, would be equal to one. So it is possible to conclude that, under the circumstances of asymmetric bidders, the revenue of Dutch auction and first-price sealed-bid auction would be higher than revenue English auction or second-price sealed bid auction. (Kagel and Levin, 2001) Consequently, in case of asymmetric bidders, *first-price sealed-bid auction* should generate higher revenue than *public auction.*

3.8 Winner's curse

Despite of that fact that player's knowledge of his or her own value was assumed in the previous sections, bidders often do not know each others' values. However, they can learn from other competitors' bids. Then the issue of winner's curse can arise. This issue was first mentioned in Capen, Clapp, and Campbell (1971) paper about competitive bidding in Outer Continental Shelf lease sales. In this paper, they

[23] It is obvious that a large multinational enterprise often have different opportunity cost than small local company.

[24] I.e. a situation in which some bidders are known to be stronger.

[25] The conclusion holds if there are no costs of placing bid.

presented winner's curse as the source of unexpectedly low rates of return in the 1960's and 1970's. According to Capen, Clapp, and Campbell (1971), the low rates of return should have been caused by bids that were correct on average, however, the winner paid the price which was the highest bid (or highest bid second highest in the second-price and English auction). Hence, the value of lease is overestimated[26]. This effect of too optimistic unconditional bids is called winner's curse. (Kagel, 2003)

3.9 Collusion

Up to this paragraph, players have been expected to compete; however, the other problem in practice is the possibility of bidders to collude. In an auction with only two players with values v and V such that $v < V$, the revenue would normally[27] be equal to v. However, if the players cooperate, the price can be equal to zero because the player with valuation v would not compete at all. So the gain for cooperating players would be equal to V. This gain can be strong incentive to collude. (Janssen, 2004)

3.10 The effect of minimum bid increment and the deposit on revenue

In practice, there are often several rules of the auction which have to be satisfied. For instance, an auction deposit, which is the amount of money that is needed in order to participate in the auction, can be required. Or a minimum increment bid which is the lowest amount by which a bid can be raised. The impact of an auction deposit or a minimum bid increment[28] has already been studied in auction theory. Tukiainen (2011) found out in his empirical analysis that a non-zero minimum bid increment is optimal. The effect of deposit has been studied by Waehrer (1994), he found out that a deposit has no or negative impact on the revenue. The effects of minimum bid increment and deposit in case of public property sales will be estimated in the following section of the work.

This was brief introduction of the auction theory linked to the aim of the work. The other possible violations of the assumptions made above will be discussed directly within the issue of comparison of *public auctions* and *first-price sealed-bid*

[26] While we expect bids to be correct on average, the highest one overestimates the true value.

[27] If all assumptions made above were satisfied.

[28] Minimum bid increment is the lowest amount by which a bid can be raised. Again in the model, it is used as fraction of the estimated price.

auctions. The theoretical predictions and empirical evidence from public property sales follows.

4 A comparison of public property sales methods

4.1 A theoretical comparison of first-price sealed-bid auction and English auction

The theoretical comparison of auction methods was frequently discussed in auction theory. According to the already mentioned Revenue Equivalence Theorem, the revenue of English, Dutch, first-price and second-price sealed-bid auction would be the same. However, the theorem holds only under the strict set of assumptions which were mentioned in theoretical section of the work. If these assumptions were not satisfied, the payoff could be different for different auction mechanisms and there would be clear prediction about dominance of one of auction mechanisms. (Chow and Ooi, 2012)

In the following paragraphs the possible violations of the theorem that leads to a dominance of either *public auction* or *first-price sealed-bid* will be discussed. Firstly, let us relax the assumption of symmetric[29] bidders. As it was predicted in the previous chapter, *first-price sealed-bid* auction and Dutch auction are expected to generate higher revenue then English and second-price sealed-bid auction in this case. Consequently, *first-price sealed-bid auction* should be preferred over *public auction* if revenue maximization is the case.

