



Empirical studies of auctions of non-distressed residential real estate

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Foreword

In the autumn 2007, the Association of the Swedish Real Estate Agents asked the Division for Building and Real Estate Economics at KTH to conduct an inquiry concerning brokers' price setting of tenant-owned apartments due to the hot debate in media at that time about the so-called underpricing strategy, which consists of setting a list price considerably below the expected selling price, commonly used by real estate agents and that supposedly harmed consumers' confidence in brokers. The two main objectives of the investigation were to quantify the occurrence of underpricing and to examine in more detail brokers' rationale when setting list prices and how they perceived the use of underpricing.

Professor Hans Lind, who received the research request, assigned a large part of this project to me, where I conducted interviews with brokers in Stockholm and Västerås and gathered data on list and sales prices of condominium apartments in these two markets. The question seemed simple and straightforward to answer at first, but it proved to be much more challenging than I thought: how to define *underpricing*? Given that basically all apartments are sold through ascending-bid auctions in these two markets, it is natural that the final sales price exceeds the list price in most cases. But where to draw the line of what is an "acceptable" list price and what is a "deceiving" one? Should underprice be measured as the difference between list price and final transaction price or, because transaction price is also determined by buyers' private preferences and motivations, should underprice instead be related to the difference between list price and brokers' expected sales price (market value)? These and many other questions that popped-up during the investigation were never answered in the report delivered to the Association of the Swedish Real Estate Agents. The reason was simple: there were not sufficient empirical data available for a deeper analysis. Nevertheless, these questions became the first seeds that led to even more questions related to the Swedish housing market's most common and debated sales mechanism and which I attempt to answer in the present doctoral thesis.

Stockholm, February 22nd, 2019.

Rosane Hungria Gunnelin

Abstract

Real estate auctions have become a popular sales mechanism in Sweden in the past couple of decades when the internet facilitated the marketing of properties for sale. With the possibility to display several exterior and interior pictures of the property rather than the single façade picture style of traditional newspapers advertisements, and a more detailed description of the object, brokers significantly increased the number of potential buyers at the showings of properties for sale. The increase in the number of visitors has, especially in the larger cities in Sweden, increased the frequency of bidding wars, in which the winning bid ends far above the list price. Many auction participants, especially those who are inexperienced, perceive the auction-based sales mechanism as very stressful considering that the purchase of a home is for most buyers the largest investment they will ever make. Therefore, the auction mechanism for selling homes is regularly debated in media, among politicians and by regulatory bodies. The scientific literature analyzing auctions of non-distressed homes is, however, very limited. Hence, the debate and analysis of the Swedish auction-based sales mechanism has little empirical evidence to lean on. A main reason for the lack of scientific work in this area is the difficulty to obtain sufficiently detailed auction data to study how sellers' list price strategy and auction participants bidding strategies affect the outcome of real estate auction auctions and the occurrence of a winner's curse.

The overall aim of this thesis is to study how sellers' list price strategy and bidding strategies of auction participants affect the outcome of auctions of non-distressed residential homes. The thesis is empirical and comprises four papers that analyze the housing markets in Stockholm and Gothenburg. *Papers 1* and *2* analyze sales of condominium apartments in Central Stockholm, while *Paper 3* analyzes sales of single-family homes in Stockholm County. *Paper 4* analyzes sales of condominium apartments in Gothenburg.

Papers 1, 2 and *3* contribute to the empirical auction literature by studying how the number of bidders, the seller's list price strategy and auction participants bidding strategies affect the unfolding of auctions and the resulting transaction price. Using a hedonic model *Paper 1* analyzes how the number of bidders affects the transaction price. *Paper 2* extends the database in *Paper 1* to cover a longer time period and develops the hedonic model in *Paper 1* by adding explanatory variables describing the seller's list price strategy and auction participants bidding strategies. *Paper 3* develops the hedonic model in *Paper 2* by incorporating a more thorough analysis of possible omitted variable bias and further employs methods used in the previous empirical literature to mitigate omitted variable bias by including as explanatory variable the residuals from a price regression of previous sales, as well as the residuals from a list price regression. Furthermore, the paper estimates how list price and bidding strategies affect the probability of a winner's curse.

Paper 4 studies auctions of condominiums in Gothenburg, but with a different focus than *Papers 1, 2* and *3* since detailed auction data was not available. The paper instead focuses on how sellers' list price strategy affect sales price and time-on-market, and how information asymmetry between brokers and sellers, combined with brokers' commission fee structures, affect the choice of list price.

Keywords: *housing market, auctions, underpricing, bidding strategies, time-on-market, brokers' commission fee structures, information asymmetry, winner's curse.*

Sammanfattning

Fastighetsauktioner har blivit en populär försäljningsmekanism i Sverige under de senaste decennierna samtidigt som internet har underlättat marknadsföringen av fastigheter till salu. Möjligheten att enkelt visa ett flertal exteriör- och interiörbilder av fastigheter i internetbaserade försäljningsportaler, i kombination med en detaljerad beskrivning av objekten, har ökat antalet potentiella köpare som kommer till visningar av fastigheter till salu. Ökningen av antalet spekulanter har, särskilt i storstadsregionerna i Sverige, ökat sannolikheten för budstrider där det vinnande budet slutar långt över det annonserade utgångspriset. Detta har medfört att det svenska auktionssystemet av många budgivare, särskilt oerfarna, upplevs som mycket stressande eftersom ett bostadsköp i de flesta fall är den största investering de gör i sitt liv. I media, bland politiker och i tillsynsorgan debatteras därför den svenska försäljningsmodellen regelbundet. Samtidigt är det empiriska och vetenskapliga underlaget för analyser av det svenska auktionssystemet mycket begränsat. Anledningen är framför allt brist på data från auktioner av bostäder som är tillräckligt detaljerad för att studera hur olika försäljnings- och budgivningsstrategier påverkar försäljningspris samt risken att den vinnande budgivaren överbetalar för bostaden, så kallad "winner's curse".

Det övergripande syftet med denna avhandling är att studera hur säljares prissättningsstrategi samt köpares budgivningsstrategier påverkar utfallet vid auktioner av bostäder vid frivilliga (icke exekutiva) försäljningar. Avhandlingen är empirisk och omfattar fyra artiklar. *Artikel 1* och *2* analyserar transaktioner av bostadsrätter i centrala Stockholm, medan *Artikel 3* analyserar transaktioner av enfamiljshus i Stockholms län. *Artikel 4* analyserar transaktioner av bostadsrätter i Göteborg.

Artikel 1, 2 och *3* bidrar till den empiriska auktionslitteraturen genom att studera hur antal budgivare samt säljares och budgivares auktionsstrategier påverkar auktionsförloppet och slutligt försäljningspris. I *Artikel 1* studeras med hjälp av en hedonisk modell hur antal budgivare påverkar försäljningspriset. *Artikel 2* utökar databasen i artikel 1 tidsmässigt samt utvecklar den hedoniska modellen genom att lägga till förklaringsvariabler som beskriver budgivningsstrategier samt säljarnas strategi vid val av utgångspris. *Artikel 3* utvecklar den hedoniska modellen i *Artikel 2*, dels genom en grundligare analys av bias vid estimering av de hedoniska modellerna och dels genom att använda modellspecificeringar som syftar till att minska sådan bias. Vidare studeras hur säljares och köpares auktionsstrategier påverkar sannolikheten att den vinnande budgivaren betalar för mycket för fastigheten, dvs. sannolikheten att en "winner's curse" uppstår.

Artikel 4 studerar auktioner av bostadsrätter i Göteborg, dock med ett annat fokus än de tre första artiklarna i och med att detaljerad auktionsdata inte var tillgänglig. Artikeln fokuserar istället på hur val av utgångspris i auktioner påverkar försäljningspriset och hur lång tid det tar att sälja en bostadsrätt samt hur informationssymmetri mellan mäklare och säljare kombinerat med mäklarnas provisionsstruktur påverkar val av utgångspris.

Nyckelord: bostadsmarknad, auktioner, underprissättning, budgivningsstrategier, time-on-market, provisionsstruktur, informationsasymmetri, winner's curse.

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Appended Papers:

- Essay 1: Hungria-Gunnelin, R. (2013), "Impact of Number of Bidders on Sale Price of Auctioned Condominium Apartments in Stockholm", *International Real Estate Review*, Vol. 16 No. 3, pp. 274-295.
- Essay 2: Hungria-Gunnelin, R. (2018), "An analysis of auction strategies in apartment sales", *Journal of European Real Estate Research*, 11(2), 202-233.
- Essay 3: Hungria-Gunnelin, R., "Bidding strategies and winner's curse in auctions of non-distressed residential real estate", *Working paper*.
- Essay 4: Hungria-Gunnelin, R., Kopsch, F. and Enegren, C.J., "Real estate agents' list price strategies – Higher sales price, shorter time on the market or asymmetric information?", *Working paper*.

Cover Essay

1 Introduction

Auction is a popular sales mechanism in different market places for durable goods and various types of exploration, development and production contracts. Real estate, mineral rights, oil exploration, development contracts, and public procurement contracts are examples of items offered at auctions. Given the broad access to the internet and the advancement of technologies to create online platforms for the exchange of goods, auctions have further become popular among individuals who may sell items, including e.g. residential real estate, to a larger number of prospective buyers.

The degree to which auction is used as a sales mechanism for non-distressed homes vary depending on country and property market. Countries in which auctions are common are Australia, New Zealand, Scotland, Ireland, Denmark, Norway, and Sweden (Lusht, 1996; Hungria-Gunnelin, 2013; Chow *et al.*, 2015; Stevenson and Young, 2015). However, also in e.g. the US, where search and negotiation traditionally has been the dominant sales mechanism, sales through auction or in an auction-like environment have increased the last decade (Han and Strange, 2014).

Taking advantage of the increased market exposition of objects for sale, home brokers in Sweden have permanently embraced online advertisement of homes. The increased competition among bidders in residential real estate auctions has, especially in hot housing markets, given rise to so-called “bidding wars” with an increased risk of a phenomenon well-known in the auction literature called “winner’s curse”. Loosely, a winner’s curse means that the winner of an auction prevails by submitting a bid that is not only higher than the competing bids, but also higher than the true value of the object (Hahn and Seaman, 2009). Because the purchase of a home, for the majority of home owners, represents the largest transaction they will ever make, it is important to understand the dynamics of auctions and their outcomes. In the context of this thesis, my aim is to answer the following questions: how do sellers’ and auction participants’ list price and bidding strategies affect the selling price, the probability of a winner’s curse and the time on market for a home for sale?

Since selling and buying a home represents a very large transaction for (often inexperienced) buyers and sellers, it is not surprising that there exist a plethora of advices from brokers, real estate auctioneers and the media regarding optimal selling and bidding strategies. For example, brokers commonly recommend sellers to set a low list price in order to attract many potential buyers to showings of homes for sale in hope of getting as many bidders as possible at the following auction, which in turn is believed to increase selling price.

Some of the empirical results in this thesis, as well as results in previous research, in important ways disagree with common advices provided by real estate brokers, auction houses and media. Giving a “snapshot” of such advices, the following section provides a few quotes from articles in popular media found when searching the internet for advices on selling and bidding strategies related to real estate auctions. The quotes focus on advices related to the analysis in this thesis, namely list price setting, bidder competition, early and late jump bidding, late entry in the auction, bidding frenzy and the risk of overpaying for the home, that is, the risk of a winner’s curse. I do not claim that the quotes are a full and

fair representation of what can be compiled on the internet and I make no assessment regarding the quality of the source of the advices. I simply want to demonstrate what typically comes up in a random internet search. Interestingly, however, the questions examined in this thesis relates to some of the most common advices found.

List price strategy and bidder competition:

"Properties are priced low to create maximum awareness and excitement. However that doesn't mean a buyer is over-paying. In the Los Angeles market today, buyers looking at properties up to \$1.8 million can expect to automatically be in a multiple offer situations. According to Zillow, there are more than a dozen single-family homes listed in desirable West Los Angeles, with the lowest at an auction price of \$1.57 million. The list price has become more of a sales and advertising tool and less of a metric of value"

— Ben Belack for Residential Estate, Forbes, March 21, 2018.

"I will list a property on a Monday and hold an open house the following Saturday and Sunday, an hour or two each day. The goal is to get as much consistent, overlapping foot traffic as possible because it creates a sense of urgency for the serious buyers. If there are 20 people at a given time at an open house, even if only one buyer is serious, that one buyer is seeing 19 people as potential competition. If a buyer really loves a property, the perceived competition will make them more likely to up their bid in order to get their offer accepted."

— Chris Taylor for Advantage Real Estate, LighterSideofReal Estate.Com

Early jump bidding:

"Make a bold auction bid early on. This can be an effective strategy to effectively silence other bidders before they begin. It shows you don't want to waste time reaching the reserve and are happier bidding at the potential limits of other bidders' budgets."

— Nick Cadry for BuyEast Sidney, View.Com.Au

Late jump bidding:

"A strategy commonly employed by aggressive buyers, knockout bids send a clear message. The message is that you know what you're doing, you know the value of the property, you have the money and you intend to buy. Put simply, this strategy just involves watching a few starter bids be put forward, sticking to the interval the auctioneer has selected, maybe five or ten thousand, and then, coming in strong with a bid that doubles or triples the interval and takes the bid to a whole new level."

— Allan McDonald for SaleEzy.Com.Au, 4 July 2017

Late entry in the auction:

"One of the most common techniques used by bidders at auctions, and one that places more pressure on the agent, is to remain out of the game for as long as possible to see how the auction proceeds. The biggest risk of this strategy is if everyone else adopts it, the vendor may become dissatisfied with the level of interest in the property (due to a lack of auction bids) and pass the property in. The best way to decide whether to go in strong or hold back is to look at the other bidders."

– Nick Cadry for BuyEast Sidney, View.Com.Au

Bidding frenzy:

"One common strategy involves bidding quickly after any other auction bids, showing no signs of hesitation. Much like a poker game, this technique projects confidence and gives nothing away to other bidders. Bidding techniques are ultimately targeted towards slowing down the momentum of an auction, to keep the price low." –

Winner's curse:

"Once you're at the auction, it's very difficult to keep your cool and make a rational decision. To prepare for the auction, consider your strategy for two different scenarios: one if the auction is a dud and you're the only bidder, and the other if there are many bidders and the prices soar quickly past your limit. You should have a plan for each of these two cases and stick to it. This is the most important tip — ask yourself, are you willing to walk away if the bidding goes past your limit? If the answer is, 'no this is my dream place' then you're likely to overpay."

– Professor Sven Feldmann, Melbourne Business School, ABC News, 16 Mar 2018

"It can be easy to get swept up in the emotion of a bidding war; not only because you love the house, but also because it feels great to win! Yet, it's important to remember that it's just a house and there are other houses available."

– Sarah Davis, Money Under 30, September 19, 2018

The above quotes relate to several of the discussion topics that recurrently is brought up in the Swedish media, for example the critique of the common underpricing strategy with list prices far below final selling prices and the stressful situation for bidders in fast pacing auctions, which may lead inexperienced auction participants to overpay for a home in order to win the auction.

While a plentitude of advices and anecdotal evidence regarding optimal list price and bidding strategies exist as exemplified above, empirical analysis of these questions in the scientific real estate literature is sparse. A main reason is that detailed data that can be used to construct variables describing bidding strategies in residential real estate auctions is rare. Furthermore, when analysis of list price and bidding strategies is made in a statistical framework such as e.g. hedonic house price regressions, there is a

simultaneous need for detailed data on housing and geographical attributes in order to control for the heterogeneity that typically characterizes homes for sale, which is also difficult to obtain.

By using a unique dataset on auction transactions of condominiums and single-family houses in the Stockholm region during the time period 2010 – 2011, containing detailed information about the unfolding of the auctions, such as the size and time of each bid and identification code for each bidder and list and selling price, this thesis tries to close the gap between anecdotal evidence regarding list price and bidding strategies and quantified results from scientific examination of these strategies.

2 The Theoretical Framework

The framework for the thesis is mainly auction theory and classical theory of valuation of real assets, that is, the value of an asset represents the present value of the stream of utility or cash flow that the owner is entitled to. One may also include in the theoretical framework “property valuation theory”, even though this concept is perhaps not seen as a freestanding economic discipline or theory. Rather, it is the basis for quantitative and qualitative property valuation methods. In essence, the (unobservable) market value of a property is defined as the mean of a probability distribution of possible selling prices and actual observed transaction prices are a function of quantifiable attributes as well as purely random events, so-called transaction price noise (Geltner *et al.*, 2013). For example, a market value assessment is usually based on inference from prices of properties similar to the assessed property, so-called *comparable sales*, while the actual transaction price also depends on random events such as e.g. the unfolding of an auction of the property which, in an *ex ante* perspective, is a random event.

The thesis does not aim at making a theoretical contribution to the auction literature or the literature on valuation of real assets. Rather, the aim is to contribute to the empirical literature on hedonic property price modelling by incorporating explanatory variables describing list price and bidding strategies in auctions of non-distressed homes. Nevertheless, predictions from the theoretical auction literature, as well as results from the empirical literature, are natural starting points for the formulation of hypotheses regarding the relationship between auction-related explanatory variables and the sales price of homes. For example, a central prediction in the theoretical auction literature on common value auctions, supported by empirical evidence, is that the winning bid is increasing in the number of bidders (Kagel and Levin, 1986, Giliberto and Varaiya, 1989, Bajari and Hortacsu, 2003). A positive correlation between the number of bidders and observed transaction prices is also supported by anecdotal evidence from brokers active on the Stockholm housing market who recommend setting a low list price as a means to attract many bidders to the auction of a home for sale. There are, however, contrasting results in the literature where no relationship between the number of bidders and bidder returns has been found (see e.g. Boone and Mulherin (2008), who study corporate takeovers).

With a positive correlation between the number of bidders and the size of the winning bid in an auction as a starting point, several papers have examined the efficiency of strategies aimed at scaring off

competition, such as jump bidding and fast paced counter bidding. With respect to aggressive bidding in terms of the pace of counter-bidding, empirical findings are mainly that fast auctions do not scare off enough competition to lower the winning bid. On the contrary, the winning bid is increasing in the speed of the auction (Adam *et al.*, 2011). A common explanation for this result is based on the behavioral/psychology literature that draws a link between the speed of an auction and increased risk of so-called *auction fever*, where inexperienced bidders are lured to bid above the true value of the object for sale (Chen, 2011). Results regarding jump bidding are mixed (He and Popkowski Leszczyc, 2013). Another strategy studied in this thesis is so-called *late bidding*, where a bidder waits as long as possible before committing a bid, the rationale being that a late bidder may learn about the value of the item for sale from other bidders bids and simultaneously avoid sharing information through early bids (Ockenfels and Roth, 2006).