Secondly, the theorem does not hold if the assumption of risk-neutral bidders is relaxed. Let us assume risk-averse bidders. In open auctions, the optimal strategy for the bidder *i* is still to wait until his estimation of value is reached and then drop out. Hence the output remains the same. On the contrary in sealed-bid auctions, the output would be different. The risk-averse bidders do not want to risk of losing the auction, and therefore, bid higher. So in case of risk-averse bidders, the predicted revenue is again higher in *first-price sealed-bid* auction then in the *public auction*. (Maskin and Riley, 1985)

[29] Symmetric bidders mean that the joint probability distribution function from which the bidders' values are drawn is identical for all bidders. (Maskin and Riley, 1998)

The next theoretical prediction of the dominance[30] of sealed-bid auction mechanisms is based on collusion effect. To compare open auctions and sealed-bid auctions in terms of collusive behaviour, it is good to point out that the basic difference between the English auction and sealed-bid auction is that bidders can observe other bidders behaviour. (Graham and Marshall, 1987) Therefore, they can inspect each other's behaviour and the possibility of collusion is generally higher. (Chow and Ooi, 2012)

Further, Robinson (1983) pointed out that if some conditions[31] are satisfied collusion is a dominant strategy for English auction mechanism (i.e. for *public auction*). Using the arguments described above and Robinson's theorem, it is possible to conclude that the expected revenue should be higher in sealed-bid auctions and that sealed-bid auctions are prevention of collusion. (Chow and Ooi, 2012)

These three cases described situations in which *first-price sealed-bid auction* should dominate over *public auction*. However, there is also situation in which *public auction* should dominate over *first-price sealed-bid auction*. This situation is described in the following paragraph.

In a general model developed by Milgrom and Weber (1982), the dominance of English auction mechanism over all other common auction mechanisms[32] is predicted. This prediction implies that *public auction* should generate higher revenues than other methods of public property sales. The theoretical prediction is based on winners' curse effect. This phenomenon means that, in open auctions, bidders can inspect other bidders' behavior during the auction; therefore, they can get additional information about the value of the object from other bidders' behavior, and consequently they will bid more aggressively.

These four predictions were theoretical results about which auction mechanism generates higher revenue. However, there are also previous natural economic experiments that compare the revenues. One of the first papers dealing with the experimental auction mechanism comparison is Johnson's (1979) "Oral Auction

[30] "Dominance" is meant in terms of expected revenue.

[31] The exact theorem states: In the common value model, if all members have the same information:

(I) any cartel solution giving a positive fraction of profits to every member is a dominant strategy equilibrium for the English and second-price auctions, but

(II) no cartel solution is an equilibrium in a non-repeated first-price auction if any cartel member earns a positive expected profits. (Robinson, 1983)

[32] Dutch, first-price sealed-bid bid, and second-price sealed-bid auction mechanisms.

versus Sealed Bids: An Empirical Investigation". In this paper, the data from Forest Service timber sales in the United States were used. It is optimal data-set, because historically both open and sealed-bid auctions were used. Johnson has shown that sealed-bid mechanism generates higher yield in case of non-homogenous[33] bidders. This is exactly the case which was predicted in the theoretical section about asymmetric bidders.

Newer data from U.S. timber auctions were studied by Athey, Levin, and Seira (2011). This study again confirmed the previous result that sealed-bid auctions dominate in this case and it also pointed out that sealed-bid auction attracts larger amount of small bidders.

There is also Chow and Ooi's (2012) paper about real estate auction which is more relevant to this work because it is focused on real estate sales. It compares first-price sealed-bid tender and English auction. The data from 145 land sales program at Kew Drive, Singapore are used. There were 86% of parcels sold through the sealed-bid auction and the through English auction. Generally, the data-set is similarly large and it is also structurally similar. The result was completely different than in the previous papers. They estimated, using the classic hedonic pricing model[34], that the revenue in sealed-bid tenders is about 7.5% lower than in English auction.