The general predictions and empirical findings in the auction literature regarding how bidding strategies, as well as other determinants of the unfolding of an auction, affect the size of the winning bid is directly related to the winner's curse phenomenon. Most industry professionals and academics seem to be of the opinion that the winner's curse is a real phenomenon in common value auctions. This opinion is also supported by empirical studies of the winner's curse in various industries and auction settings (Koch and Penczynski, 2018). However, most studies have analyzed the winner's curse indirectly. For example, an indirect test of the existence of a winner's curse is suggested by Milgrom and Weber (1982). Their model predicts that bidders will reduce their bids in response to increased number of bidders to compensate for the increased risk of a winner's curse due to increased competition. A testable hypothesis is, then, that the average bid in an N-bidder auction is lower than in an (N-1)-bidder auction (see e.g. Bajari and Hortaçsu (2003) for an application to eBay auctions). Other indirect tests examine whether or not variables related to the winner's curse according to auction theory, e.g. bidder competition or uncertainty about the true value of the auctioned item, affect auction revenues, which, while informative, does not explicitly measure the occurrence or severity of a winner's curse. As expressed by Boone and Mulherin (2008), "[in] empirical field studies, one difficulty in definitively determining the presence of the winner's curse is the lack of a benchmark market value for auctioned assets".

A research area in which the market value of the auctioned asset is observable is the study of auctions related to e.g. corporate takeovers of public companies, where prices of auctioned assets, i.e. securities of publicly traded companies, are observable. A well-known puzzle is the commonly observed negative return for the acquiring company following a takeover and a positive return for the company being acquired. One of the explanations to this empirical observation is that there exists a winner's curse in the bidding for the acquired company (Varaiya, 1988).

With respect to property auctions, determining the market values of auctioned asset for the purpose of studying the winner's curse phenomenon is not as straight forward as when studying e.g. takeovers of publicly traded firms, but compared to the majority of other illiquid assets sold through auctions, the market value of a home can be determined with rather good precision. Given a sufficiently rich database with information on transacted properties, statistical methods such as hedonic property price modelling are able to explain a very high fraction of variation in observed transaction prices. That is, such models

do a good job of estimating market values defined as the predicted price according to the estimated model.

Many sales of homes through auctions involve inexperienced or “naïve” bidders that may behave irrational and there exists an informational asymmetry between bidders and the seller of a property with respect to the quality of the object for sale. We can therefore expect the occurrence of a winner’s curse to be more common, and the degree of winner’s curse to be more severe, compared to property auctions, e.g. auctions of commercial properties, in which mainly experienced and more rational agents participate, (Gonçalves, 2008).

3 The Institutional Framework

Ascending-bid auction is widely used in the sales of basically all residential properties¹ in Sweden, especially in the big cities, where demand is large. The Swedish auction sales design is, however, quite unique and requires attention, as it is believed to influence bidder behavior and consequently the distribution of sales prices.

Differently from traditional auctions, the sales of non-distressed residential real estate in Sweden do not occur in an auction house; instead, the home for sale is shown during specific dates, and at a specific time only, predetermined by the broker² and bids are placed over the phone or online. During the showings, the name and telephone number of interested potential buyers are collected and put on an interest list. The day after the last showing, the broker makes round calls to everyone on that list. Every incoming bid is simultaneously announced to everyone in the list through text message and on the brokerage firm’s website and anyone is free to contact the broker to place a higher bid through the phone or online (in case the brokerage firm offers an online bidding service). These calls are made until all bidders but one drop out from the auction. The remaining bidder is the winner and he or she is normally prompted by the broker to sign the sales contract as soon as possible.

A probable reason why brokers stresses the winning bidder to sign the sales contract – normally on the same day the bidding is over – is the fact that bids are not binding and that the winner can withdraw from the transaction without incurring any cost. Similarly, a seller is neither obliged to sell until the sales contract is signed. Moreover, the seller has no obligation to sell to the person who placed the highest bid.³ Furthermore, considering the highly competitive environment, where new homes are listed every week, encouraging a quick signing of the sales contract may be a rational strategy from the broker to

¹ With the exception of new construction.

² Normally, two dates are predetermined and announced in the local newspapers and on the web, on the brokerage portal Hemnet.se. The majority of the showings are open for anyone and interested potential buyers are welcome to these showings without needing to register in advance.

³ Though it is a rare situation, sellers can refuse to sell their home to the winner of the auction. Such a decision is normally based on the recommendation of the broker, who may doubt the winner’s financial capacity to be granted a loan (Hungria-Gunnelin, 2013).

decrease the risk that the winner becomes interested in newly incoming and more attractive objects for sale.

These peculiarities in the Swedish market of homes for sale may form the underlying factors that justify why Sweden, from an international perspective, has a very short time-on-market⁴, with an average of 3.7 days for single-family houses and 3.0 days for condominium apartments during the period studied in this research work.

Another factor that is quite unique to the residential real estate market is that brokers do not only represent sellers' interests but shall instead be a neutral party during the entire sales process and, hence, protect buyers' interests equally. Therefore, the level of list price chosen by the seller (usually recommended by the broker) have been the target of great criticism by the media and by consumers as list price has, on average, been considerably below final sales price, especially in the city of Stockholm during periods of economic booms, and this practice have been considered deceiving for consumers. As discussed in Hungria-Gunnelin and Lind (2008), broker's use of substantial underpricing in Stockholm as a strategy to attract a higher number of visitors to the showings has acted to trigger bidding frenzy, or auction fever, in many sales, especially in times when the market is booming. Adding to such an overheated situation is the fact that bids are not binding, which may encourage non-serious bidders to place simultaneous bids on several objects, as participation is a costless option that anyone can exercise. As discussed in Paper 2, in an ascending auction context, these "extra" bids may amplify the gap between list price and sales price and augment, in its turn, the effect of the underpricing strategy.

Some brokers have recognized the need of a review of the Swedish auction rules regarding the regulation of bids. They believe that binding bids would prevent the participation of non-serious bidders, as well as the placing of fraudulent bids, and it would also have a cooling effect by considerably decreasing the speed of auctions and, consequently, reducing bidding frenzy behavior. The Swedish Consumer Agency is, on the other hand, skeptic to this type of regulation as their opinion is that binding bids would do more harm than good for consumers in the form of increased stress during the auction (Tuvhag, 2017).

4 Methodology

The nature of this thesis is empirical and the analysis is based on statistical methods applied to economic problems in order to test hypotheses regarding the relationship between the economic variables of interest, that is, econometric modelling. The predominant method used in the thesis is regression

⁴ It may be a bit awkward to refer to time-on-market (TOM) for auctions as traditional auctions normally occur during a single day and, therefore, it is quite meaningless to refer to TOM in this context. However, although the Swedish market uses ascending-bids in residential property sales, it has no predetermined ending date or time. Therefore, it is, in this case, interesting to compare the speed of residential property sales under an auction-like environment (as in Sweden) with other markets where private negotiations are predominant.

analysis in the form of ordinary least square (OLS) regressions, spatial regressions, probit regressions and Hazards regressions.

The scientific literature applying the framework of Classic Linear Regression (CLR) as well as more complex regression methods when studying determinants of property prices, e.g. hedonic price modelling, is abundant. Compared to standard hedonic modelling of the price of a good where the good is not tied to a particular geographical location, modelling of property prices is more complex since the fact that a property has a fix location may introduce bias in parameter estimates if there is spatial autocorrelation in the data. By spatial autocorrelation is meant that the price of a property in a particular location is dependent on observed prices in neighboring locations or that there is a variation in the relationship between variables over space. From the end of the 1990s so called spatial models applying spatial econometrics in order to take spatial autocorrelation into account has become standard in the hedonic modelling of property prices (see Wilhelmsson (2002) for an overview).

Another common problem in hedonic property price modelling is omitted variable bias. Typically the researcher do not have detailed enough data to control for all important property attributes, such as e.g. technical quality of buildings and architectural attributes of buildings and the surrounding lot and neighborhood. Paper 3 in this thesis apply methods used in previous literature on hedonic models for residential real estate to mitigate the bias in coefficient estimates due to omitted variable bias, such as the inclusion of residuals from hedonic regressions containing repeat-sales of the properties in the auction dataset (Bokhari and Geltner, 2011; Buchianeri and Minson, 2013; and Clapp *et al.*, 2018), or inclusion of the residuals from a list price regression for the properties in the same dataset (Xie, 2018). Furthermore, omitted spatial variables are addressed through spatial modelling in Papers 1-3.

5 Data

Datasets containing detailed data describing the unfolding of auctions of non-distressed residential homes are rare. There are, however, a few previous papers that have had sufficient data on list price, number of bidders, and final transaction price in order to analyze how these variables affect the outcome of real estate auctions (Brown *et al.* 2013 and Han and Strange, 2016). This thesis makes a series of important contributions to this small literature of real estate auctions. One of the main direct contributions lies in the uniqueness of the empirical data gathered that permits the construction of auction variables such as the bid amounts, the time between each bid, identification code for each bidder and in which order bidders bid at the auction.

5.1 The eBud Dataset

eBud is the main dataset used in this research work, as it contains unique detailed auction data of sales of homes in Sweden through auctions. The eBud dataset is used in *Papers 1 to 3*. eBud was an online service owned by Handelsbanken for brokers interest in increasing the transparency of home sales by

reporting incoming bids on the eBud website. Brokers did, however, drastically diminish the use of this service in February/March 2012 and the service was discontinued in March 2012.

I wrote *Paper 1* while I was still working on the data gathering. This is why there are less observations and the observation period is shorter in *Paper 1* than in *Paper 2*, which also analyzes apartment sales. *Paper 3* uses the eBud data, with the difference that I analyze the sales of single-family homes instead of apartments. The time period under study is the same for *Paper 2* and 3. *Table 1* below shows a summary of the studied period, number of observations and variables used from the eBud dataset.

Table 1 | Summary of data gathered from eBud plus extra variables added to the eBud dataset

	Paper 1	Paper 2	Paper 3
Study period	January 2010 – November 2010	January 2010 – December 2011	January 2010 – December 2011
Number of observations	512	629	802
Property type	Condominium apartments	Condominium apartments	Single-family houses
Geographical area	Stockholm inner-city	Stockholm inner-city	Stockholm County
Variables	<ul style="list-style-type: none"> • List price • Sales price • Sales date • Address • X- and Y-coordinates¹ • Living area • Number of rooms • Condominium fee • Number of bidders 	<ul style="list-style-type: none"> • List price • Sales price • Sales date • Address • X- and Y-coordinates¹ • Living area • Number of rooms • Condominium fee • Number of bidders > 2 • Bid amount per bidder • Time of each bid • Id-number for each bidder • Construction year² 	<ul style="list-style-type: none"> • List price • Sales price • Sales date • Municipality • Address • X- and Y-coordinates* • Living area • Extra area • Plot size • Number of rooms • Number of bidders > 1 • Bid amount per bidder • Time of each bid • Id-number for each bidder • Value year³ • Construction type³ • Legal ownership (groundlease vs. freehold)³ • Sea/lake front plot³ • Standards points³ • PVO⁴

¹Manually added to the database and gathered from *Hitta.se*. ²Manually added to the database and gathered from *Datscha.se*.

³Cross-added variables from the SMCLR-dataset. ⁴Cross-added variable from the Swedish Tax Authority dataset.

The eBud dataset was mainly used by brokers from smaller independent brokerage agencies and not by the biggest ones. My assumption is that these brokers were willing to increase the transparency of the bidding process for consumers. This self-selection among those who chose to get exposed on the online eBud service may imply a selection bias in the data sample concerning, for example, how these brokers set the announced list price. The choice for exposing one's own sales practice is, in my opinion, a signal that you have nothing to hide. A rationale here may lead to the conclusion that brokers that seek higher transparency are not the ones that practice severe underpricing, which was already well-known by 2010-2011 was condemned by the Swedish Brokers' Association.

Another overrepresentation in the data concerns small apartments; the majority of the transactions in the eBud dataset are of 1- and 2-room apartments in Papers 1 and 2, which together comprise 74 and 73 percent in Papers 1 and 2, respectively.

5.2 The Swedish Broker Association Dataset

The Swedish Broker Association (Svensk Mäklarstatistik) dataset was used in *Paper 2* as a secondary dataset to mainly estimate the market value of all apartments in the eBud dataset through a hedonic mass valuation model. This dataset consists of 12,279 apartment transactions between December 2009 and November 2011. The reason why December 2009 is included is because the model estimates market values with one-month lag, which better represents brokers' valuation practice for market values (Geltner *et al.*, 2003). The market value estimates were used to create the variable that measures the sellers' list price strategy, i.e. the degree of underpricing.

5.3 The Swedish Mapping, Cadastral and Land Registration Authority (SMCLR) Dataset

The SMCLR dataset consists of data from the Swedish official property register and contains all the sales of single-family houses in Stockholm County (a total of 196,744 transactions) during the years 1996 – 2016. Apart from complementing the eBud dataset in *Paper 3* with the variables construction type, value year, legal ownership, sea or lake front plot, and standard points, this secondary dataset is used in a similar fashion as the Svensk Mäklarstatistik dataset was used in *Paper 2* to estimate the market values of single-family houses sold during the period 2010-2011. This dataset contains very detailed data on the properties' quantitative attributes such as living area, extra area, plot area, sales price, assessed value, standard points, geo coordinates, the land value area (VO), as well as on its legal and qualitative characteristics, such as construction type, land use rights (leasehold or freehold), reasons for extra adjustment of assessed value, construction year, value year, sea or lake front plot and the transaction registration date.

Another dataset acquired from the Swedish Tax Authority was added to the SMCLR dataset containing a classification of the land into slightly larger areas than VOs – the PVOs – but where locational factors affecting property values are still very similar. The PVOs are very useful as geographical dummies when, as in the case of the auction database used in *Paper 3*, the number of transactions in a certain VOs is too small.

Because the SMCLR dataset covers a 20-year period, it allows information on repeat-sales of the properties included in the eBud dataset. The repeat-sales are used in *Paper 3*, where the regression residuals from these transactions are included as an explanatory variable to mitigate omitted variable bias problem, as discussed in Bokhari and Geltner (2011), Bucchianeri and Minson (2011), and Clapp *et al.* (2018).

5.4 The Booli Dataset

The Booli dataset is used in *Paper 4* and contains 11,658 apartment transactions in Gothenburg during the period August 2012 to September 2016. The dataset includes information about apartments' living area, number of rooms, address, longitude and latitude coordinates, construction year, condominium fee, floor number, list price, highest bid (used as a proxy for sales price), advertisement publication date, sales date, and brokerage firm.

This dataset includes the brokerage firm for each sale, which facilitated the construction of a dummy variable for the brokerage firm Hemverket which is used in conjunction with the test of one of the hypotheses in *Paper 4*. This variable proxies for the type of incentive clause in which the commission is a fixed rate of the sales price since Hemverket only uses fixed rate contracts. There is, however, possible selection bias due to the self-selection of sellers that choose to sell through this brokerage firm since this category of sellers do a great part of the sales work by themselves and they may also have different reservation prices than the average seller. Furthermore, the dummy for Hemverket only partially controls for the specific type of commission, i.e, fixed rate commission. The other brokerage firms may also offer fixed rate commission contracts, but this is unobservable in the database.

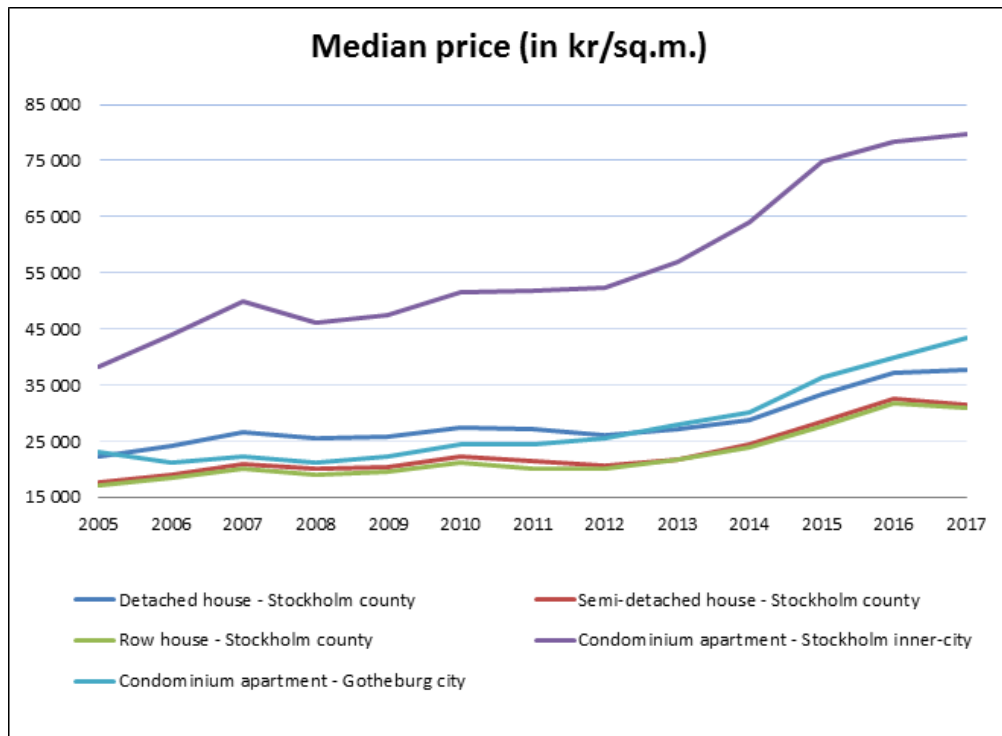
5.5 Descriptive Statistics of the Property Markets in Stockholm and Gothenburg and the Auction Unfolding in Stockholm

To put the time period studied in this thesis in some perspective, basic descriptive statistics concerning transaction volumes and property price levels in the Stockholm and Gothenburg regions are presented in the following. Furthermore, the unfolding of the auctions in the auction dataset is characterized by summary statistics with respect to list price, sales price and the number of bidders in the auctions in Stockholm.