4.2 The data

In order to compare methods of public property sales, a sample of 405 auctions was collected out of which 137 auctions were successful. The rest of them failed. The data comes from two sources. A part of the dataset containing *public auctions* comes from *Centralni adresa*. This source has been chosen, because a *public auction* of immovable property has to be announced on this portal. A part of the dataset containing *first-price sealed-bid auctions* is a dataset provided by JH Partners, s.r.o. and enriched by the data collected by using "Act No. 106/1999 Coll. on Free Access to Information" which allows anyone to ask for information from public subjects. This method of collecting may potentially cause selection bias, because the data-set

[33] "Homogeneity as defined here is an important concept because it implies that no bidder possesses a known a priori advantage over any other bidder." (Johnson, 1979, p. 317) "The conditions of homogeneity can also be stated in a manner analogous to a parlor game where there are n bidders, each drawing a value at random from the same well-defined distribution"

[34] Hedonic model assumes that price of property is determined by its attributes or characteristics. (Rosen, 1974)

contains only those auctions about which public subjects provided data. Specifically, 44 public subjects such as cities, ministries etc. were asked, 75% of them answered; however, only 38% of public subjects provided relevant data. The rest of them answered either that no bidder bid or that special payment for very difficult and costly search is required in order to receive the data. Generally, it seems that the auctions, about which the information were obtained, and the rest of the auctions do not differ in terms of opening bids, auction deposits et cetera. Therefore, it is reasonable to expect that the omitted auctions are not strongly correlated with the independent variables, and consequently, the bias should not be significant. The brief description of the data containing successful auctions follows.

The dataset consists of 95 *public auctions* – i.e. English auctions and 42 tenders – i.e. *first-price sealed-bid auctions*. A majority of *public auctions* is run by self-governing territorial units such as cities. Tenders were run by ministries, regions, and cities as well. The property sold was unneeded real estate and it was sold for 195 969 472 CZK[35] in total. The total revenue from *public auctions* is 62 011 212 CZK and the total revenue from *first-price sealed-bid auctions* is 136 721 298 CZK.

4.3 A comparison of the revenue ratios from the sales through public auctions and through first-price sealed-bid auctions

For this moment, the revenue ratio is defined as $Revenue\ Ratio = \frac{Realised\ Price}{Estimated\ Price}$. This ratio will be used to compare the revenues. In order to choose suitable method for the revenue ratios comparison, firstly, it is necessary to find out whether the data are normally distributed. Therefore, Shapiro–Wilk test, and Shapiro–Francia tests were run. The p-values obtained from both tests are indistinguishable from zero; hence, the null hypothesis of normality of the data was rejected and Mann-Whitney two-sample test, which is non-parametric, and therefore, robust to non-normality, was used for the comparisons.

4.3.2 The hypothesis

This work is focused on the difference between revenues from *public auction*s and *first-price sealed-bid auctions*. Hence, the hypotheses states:

[35] It is an equivalent for approximately 10 004 056 USD (the average exchange rate by Czech National Bank in 2012 was 19.589 CZK per 1 USD).

H_0: There is no difference between the revenue ratios from *public auctions* and *first-price sealed-bid auctions*.

H_A: The revenue ratios are higher in case of *first-price sealed-bid auctions*.

Table 4.1: Mann-Whitney test of the revenues ratios

	Standard z-scores	P-value (one-sided)	Significance
The revenues ratios based on the estimated prices	-3.962	0.00005	***

Source: author's computations.

In the Table 4.1., there are the results of the test. The null hypothesis is rejected at 1% significance level. It suggests that the revenue ratios from the sales through *public auctions* and through *first-price sealed-bid auctions* are statistically different and it also suggests that *first-price sealed-bid auctions* generate relatively higher revenue than *public auctions*. However as it was mentioned in the theoretical section of the work, the opening bid has to be[36] higher or equal to the estimated price in case of sealed-bid auctions. If this is the case then majority or all of the revenue ratios based on the estimated prices should be higher than 1 and it may cause selection bias in the model. The evidence that this is the case is in the Table 4.2. The table shows the revenue ratio distribution and it confirms that all of the quantiles stated in the table, which are 5th, 25th, 50th, 75th, and 95th, are higher or equal to 1 in case of *sealed-bid auctions*.