Figure 1 depicts deflated median prices per square meter for all housing types studied in the thesis. Except for the slight down-turn during 2007-2008 and a following period of steady prices, coinciding with the global financial crisis and its unwinding, condominium and house prices have increased considerably in real terms during the past couple of decades in Stockholm and Gothenburg. Overall, the real prices approximately doubled during the period 2005-2017 for all housing types in *Figure 1*, except for condominium apartments in Stockholm, which increased by 140 percent. In particular, from 2012 and onwards, prices were booming. The sharp increase in real prices was as an effect of the stable Swedish economy in combination with low interest rates and a muted supply response to the increased demand in the regions under study. Worried about the systemic risks to the banking system and the Swedish economy as a whole that high price levels in combination with high debt-to-value ratios imply, the

Swedish government instituted a compulsory amortization of mortgages⁵, which cooled the housing market to a certain level from 2016, which can also be observed in *Figure 1*.

Figure 1 | Deflated Annual Median Price per Square Meter.

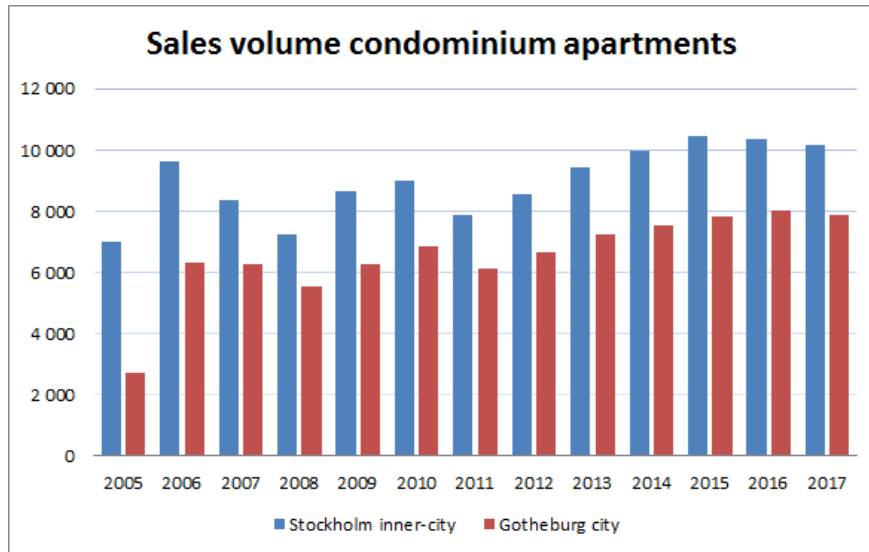


Source: Svensk Mäklarstatistik.

As shown in *Figure 2*, the number of sales of condominium apartments in both Stockholm and Gothenburg behaves in a similar fashion. As depicted in *Figure 2*, a rise in sales in 2006 was followed by a fall in sales volume during 2007-2008 of approximately 12 percent compared to 2006, as an effect of the global financial crisis. The study period analyzed in this thesis (2010-2011) is marked by a recovery period in the Swedish economy, which grew three times faster than the Euro Zone's economies from the initiation of the financial crisis until 2010 (The Economist, 2014). This rather quick recovery is part due to the fact that Sweden stayed outside the euro area and its Central Bank had ample flexibility to combat the recession that hit Sweden in 2008-2009, by sharply decreasing the interest rate in January 2010. In July 2011, confident with the growth promoted by the low interest rate, the Swedish Central Bank decided to raise the interest rate again, which slightly cooled the housing market, as observed both in prices levels in *Figure 1* and transaction volume in *Figure 2*.

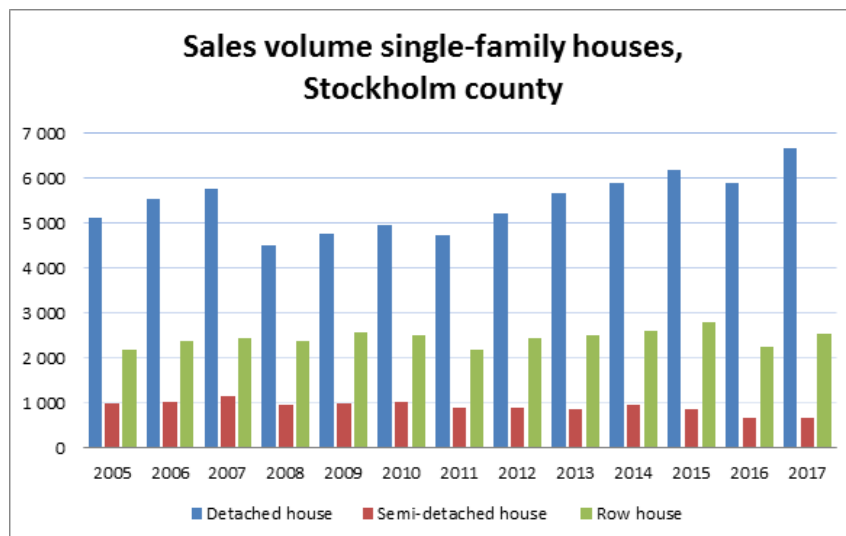
⁵ The compulsory amortization mainly concerns new mortgages which must be amortized with at least 2 percent per year for debt above 70 percent of the value of the home and 1 percent per year for debt within 50-70 percent of the value of the home.

Figure 2 | Sales Volume of Condominium Apartments in Stockholm Inner-City and Gothenburg.



Source: Svensk Mäklarstatistik

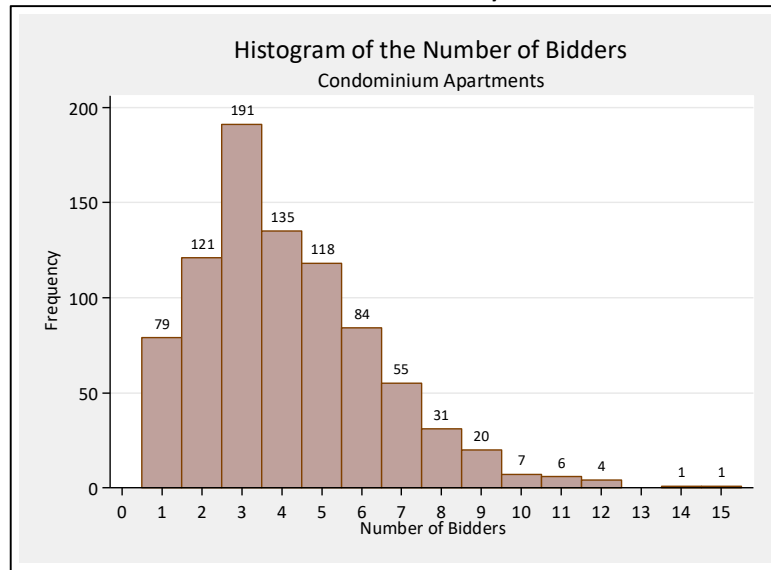
Figure 3 | Sales Volume of Single-Family Houses in Stockholm County.



Source: Svensk Mäklarstatistik.

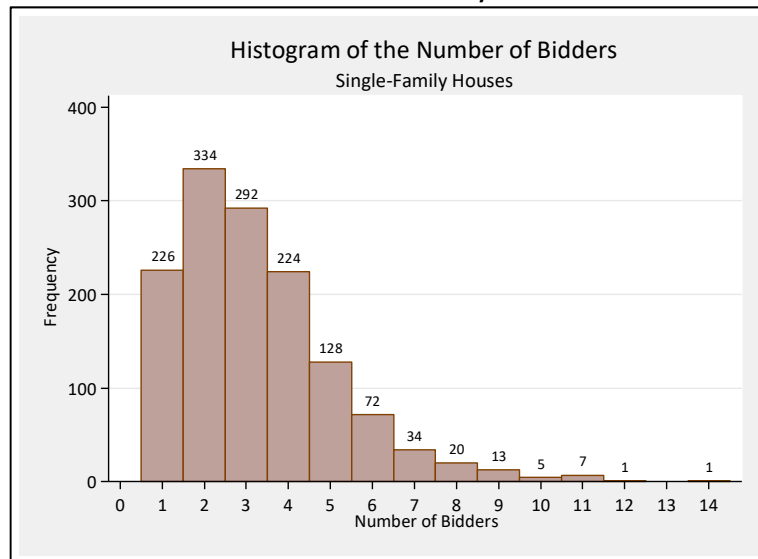
Figure 3 shows the sales volumes for single-family houses in Stockholm County. Differently from condominium apartments, the sales volume of houses continued to increase in 2007, only seeing a decrease in 2008 (of approximately 22 percent). Looking at detached houses as well as semi-detached and row houses, we can see that they similarly followed the pattern of condominium apartments in Stockholm and Gothenburg. In relation to 2010, the sales volume of detached houses in 2011 fell marginally by 5 percent, semi-detached houses by 11 percent, and row houses by 13 percent.

Figure 4 | Histogram of the Number of Bidders in Sales of Condominium Apartments in Stockholm Inner-City.



Source: eBud, variable compiled by the author.

Figure 5 | Histogram of the Number of Bidders in Sales of Single-Family Houses in Stockholm County.



Source: eBud, variable compiled by the author.

Figure 4 shows a histogram of the number of bidders in sales of condominium apartments in Central Stockholm. The number of bidders varied between one and fifteen in all sales during the period for which auction data was available (2010-2011). Since the number of bidders is bounded above zero, the distribution is skewed. Approximately 9 percent of the auctions have only one bidder, 60 percent less than five bidders and 95 percent of the auctions less than nine bidders. In comparison, a larger fraction

of the auctions of single-family houses, displayed in *Figure 5*, have only one bidder (17 percent). About 80 percent of the auctions have less than five bidders and 98 percent less than nine bidders.

Table 2a | Below-, At-, and Above-List Sales of Condominium Apartments in Stockholm Inner-City by Year.