Table 4.2: The quantiles from the revenue ratio distribution

	Base Price	5%	25%	50%	75%	95%
Public auctions	Estimated	.7	.8234	.9333	1.0833	1.4815
First-price sealed-bid auctions	Estimated	1	1.0012	1.0211	1.1070	1.6154

Source: author's computations.

[36] There are a few exceptions, the details are provided in the Section 2.5.

Figure 4.1 demonstrates the same thing graphically. The upper histogram shows the distribution of *revenue ratios* in case of *first-price sealed-bid auctions* and the lower one shows the distribution in case of *public auctions*. It is obvious that there are only a few exceptions and the majority of the ratios in case of *first-price sealed-bid auctions* are really higher than 1. On the other hand, the revenue ratios in case of *public auctions* are more or less normally distributed.

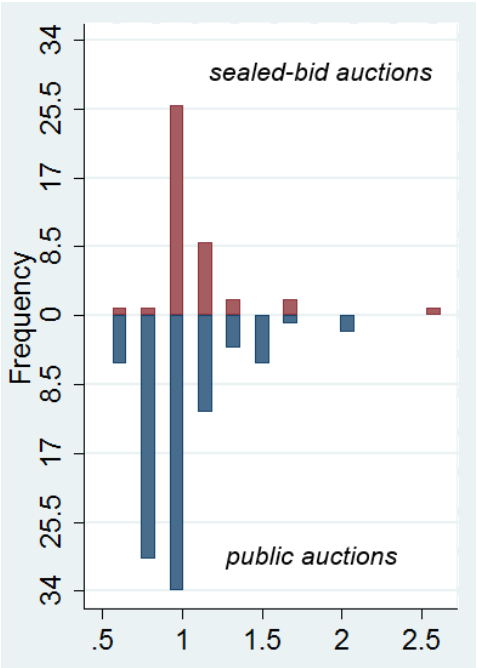

Figure 4.1: Histograms of the estimation ratios

This result may suggest that the estimated prices of properties sold through *first-price sealed-bid auctions* were underestimated, because the realized price of the majority of them are higher than the estimated price[37]. The seller's incentive to lower the estimated price may be higher in case of *sealed-bid auctions* since there is explicit threat of not-selling the property if the estimated price is high, because, as it was mentioned above, in this case the opening bid has to be generally[38] higher or equal to the estimated price. In order to prove this hypothesis statistically, let us firstly define *administrative price* and then *estimation ratio*. As it was discussed earlier, pricing maps[39] provide unbiased price estimation which is common for both methods of sale. The price estimation obtained from pricing maps is further called an *administrative price*. The *estimation ratio* is defined as $\frac{estimated\ price}{administrative\ price}$. If this ratio is higher than

[37] I.e. the revenue ratio based on the estimated price is higher than 1.

[38] The details are provided in the Section 2.5.

[39] Pricing maps are introduced in the Section 2.7 and the detailed description is provided in the Appendix A.

1 then the property is either better quality than the average property in the area or it is overestimated. However, if the *estimation ratio* was lower on average in case of *first-price sealed-bid auctions* than in case of *public auctions* then it would be possible to say that the estimated price in case of *first-price sealed-bid auction* underestimates the true value of property at least in comparison with *public auction* estimates. Non-parametric Mann-Whitney two-sample test will be employed in order to prove it. The hypotheses states:

H_0: There is no difference between the estimation ratios from *public auctions* and *first-price sealed-bid auctions*.

H_A: The estimation ratios are lower in case of *first-price sealed-bid auctions*.

Table 4.3: Mann-Whitney test of the estimation ratios

	Standard z-scores	P-value (one-sided)	Significance
The estimation ratio based	-2.925	0.0017	**

Source: author's computations.