	Sales/List ratio	Below List (%)	At List (%)	Above List (%)	Mean Price (Tkr)	# Observa- tions	% Multiple bidders
2010	1.29	0.76%	2.46%	96.78%	3 180	528	92.99%
2011	1.21	4.92%	5.85%	89.23%	3 320	774	87.08%

Table 2b | Bidding Statistics for Below-, At-, and Above-List Sales of Condominium Apartments in Stockholm Inner-City.

	Number of bidders		% Multiple bidders	
	Mean	Std. Dev.	Mean	Std. Dev.
Sales Price < List Price	1.75	1.21	1.00%	0.11
Sales Price = List Price	1.00	0.00	0.00%	0.00
Sales Price > List Price	4.35	2.19	99.00%	0.11

Tables 2a and *2b*, and *Tables 3a* and *3b*, display descriptive statistics regarding the ratio of sales to list price and its relation to the number of bidders for condominium apartments and single-family houses, respectively. Characteristic for the Swedish housing market, for the vast majority of transactions, sales price is above list price. In *Table 2a*, for 2010, almost 97 percent of the sales were above list price and 93 percent of the auctions had more than one bidder. For 2011, the number of sales above list price was slightly reduced to 89 percent together with a similarly slight reduction of auctions with more than one bidder to 87 percent. The sales price was on average considerably higher (29 percent) than the list price during 2010 and while also higher in 2011 (21 percent), but not to the same extent.

Table 2b shows that the average number of bidders was higher in auctions where sales price ended above the list price, 4.35 bidders compared to 1.75 bidders. In auctions where sales price was the same as the list price, there was only one bidder.

Table 3a | Below-, At-, and Above-List Sales of Single-Family Houses in Stockholm County by Year.

	Sales/List ratio	Below List (%)	At List (%)	Above List (%)	Mean Price (Tkr)	# Observa- tions	% Multiple bidders
2010	1.16	3.85%	3.53%	92.62%	4 011	623	86.36%
2011	1.13	9.01%	7.33%	83.66%	4 298	655	81.83%

Table 3b | Bidding Statistics for Below-, At-, and Above-List Sales of Single-Family Houses in Stockholm County.

	Number of bidders		% Multiple bidders	
	Mean	Std. Dev.	Mean	Std. Dev.
Sales Price < List Price	1.66	0.95	4.00%	0.20
Sales Price = List Price	1.23	0.72	1.00%	0.09
Sales Price > List Price	3.52	1.88	95.00%	0.22

Tables 3a and 3b displays the same patterns as *Tables 2a and 2b*. However, the difference between sales and list price was not equally big. In 2010, the sales to list price ratio was 1.16, and in 2011, it was 1.13. Similarly, the number of auctions in which there were multiple bidders was slightly lower than that of apartment sales, 86 percent and 82 percent in 2010 and 2011, respectively. As seen in *Table 3b*, as for apartments, the average number of bidders in sales where sales price was higher than the list price was higher than in below list price sales, 3.52 bidders compared to 1.66.

6 Results and Thesis Outline

This thesis is comprised of four studies, outlined as follows.

Paper 1 - Impact of Number of Bidders on Sale Price of Auctioned Condominium Apartments in Stockholm

Paper 1 is the first of four papers in the thesis. The research question of the paper originated from the recurring debate in media concerning real estate brokers' use of underpricing, that is setting a list price significantly below the assessed market value of a property for sale, in particular in the larger Swedish cities. A common view among brokers is that a low list price attracts a high number of visitors to the showing of a home for sale and, as a consequence, a high number of bidders at the following auction and a high sales price. The use of underpricing is regularly debated in media and a commonly held view in the media and by the public in general, as well as by public policy makers, is that this practice is deceiving for consumers, who normally are not professionals in the real estate market and do not, therefore, have the skills to assess if a list price is set at a realistic level compared to the expected selling price. The observed large discrepancy between list prices and final selling prices is perceived as creating a very stressful situation for inexperienced bidders who often find themselves participating in a so-called "bidding war" in which they have to bid significantly higher than their expectations from the advertised list price in order to win an auction.

Paper 1's main contribution is to empirically test whether the number of bidders has an effect on the final sales price of condominium apartments in ascending-bid auctions of non-distressed apartments in the inner-city of Stockholm. Although previous studies have empirically analyzed the relationship between the number of bidders and the probability of success of an auction (i.e. that the property is sold), few papers have quantified the effect of the number of bidders on the final sales price of residential real estate. In order to do that, a database containing information about 512 apartment sales between the months January-November 2010 was used to construct a hedonic model including the following variables and where the dependent variable is log of sales price per square meter: condominium fee per square meter, living area, number of rooms, average room size, x- and y-coordinates used to calculate the Euclidean distance to the city-center (Hötorget) and sub-city-center (Stureplan), dummy variables to divide the location of the apartments into four neighborhoods (Östermalm, Vasastaden, Södermalm, and Kungsholmen), and the number of bidders in each transaction.

Paper 1 uses the classical OLS as well as spatial econometric models (SEM and SAR) to quantify this effect, where the SEM and SAR models act mainly as controls to verify the robustness of the OLS model. The results show that the number of bidders participating in an auction has both a statistically and an economically significant positive effect on the transaction price. Initially (going from one to two bidders) one extra bidder increases the selling price with approximately 4 percent but as the number of bidders increase the marginal effect of one extra bidder is decreasing. Even though the exact effect may be specific to the Stockholm residential market, it is plausible to assume that other residential markets would display similar effects. The results of Paper 1 do not, however, examine the arguments used by brokers for using underpricing, i.e. that underpricing attracts more bidders, which in turn, lead to higher final sales prices. This argument is treated in Papers 2 and 3.

Paper 2 - An analysis of auction strategies in apartment sales

Similar to Paper 1 this paper studies the outcome of auctions of non-distressed condominiums in central Stockholm in the framework of hedonic price regressions. The empirical analysis is based on the same database as is used in Paper 1, but extends the analysis to include more auction related variables than Paper 1 that focuses only on how competition measured by the number of bidders affects the size of the winning bid. The database is also extended to include observations over a longer time period than Paper 1 and contains information about 629 apartment sales during the time period November 2010-December 2011.

The first extension compared to Paper 1 is to introduce a variable measuring the degree of underpricing as an explanatory variable in the hedonic price regression. Underpricing is measured as the percentage difference between the list price and the assessed market value of the auctioned condominium. Strategic list price setting is the main tool for a seller to affect the outcome of an auction and underpricing is typically recommended by brokers as a way to attract more potential buyers to showings of homes for sale and to the following auction.

The next extension is to introduce measures of how aggressive the bidding is in form of jump bidding, measured by the average percentage bid increase, and speed of the auction, measured as the average time between bids. Furthermore, two measures of the aggressiveness of the winner of an auction compared to the losers are introduced; the ratio of the winners' average percentage bid increase to the losers average percentage bid increase and the ratio of the winners' average reaction time to previous bid to the losers' average reaction time to previous bid. Finally, the model extends that of Paper 1 by estimating a model of the number of bidders in an auction as a function of apartment attributes and list price and bidding strategies.

Instead of using the total number of bidders as an explanatory variable in the price regression as in Paper 1, the residual from the bidder regression enters the price regression in this paper. That is, the estimated coefficient on the residual in the price regression measures how random variation (variation not explained by the bidder regression) in the number of bidders affects sales price. The motivation for this

approach is that removing the expected part (the part predicted by the bidder regression) of the total number of bidders makes it possible to analyze, explicitly, the effect of different list price and bidding strategies. That is, the effect of a certain strategy, including its effect on the expected number of bidders, is measured directly by the coefficients of the variables describing that strategy.

As in Paper 1, the number of bidders has a significant and positive effect on sales price. One extra (unpredicted) bidder increases sales price with 1.5 percent. The quantitative effect is smaller than in Paper 1. However, these coefficients are not directly comparable since the residual from the bidder equation is used in this paper instead of the total number of bidders in Paper 1.

The coefficient on the variable measuring aggressiveness of bidders in terms of jump bidding is positive and strongly significant. One extra percent of average bid increase increases the sales price with approximately 1 percent. This result implies that using jump bidding as a strategy to scare off competition is on average inefficient. While jump bidding reduces the number of bidders according to the estimated bidder equation, the reduction is not sufficient to compensate for the positive effect on selling price of larger than necessary average bid increments.

With respect to aggressiveness in form of the speed of an auction, the result is similar to that of jump bidding. The coefficient on the average time between bids is negative and strongly significant. Hence, aggressiveness of an auction in terms of a short average time between bids increases the winning bid. Reducing the average time between bids with one day increases the selling price with 7 percent. This result supports findings in the behavioral literature that associates a fast pace of an auction with increased risk of so called “bidding frenzy” where (in particular inexperienced) bidders bid over the true value of the object for sale (Adam *et al.*, 2011; Chen, 2011).

Contrary to popular belief, but in line with results in the previous literature, underpricing does not attract enough competition to have a positive effect on selling price. An increase of underpricing with 10 percent reduces the selling price with 1.5 percent. This result is in line with findings in the literature studying the so-called anchoring effect (Diaz and Wolverton, 1998), where potential buyers see the list price as a reference price that influences their reservation price. Since the negative relationship between underpricing and sales price contradicts stated beliefs among brokers in Sweden and in other countries (Bucchianeri and Minson, 2013; Han and Strange, 2016), it is worth noting that brokers have an incentive to recommend a low list price with the purpose of reducing a seller’s expectations with respect to final selling price in order to increase the probability of a speedy sale. Underpricing may of course reduce broker’s commission (which is usually a percentage fee of the selling price in Sweden), but a small increase in turnover due to a quicker sale is enough to compensate for such a reduction. That is, recommending a low list price may be self-serving for a broker.