The results of the test are in the Table 4.3 and the null hypothesis, which states that the estimation ratios are equal, is rejected at 1% significance level, because the p-value is equal to 0.17%. This result indicates that in comparison with *public auctions* estimated prices are underestimated in case of *first-price sealed-bid auctions*. This result is even stronger, because it does not take into account the failed auctions which are the auctions where no one was willing to pay the estimated price or more, i.e., the opening minimum bid was higher than the market price[40]. It is important to point out that there were relatively more failed *first-price sealed-bid auctions* than failed *public auctions*. More precise comparison of the rates of failed auctions follows.

4.3.2 Comparison of the rates of failed auctions

As it was mentioned in the section about the data-set, there were run 405 auctions out of which 137 successful auctions. A rate of failed auctions is for purposes of the work defined as $\frac{number\ of\ failed\ auctions}{total\ number\ of\ auctions}$. The rate of failed auctions in case of *first-price sealed-bid auctions* is 75.8% which means that over three quarters of *first-price sealed-bid auctions* failed. In case of *public auctions*, the rate is 58.7%. In order to

[40] This proposition assumes that the potential bidders were informed about the auction.

statistically prove that the rates of failed auctions are not equal, the two sample binomial test was run. The hypotheses states:

H_0: The probability that auction fails is the same for both methods of sale.

H_A: The failed auctions are more likely to occur in case of *first-price sealed-bid auctions*.

The one-sided p-value obtained from the test is equal 0.00015; therefore, the null hypothesis is rejected at 0.1% significance level and the result indicates that the rate of failed auction is higher in case of *first-price sealed-bid auctions*. This result may be explained by the stricter regulation of publicity in case of *public auctions.* The regulation, inter alia, means the compulsory disclosure on the *Centralni adresa*[41] and disclosure on the locally common place (see the Section 2.5).

4.4 Comparison of the quantiles

In the paragraph above, it was found out that the rate of failed auctions is very high and also that the rate is different for both methods of sale. Therefore, it might be reasonable to include failed auctions in the data-set and then compare the quantiles of the distribution of the revenue ratios. The revenue ratios based on the administrative price are used in this comparison for two reasons. Firstly, these prices are determined in the same manner for both methods of sale, and secondly, they are not biased. The distributions of the revenue ratios are in the Table 4.4.

Table 4.4: The quantiles from the revenue ratios' distributions

	5%	10%	25%	50%	75%	85%	90%	95%
Public auctions	0	0	0	0	.486	0.682	0.732	0.843
First-price sealed-bid auctions	0	0	0	0	0	0.672	0.721	1.011

Source: author's computations.

This table corresponds with the above proposition that the majority of auctions failed. It also confirms that the rate of failed auctions is higher in case of *first-price sealed-bid auctions*. However, there is a remarkable result which is that the revenue ratios are almost equal for both methods of sale in the 85th and in the 90th

[41] *Centralni adresa* is a web portal about public auctions and procurements available at http://www.centralniadresa.cz/cadr/.

quantile. The distributions are shifted by failed auctions to one side; however, if this shift is taken into account, the revenue ratios based on the administrative prices are very similar. This is interesting result, because it confirms that the Revenue Equivalence Theorem holds under these circumstances and it shows that the revenues are similar despite of the method of sale used.

The one thing which may be different according to the distributions in the table is variance of the revenue ratios, because the 75^{th} and 95^{th} quantiles are more different comparing the case of *public actions* and the case of *first-price sealed-bid auctions*. This result also would not be too much surprising, because the random variables are proved not to be normally distributed. The formal statistical test of the equality of the variances follows.

4.5 Variance of the revenue ratios

In order to prove the hypothesis of inequality of the revenue ratios variances, the Brown–Forsythe test will be run. The hypotheses states:

H_0: There is no difference between the variances of the revenue ratios of successful *public auctions* and *first-price sealed-bid auctions*.

H_A: The variances of the revenue ratios are higher in case of *first-price sealed-bid auctions*.

The results of the test are in the Table 4.3.