Some caution is warranted with respect to the finding that increased underpricing reduces selling price since the estimated coefficient on underpricing may suffer from both omitted variable bias and error-in-variables bias. This is because the benchmark for the measure of underpricing – the market value of the transacted property estimated by a hedonic price equation – may suffer from omitted variable bias and

that the market value, even in the absence of omitted variable bias, is estimated with error. A mitigating effect is, however, that these two types of bias act in opposite directions; omitted variable bias acts in the direction of making the coefficient on underpricing more negative while measurement errors in the underpricing variable bias the coefficient towards zero.

Paper 3 - Bidding strategies and winner's curse in auctions of non-distressed residential real estate

Paper 3 builds on Paper 2 in that it uses a similar methodological approach to study how list price and bidder strategies affect the outcome of auctions of homes in the Stockholm region but it extends the analysis. The main extensions are as follows. Firstly, while paper 2 studies auctions of non-distressed condominiums this paper studies similar auctions of single-family houses. Secondly, it contains a more thorough analysis of possible omitted variable bias in the estimation of the hedonic equations and further employs methods used in the previous empirical literature to mitigate omitted variable bias such as including as explanatory variable the residuals from a price regression of previous sales (Bokhari and Geltner, 2011, Bucchianeri and Minson, 2013 and Clapp *et al.*, 2018) or including the residuals from a list price regression (Xie, 2018). Thirdly, using a mass appraisal model, market values of the auctioned properties in the database are estimated and used as a benchmark for analysis of how list price and bidding strategies affect the probability of a winner's curse. Finally, a variable measuring late bidding that is, waiting until the end of the auction before placing a bid is included in the analysis.

The analysis is based on data from 802 transactions of non-distressed single-family houses sold by auction in the Stockholm region. Six auction related variables are included in the hedonic models; number of bidders, degree of jump bidding in the first and the winning bid measured by the percentage bid increment, speed of the auction measured as the average time between bids, degree of underpricing measured as the ratio of list price to assessed market value and late bidding measured by a dummy variable that equals one if the winner of an auction only made one bid. Similar to paper 2, the number of bidders enters the models in the form of the residual from a regression of the number of bidders on explanatory variables including property, locational as well as auction related variables.

The estimated effect on price of the number of bidders is stronger for single-family houses than the estimated effect for condominiums in Paper 2. One extra (unpredicted) bidder increases the winning bid with approximately 2.5 percent compared to 1.5 percent for condominiums. The positive and strongly significant relationship between the speed of an auction and sales price found in Paper 2 is also found in this paper although the effect is weaker which is expected since the average time between bids was longer for single-family houses than for condominiums during time period under study. Increasing the average time between bids one day reduces the price by approximately 2 percent.

Also confirming the results in Paper 2, trying to scare off competition through jump bidding seems to be an inefficient strategy since increased bid increment in the first as well as the winning bid increases the final sales price. An initial bid that is 10 percent higher than the list price increases the winning bid with

approximately 5 percent compared to when the initial bid equals the list price. The effect of jump bidding in the winning bid is weaker. A winning bid that is 10 percent higher than the next highest bid increases the winning bid with 2 percent on average. One explanation for this result may be that the tactic of scaring off competition works a bit better (or less bad) in the end of an auction when bids are closer to the true value of the auctioned property. Another reason could be that a very high initial jump bid from an inexperienced bidder implies winner's curse, since other bidders with better signals about the value of the property withdraw before signaling their knowledge.

The result with respect to underpricing is likewise similar to that obtained in Paper 2, only stronger. That is, underpricing is an inefficient strategy to obtaining a high selling price. A list price 10 percent below the estimated market value reduces the winning bid with approximately 5 percent compared to a list price that is equal to the market value. Similar to Paper 2, some caution is warranted when interpreting this result since possible omitted variable bias as well as error-in-variables bias may affect the estimated coefficient on underpricing. A mitigating effect is however, as discussed in the summary of Paper 2, that these two different types of bias act in opposite directions and hence to some degree cancel each other out. Furthermore, re-estimating the hedonic price equation employing methods used in the previous literature to mitigate omitted variable bias do not significantly alter the estimated coefficient for underpricing.

The only auction related variable that is not significant in the price equation is the variable measuring late bidding. Hence, waiting to place a bid until the end of the auction does not seem to be advantageous. One caveat here is that the variable measuring late bidding only imperfectly captures a deliberate strategy of bidding late in the auction. The *ex post* fact that the winning bidder only submitted the winning bid may be the effect of a deliberate strategy, but it may also be a coincidence.

Not surprisingly, the estimated probit model of the winner's curse shows that the variables describing list price and bidding strategies affect the probability of a winner's curse in the same direction as these variables affect sales price. Calculation of the average marginal effects of the auction related variables on the probability of a winner's curse show that in particular the number of bidders and jump bidding in the first bid have a large positive effect on the probability of a winner's curse, while underpricing has a large negative effect. The average marginal effect of one extra bidder is an increase of the probability of a winner's curse with approximately 5 percent and the corresponding effect of a one percent increase in jump bidding in the first (last) bid is an increase in the probability of a winner's curse with almost 2 percent (1 percent). An increase in underpricing with 1 percent on the other hand reduces the probability of a winner's curse with approximately 2 percent. The effect of increasing the time between bids with one day is a reduction in the probability of a winner's curse with a bit more than 2 percent. Contrary to the result in the price equation, the effect of late bidding is statistically significant (however only at the 10 percent level). The effect is also large. The probability of a winner's curse for a winner that only bid once is about 7 percent lower than that of a winner who place more than one bid.

It is quite interesting to observe that the effect on sales price of list price and bidding strategies is conforming when comparing the condominium and the single-family markets, as analyzed in Papers 2

and 3, respectively. While these results may be specific for the housing markets in Stockholm County and the Swedish auction sales mechanism, the fact that two different types of markets with different types of buyers and sellers generate similar results, increases the generalizability of the findings.

Paper 4 - Real estate agents' list price strategies – Higher sales price, shorter time on the market or asymmetric information?

Paper 4 analyzes how list price setting affects the outcome of a property sale. Based on the empirical observations that underpricing is common in Sweden, in particular in the largest cities, three hypotheses concerning the rationale for this behavior are formulated and tested. The first hypothesis tests whether a low list price in relation to the property's market value leads to higher sales prices; the second hypothesis tests whether a low list price leads to quicker sales; and the third hypothesis tests whether a low list price compared to the apartment's market value can be explained by an information asymmetry between the seller and the broker, where the broker takes advantage of their knowledge on price to misguide sellers to sign a service contract based on an incentive curve fee model that mostly benefits the broker.

Based on previous studies that investigate list price as a selling strategy (see e.g. Adam *et al.*, 2011; Chen, 2011; Ku *et al.*, 2005; Haurin *et al.*, 2010; and Haurin *et al.*, 2013), the argument for *Hypothesis 1* is that a lower list price attracts more potential buyers to the showing of a property, since a larger number of potential buyers have a reservation price above the list price. More potential buyers at showings increase the probability of a high number of bidders in the following auction, which, in turn, increases the probability of a high sales price.

Hypothesis 2, on the other hand, tests whether a low list price leads to quicker sales, not necessarily meaning that final sales prices are higher in these auctions. In other words, even if *Hypothesis 1* is rejected (i.e. a lower list price does not lead to a higher sales price), the probability that a matching buyer shows up at the auction should increase when list price is low, which would then result in a shorter time on the market (*TOM*). A shorter *TOM* means that less effort is needed to sell the property. As argued by Levitt and Syverson (2008), the increase in commission from a higher sales price is a relatively small incentive for a real estate broker taking into consideration the extra effort needed to increase the sales price, which raises the question of which goal is more important to the broker: selling at a high price or selling quick.

Hypothesis 3 tests whether a low list price (in relation to the object's market value) is an agency problem that emerges due to information asymmetry between the seller and the broker. The most common commission structures in Sweden are: a) a *fixed fee rate* that represents a percentage of the selling price; b) a *fixed fee amount*; and c) a *minimum commission amount plus a larger percentage fee rate* calculated on the part of the sales price that exceeds some agreed upon threshold price. The argument behind *Hypothesis 3* is that brokers may be tempted to take advantage of their market know-how and convince sellers that a certain list price is correctly set (which in reality is considerably below the broker's *ex ante*

assessment of the property's market value) in an attempt to make the client sign a service contract that is based on an advantageous commission percentage rate fee as described in commission structure c) above. Although we lack information regarding which objects have been sold using commission structure c), and we do not have information about how large the information asymmetry between sellers and brokers is, we will attempt to proxy this information by identifying, through a dummy variable, the sales made by the brokerage firm *Hemverket*, who always charge a fixed commission rate, and assume that the other firms in the database make use of other incentive structures.

To test *Hypothesis 1*, a mass valuation model is constructed to estimate the market value of the apartments in the dataset. The market value is then used to construct the variable *degree of overpricing (DOP)* defined as the ratio between list price and estimated market value minus one. Hence, underpricing occurs when *DOP* is negative. A hedonic price regression is then run including *DOP* as explanatory variable together with apartment attributes, location, a dummy variable for apartments sold through *Hemverket* and a variable measuring time on market. The results show that *DOP* is significant and positively correlated with sales price, which is contrary to what we expected from *Hypothesis 1* but in line with the results of Paper 2 and 3. The effect is in fact a bit stronger than in those papers. An increase in list price with 10 percent increases sales price by approximately 8.5 percent. The results further show that the coefficient on *TOM* is negative and significant indicating that the longer the *TOM* the lower the sales price.

Hypothesis 2, however, does not concern the effect on price of *TOM*. Rather, the hypothesis concerns how list price affects *TOM*. In order to test *Hypothesis 2*, we construct two hazard models, assuming a Weibull distribution in the first and a Cox proportional hazard function in the second one. The results from both models are similar with respect to *DOP*, the variable of interest in the second hypothesis, showing a *DOP* hazard ratio of 0.58 and 0.739, respectively (both coefficients are significant at the 1 percent level) for the linear term and a hazard ratio of 0.977 and 1.03, respectively (both not significant) for the squared term. These results suggest that the higher the *DOP*, the longer the *TOM*, which supports *Hypothesis 2*.

To test *Hypothesis 3*, *DOP* is regressed on the same variables as those used when testing the first two hypotheses including the dummy variable identifying which sales are made through *Hemverket*. The results show that apartments sold through *Hemverket* have a lower list price in relation to assessed market value than apartments selling through other real estate agents. This evidence does not support the third hypothesis. The coefficient is not statistically significant on the 5 percent level, but using a more lax criterion on statistical significance we can say that the results contradicts what we would expect if *Hypothesis 3* was true.

7 Contributions and general conclusions

The origin of this doctoral thesis was the ongoing debate in Swedish media concerning the prevailing empirical observation that list prices of homes for sale, in particular in the larger Swedish cities, are on

average considerably lower than observed transaction prices. A popular explanation in media for this underpricing phenomenon, as well as the stated belief of many brokers, is that a low list price acts to generate a large interest from potential buyers (that may believe that they can make a bargain), which increases competition at the auction of the home for sale and, consequently, increases selling price. In short, the popular explanation is that the list price setting is part of the seller's auction strategy. This "folk wisdom" model of explanation – low list price leads to many bidders at the auction which leads to high selling price – is not unique for the Swedish property market. Several academic papers, brokers and auction houses, as well as articles in the media, report the same story for property markets in other countries in which properties are sold through auctions or in auction-like environments (Haurin *et al.*, 2013; Brown *et al.*, 2013; Buccianeri and Minson, 2013; Han and Strange, 2016; Pryce, 2011; Stevenson *et al.*, 2010). Yet, papers formally testing this chain of hypotheses related to sellers' list price strategy has been lacking in the empirical literature analyzing auctions of non-distressed residential properties. Similarly, papers analyzing bidding strategies at auctions of residential properties are almost void (Brown *et al.*, 2013; Han and Strange, 2016).

The main reason for the lack of empirical research analyzing sellers and buyers auction strategies is likely the difficulty to obtain sufficiently detailed data from real estate auctions. A main contribution of this thesis is the collection of datasets that comprise both detailed information on auctions as well as property data of real estate transactions. Other main contributions are the novel empirical results with respect to the unfolding of auctions of non-distressed homes. To my knowledge, the papers contained in the thesis are the first ones to quantify how number of bidders, list price and bidding strategies affect sales price and the probability of a winner's curse in auctions of residential properties. An interesting note is that the results with respect to the auction variables are robust across the various model specifications employed in the studies and between the condominium apartment and single-family house markets.

A general conclusion of the thesis is that an increase in competition in the form of number of bidders at an auction on average increases sales price. This is the main result of Paper 1, which adds the number of bidders as explanatory variable to a standard hedonic property price equation. This result is in line with the findings in Brown *et al.* (2013), who analyze the effect of number of bids on sales price instead of the number of bidders, as well as in Han and Strange (2016). However, the results of Paper 2 and 3 show that when adding variables describing the unfolding of auctions in more detail, such as list price and bidding strategies, the relationship between the number of bidders and sales price is not so clear-cut. An important insight from those papers is that the effect on final selling price of competition depends on the reasons for an observed level of competition in a particular auction. If, for example, the number of bidders is low due to jump bidding successfully scaring off competition, then sales price is still high on average since the deterring effect of jump bidding is insufficient to compensate for the larger bid increments. If, on the other hand, there are few bidders due to purely random causes, e.g. the weather was really bad on the day of the showing of a house, resulting in few potential buyers showing up, then sales price is low on average if the low attendance at the showing lead to few participants in the following auction.

Another general conclusion is that aggressive bidding in terms of quick counter-bids, similar to jump bidding, is an inefficient bidding strategy since auctions with a short average time between bids produces a high selling price. This result supports findings in the behavioral economics literature that attribute this effect to so-called “bidding frenzy” and “social arousal” in which actors with limited rationality bid over their *ex ante* reservation price (Genesove and Mayer, 2001; Gilovich *et al.*, 2000; Murnighan, 2002; Zajonc, 1965).

Returning to the origin of the thesis, a general conclusion from the last three papers in the thesis is that there is little empirical evidence in support of claims that underpricing, by attracting more bidders to an auction, leads to a higher selling price. On the contrary, the estimated hedonic models in Paper 2, 3 and 4 all show a negative effect on sales price of underpricing. This result is, however, in line with results from previous research concerning list price strategies in property sales (Björklund *et al.*, 2006; Buccianeri and Minson, 2013; Pryce, 2011).

A natural question to ask is why there is a discrepancy between the results in this thesis, as well as in previous research, and common advices from industry professionals such as brokers and auction houses regarding list price and bidding strategies; advices that are recurrently cited and promoted in media articles about strategies at real estate auctions. With respect to the sellers’ list price strategy, the results in Paper 4 indicate that a lack of alignment between brokers/auction houses interest and the sellers’ interest, or other priorities of the seller than maximizing selling price, may affect list price setting. For example, a main result in Paper 4 is that increased underpricing reduces the time on market of a property for sale. Hence, given the typical commission structure where the broker gets a percentage fee of the sales price, it may be self-serving for a broker to recommend underpricing to an uninformed seller in order to reduce the time on market, i.e. increase the turnover rate, rather than recommending a list price that maximizes sales price. An alternative explanation is that the degree of underpricing is determined by the seller’s urgency to sell. However, my opinion is that sellers predominantly set the list price based on advice from the broker in order to maximize selling price.

The discrepancy between findings in empirical research and advices from professionals also concerns the common advice to be aggressive in the bidding with respect to both bid increments (jump bidding) and speed of counter-bids in order to show determination. Empirical research mainly confirms (Adam *et al.*, 2011) that a fast auction increases the risk of so-called bidding frenzy or auction fever, resulting in a higher winning bid but shows mixed results with respect to jump bidding (He and Popkowski Leszczyc, 2013). Both Papers 3 and 4 in this thesis, however, find that jump bidding increases the winning bid as do increases the speed of the auction. While this research does not provide a specific explanation for the discrepancy between the empirical results and advices from professionals, one may speculate that brokers/auction houses potentially self-serving interest in striving for quick auctions in order to increase turn-over may make it tempting to provide advice that increases selling price without increasing time-on-market (jump bidding) or advice that simultaneously reduces time-on-market and increases selling price.

A peculiar feature of Swedish property auctions is that bids, according to Swedish property law, are not binding and sellers are free to withdraw the property even after a successful auction, or to sell the property to a losing bidder or any other buyer. These features may, of course, make the results in the

thesis different from what would be found when studying a market in which both bidders and sellers are committed to transact if the auction is successful. For example, one may hypothesize that the fact that bids are not binding may lead to two opposing forces with respect to selling price and the probability of a winner's curse. Firstly, a bidder that is not committed to her bid may dare to bid higher, since it is always possible to regret a winning bid that you believe is cursed. The ability to regret a winning bid would act in the direction of producing higher winning bids compared to when bids are binding. Secondly, since bids can be withdrawn, presumably winning bids are withdrawn when the winner believes that the bid implies a (severe enough) winner's curse. Such withdrawals would act in the direction of reducing completed transactions in which the winner's curse is severe and hence reducing the average observed transaction price. How these forces are balancing is an interesting and important question to analyze. However, to do that one would need a dataset from the same property market containing both auctions in which bids are binding and auctions in which bids are not binding, which is not possible to gather in Sweden.

A caveat with respect to the interpretation of the underpricing result in this thesis, as well as in other empirical papers, is that estimating the effect of this particular variable may suffer from statistical measurement problems that, in turn, may lead to biased estimates of the effect of underpricing. Specifically, the problem lies in the benchmark for measuring the degree of underpricing, the market value of the property for sale, which is estimated with error. If the estimation error is unsystematic (error-in-variables bias), the potential problem is less severe since it will only lead to a bias of the coefficient on underpricing towards zero. However, if the estimation error leads to systematic errors in the calculation of the variable measuring underpricing, such as unobserved property attributes that may be correlated with the list price, there may be an omitted variable bias that may exaggerate the negative effect on selling price of underpricing. Unfortunately, neither of the two types of errors is observable and the resulting effect is, therefore, not quantifiable. An interesting venue for future research would therefore be to study the effect of underpricing on sales price using market value estimates that do not suffer from systematic errors, for example using brokers *ex ante* estimates of selling price.

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