Table 4.5: Brown–Forsythe test of the equality of the variances

	Variance	Coefficient of variation[42]	W statistics	P-value	Significance
Public auctions	.0447	.3635	9.3864	.0027	**
First-price sealed-bid	.3486	.6205			

Source: author's computations.

The null hypothesis states that the variances are equal across the groups. Because the p-value obtained from the Brown–Forsythe test is equal to 0.27%, the null hypothesis is rejected at 1% significance level. This result suggests that the variances are not equal across the groups and that the variance of the revenue ratio in

[42] The coefficient of variation is defined as the standard deviation over the mean.

case of *first-price sealed-bid auction* is much larger than in case of *public auction*. Consequently, the result suggests that a public subject can expect the revenue to be not very different[43] from the administrative price when selling the object through a *public auction*. On the contrary, in case of *first-price sealed-bid auctions* a public subject can expect the revenue to vary from the administrative price.

4.6 Estimation of the effect of deposit and minimum bid increment on revenue

As it was mentioned in the Section 3.10., the effect of deposit and minimum bid increment on the revenue has already been studied; therefore, it might be interesting to find out if these parameters also influence the revenue in case of public property sales.

In sealed-bid auctions, a minimum bid is always equal to zero[44]. On the contrary in *public auctions*, a minimum bid increment varies from 4 000 to 10 000 CZK. Deposits vary across both methods of sale. In order to make the estimation of the effects, two separate models were developed.

In case of *public auctions*, the model uses a revenue ratio based on the administrative price[45] as dependent variable. The independent variables are *minimum opening bid, minimum bid increment, auction deposit,* and *days*. *Minimum opening bid* is the lowest first bid that is accepted, and in the model, it is used as fraction of the estimated price. So for example, if minimum opening bid is 100 000 and the estimated price is 200 000 CZK. Then the value of the variable *minimum opening bid* is equal to 0.5[46]. *Minimum bid increment* and *auction deposit* are also used as fraction of the estimated price. Variable *days* denote the time (in days) between the auction announcement and the auction itself. Since it is reasonable to expect that the longer the time between the announcement and the auction itself is, the more bidders are

[43] In fact, the tests suggest that the revenue would slightly lower.

[44] This holds at least for the data-set used in this work.

[45] The administrative prices are preferred for two reasons. Firstly, the administrative prices are determined in the same way for both methods of sale. Secondly, the administrative prices cannot be manipulated, and therefore, they do not suffer from endogeneity.

[46] $\frac{opening\,bid}{estimated\ price} = \frac{100000}{200000}$

attracted, and consequently, the higher revenue can be. Due to the fact that a simple OLS[47] estimation shows that the data sample contains many outliers, Robust regression was employed to estimated the model. (UCLA , n.d.) The results of the estimation are in the Table 4.7.

Table 4.6: The estimation of the model in case of public auctions

	Coefficient	Standard error	P-value	Significance
Minimum opening bid	1.058418	.0536937	0.000	***
Minimum bid increment	5.45091	3.646172	0.139	ns
Auction deposit	-.4749369	.4372672	0.281	ns
Days	-.0015222	.0019549	0.438	ns
Days squared	7.68e-06	.000011	0.489	ns
Constant	.0542847	.0564718	0.339	ns

Source: author's computations.

The model suggests that the only significant coefficient is coefficient for *minimum opening bid*. The significance and the fact that this coefficient is positive, was expected for two reasons. Firstly, the opening bid gives information about the seller's valuation of the object. The seller has additional information that is not contained within the administrative price. So if the seller believes that the object sold is property of high quality and it will be sold despite of the relatively high price[48], he will prefer high *minimum opening bid*. On the contrary, in case if he does not believe that the property will be sold, he will rather choose low *minimum opening bid*[49]. Secondly, an opening bid acts as a protection against low revenue - i.e. in the same manner as a reserve price. The higher the reserve price is, the higher the revenue. However, it is necessary to notice that a high reserve price lowers the probability of successful sale. (McAfee and Vincent, 1992) Since there are only successful (realized) auctions in the data, the higher opening bid should lead to the higher revenue of the auction which is exactly what was obtained (a positive significant coefficient). The rest coefficients are insignificant. So the expectations about *deposit* and *minimum bid increment* were not confirmed and it is possible to conclude that the

[47] The OLS estimation is in Appendix B.

[48] Relatively is meant here in comparison with the estimated price.

[49] This may also be related to the seller's relation to risk. Risk-averse one will prefer the certainty and will choose low *minimum opening bid*, and vice versa, risk-lover may choose high *minimum opening bid* while hoping that the property will be sold at a high price.

auctions work similarly to the perfect market since the procedural parameters of auction do not interfere with auction result, which may thus be seen as efficient.

In case of sealed-bid auctions, the variables remained almost the same. *Minimum bid increment* was excluded because of perfect collinearity (*minimum bid increment* is equal to 0 in every observation). In order to examine the optimal time between the announcement and the successful auction, variable *days squared* was included into the regression because the long time can reveal the unattractiveness of the object as it needs many unsuccessful rounds[50] until the auction is successful.

The results of Robust regression are almost the same as in the case of *public auctions*. The coefficient for m*inimum opening bid* is significant, the rest of coefficients are not.

Table 4.7: The estimation of the model in case of sealed-bid auctions

	Coefficient	Standard error	P-value	Significance
Minimum opening bid	.9944731	.0102341	0.000	***
Auction deposit	.1234941	.0986239	0.221	ns
Days	.0002581	.0003731	0.495	ns
Days squared	-1.03e-06	3.09e-06	0.743	ns
Constant	.0061959	.0108937	0.574	ns

Source: author's computations.

The coefficient for *minimum opening bid* is positive and it is not very different from coefficient for *minimum opening bid* in case of *public auctions* which confirms that the both methods of sale work similarly.

[50] In most cases, auction rounds repeat after a few weeks and the minimum opening bid is often lowered for the next round.

5 Conclusion

The aim of the thesis was to compare public methods of property sales in the Czech Republic. There are two common mechanisms. These are *public auctions*, which are regulated form[51] of an English auction, and *first-price sealed-bid auctions* which are regulated only by the general laws about disposing of public property.

The empirical comparison of revenues dealt with the issue of selection bias because according to the law, for the most of *first-price sealed-bid auctions*, the opening bid has to be higher or equal to the estimated price[52]. Therefore, the observed revenues are mostly higher than the estimated price when selling through *first-price sealed-bid auctions.* Since there is explicit threat of not-selling the property if estimate is high (for sealed bid auctions), there is clear motivation for pushing these estimates down. Hence, the comparison of the ratios of the estimated price to the unbiased benchmark of the property's value, which is the administrative price, was made. This ratio is high if the estimated price of the property is higher than the average price in the area (i.e. the administrative price). It turns out that the ratio is significantly lower in case of *first-price sealed-bid auctions* which indicates that the properties sold through *first-price sealed-bid auctions* are underestimated more often.

Because of the fact that the estimated price appeared to be biased, the administrative prices were used instead of estimated price. Using these adjusted data, it was showed that the revenues are very similar in both methods of sale. Consequently, the theoretical prediction of the Revenue Equivalence Theorem was partially confirmed[53] in this case.

Despite of the underestimation in case of *sealed-bid auctions*, the rate of failed auctions is significantly lower when selling through *public auction* which can be explained by stricter regulation of publicity. This result might make *public auctions* preferable method of sale and this attractiveness of *public auctions* is also

[51] There is a special act that deals with public auctions. This act is described in the Section 2.5.

[52] There are some exceptions and these are described also in the Section 2.5.

[53] It confirms only part of the theorem because the theorem states the equivalence of four auction mechanisms. In this work, only two of them were confirmed.

supported by the lower variance of the revenue ratios[54], because it makes the future revenue more predictable for public subjects.

This work does not discuss all the issues linked to public property sales and it can be extended in at least two ways. Firstly, the transaction costs of both methods can be discussed, because the difference in these costs might influence attractiveness of the methods. Secondly, it would be interesting to analyze which parameters of the auction increases the probability of sale. This result may also have large policy implication, because the parameters of the auction proved to increase probability of successful sale should help in designing auctions.

[54] The revenue ratio is defined as the realized price over the administrative price.

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Appendix A: Pricing maps

The pricing maps used in the work can be divided into two groups: the pricing maps made by local authorities and the pricing map made by ARK ČR.

The pricing maps made by local authorities were used for price estimation of contruction sites. These are four pricing maps for large cities and the last pricing map contains prices for the rest of the Czech Republic.

- Prague's pricing map available at http://wgp.praha-mesto.cz/tms/projects_h/cmp08/.
- Mladá Boleslav's pricing map available at http://twist.mb-net.cz/tms/cenmapa_a/#c=-703920%252C-1011770&z=5&l=ortomb2008,cenmapa,dkm,pop,copy&p=&.
- Ostrava's pricing map available at http://gisova.ostrava.cz/webmaps/mapacena/viewer.htm.
- Brno's pricing map available at http://gis.brno.cz/tms/cenovamapa_a/.
- For the rest of the country, the database ofr price prepared by Česká společnost certifikovaných odhadců majetku was[55] used. It is available at http://www.cscom.cz/ceny_pozemku.php.

These sources provide price per square meter. If the area of the property is not available and it is reasonable, the average area of the similar building or flar is used. Avarage areas according to CSB and MMR were used.

[55] This is a professional association of valuers of the Czech Republic.

Appendix B: OLS estimation

```
. regress revenue_fr_a price_fr_a min_bid_fr_a deposit_fr_a days days_sq if tender==0

      Source |       SS       df       MS              Number of obs =      89
-------------+------------------------------           F(  5,    83) =  182.61
       Model |  3.60682202     5  .721364403           Prob > F      =  0.0000
    Residual |  .327878428    83  .003950343           R-squared     =  0.9167
-------------+------------------------------           Adj R-squared =  0.9117
       Total |  3.93470044    88  .044712505           Root MSE      =  .06285

------------------------------------------------------------------------------
revenue_fr_a |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  price_fr_a |   1.056605   .0487459    21.68   0.000     .9596512    1.153558
min_bid_fr_a |   5.887153   3.310182     1.78   0.079    -.6966659    12.47097
deposit_fr_a |  -.4806906   .3969735    -1.21   0.229    -1.270255    .3088737
        days |  -.0014382   .0017748    -0.81   0.420    -.0049682    .0020917
     days_sq |   7.24e-06     .00001     0.72   0.472    -.0000127    .0000272
       _cons |   .0539807    .051268     1.05   0.295    -.0479892    .1559506
------------------------------------------------------------------------------

. regress revenue_fr_a price_fr_a min_bid_fr_a deposit_fr_a days days_sq if tender==1
note: min_bid_fr_a omitted because of collinearity

      Source |       SS       df       MS              Number of obs =      33
-------------+------------------------------           F(  4,    28) =   10.95
       Model |  6.80509167     4  1.70127292           Prob > F      =  0.0000
    Residual |  4.35128878    28  .155403171           R-squared     =  0.6100
-------------+------------------------------           Adj R-squared =  0.5543
       Total |  11.1563804    32  .348636889           Root MSE      =  .39421

------------------------------------------------------------------------------
revenue_fr_a |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  price_fr_a |   1.088221   .2129462     5.11   0.000     .6520208    1.524422
min_bid_fr_a |          0  (omitted)
deposit_fr_a |  -1.393469   1.971677    -0.71   0.486    -5.432266    2.645327
        days |  -.0003786   .0022305    -0.17   0.866    -.0049477    .0041904
     days_sq |   2.03e-07   3.14e-06     0.06   0.949    -6.22e-06    6.63e-06
       _cons |   .1416551   .1997194     0.71   0.484    -.2674516    .5507617
------------------------------------------------------------------------------
```