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

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This paper empirically tests the effect of the number of bidders on the sale price of condominium apartments in Stockholm by using data gathered during 2010. The results show that the number of participants in a real estate auction plays a significant role in the final auctioned price. The average price per square meter paid by every extra bidder has an increasing but decelerating growth, starting with an approximate 4 percent increase when going from one to two bidders.

Keywords

Real estate auction; Number of bidders; Price effect

1. Introduction

In most residential real estate markets, the sale of houses predominantly occurs through private negotiations. Auctions are usually associated with the sale of distressed properties that tend to be less attractive and located in less favorable areas (Eklöf and Lunander, 2003). However, in Sweden, the number of private negotiations has dramatically diminished during the past 15 years with the advent of the internet (Kyhlstedt, 2010), and today, auctioning is the dominant pricing mechanism for all types of sale, not only for distressed ones. Internet-based marketing for homes gathered in a single portal[1] made for and used by the largest realtor agencies in the country has been one of the factors that have triggered demand for auctions, and consequently their use. Today, the number of residential properties privately sold corresponds to approximately 10 percent[2] of the entire residential market (Kyhlstedt, 2010).

Where demand exists, auctions have proven to be the best selling mechanism when it comes to maximizing revenues. Milgrom (1987) argues that the auction is a popular selling mechanism, as it leads to stable and efficient allocation outcomes. According to him, the *competitive auction* specifically enables a seller in a weak bargaining position to do as well as one in a strong bargaining position. One explanation for this could be that potential buyers who are simultaneously participating in a sale have less bargaining power and are impelled to place their maximum bid (demonstrate their willingness to pay) if they really want the asset. To emphasize this supposition, Bulow and Klemperer (1996) have carried out a theoretical analysis of auctions versus private negotiations for company sales. Their results show that a simple competitive auction with a single extra bidder yields a seller more revenue than s/he could expect to earn by restricting the number of buyers to *N* bidders (as through private negotiations). In a follow-up study, Bulow and Klemperer (2009) confirm this assertion and add that auctions only require a limited number of potential bidders to generate higher revenues, when the values of bidders have higher price dispersion. In a study that applies both theoretical and empirical comparisons between auctions and negotiated sales of real estate, Chow et al. (2011) find that the auction mechanism attains a higher relative price when demand for the asset is strong. In other words, real estate auction revenues are dependent on market conditions, where higher prices are obtained in an up market, rather than in one that is flat or down. They also find that auctions are more effective than negotiated sales when the asset is more homogeneous and when auctions attract bidders with (high) independent private valuations.

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[1] *Hemnet.se*

[2] Private advertisement of home sales is found on internet portals, such as *Blocket.se* and *Booli.se*.

In Sweden, the transition of the pricing mechanism from private negotiations to auctions has changed the pricing strategy that brokers tend to use. An ongoing debate in the Swedish media concerns the use of underpricing by brokers (a list price significantly below the expected selling price/market value) of dwellings, which mainly occurs in the larger cities. The Swedish Board of Supervision of Estate Agents (FMN) considers the use of underpricing a serious problem and not lawful, as it is believed to mislead consumers (FMN, 2011)[3]. At the same time, it is very difficult to prove that this pricing strategy has been used, as the true market value of a home is imperfectly observable (Robins and West, 1977; Goodman and Ittner, 1992; Geltner, 1993). Brokers defend the use of underpricing with the argument that it attracts a high number of potential buyers to the exhibition of the dwelling for sale and since "all other brokers do it", they cannot be the only one who does not (Hungria-Gunnelin and Lind, 2008). Hence, the attracting of many visitors to a showing is presumed to increase the number of bidders, and as an effect, increase the sales price[4].

Besides the extensive use of auctions, there are a number of other features that are specific to the Swedish housing market and the auction system. First, bids in auctions are not binding. That is, a buyer can – without cost – back out of the deal until it has been signed. Similarly, a seller is never obliged to sell until the deal is signed. Furthermore, the seller is not obliged to sell to the highest bidder.[5] Sellers are also strictly forbidden to place bids on their own property. Finally, by law, brokers not only represent the interests of the sellers, but shall instead be a neutral party during the entire sales process, and hence, equally protect the interests of the buyers.

So far, no attempts have been made to scientifically examine the underlying rationale for the use of underpricing in terms of testing whether the stated intent (among brokers) of attracting more potential buyers actually has a positive effect on achieved selling price. The more common hypothesis in the literature is, on the contrary, that list price acts as an upper limit for offers from buyers, see for e.g., Horowitz (1992) and Haurin et al. (2010). This hypothesis, however, is predominantly common in literature that studies

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[3] The media debate and attention from consumer organizations have triggered various attempts to reduce the use of underpricing. The latest attempt is a voluntary agreement by brokers organized by the Association of Swedish Real Estate Agents (Mäklarsamfundet) to show average selling prices of dwellings in the neighborhood in advertisements of apartments for sale.

[4] One may argue that it might not be optimal for brokers to increase the number of participants in auctions since it will take a longer time before a winner appears and brokers may prefer shorter auctions in order to be able to sell more apartments. However, in Stockholm, auctions are concluded with unusual speed, irrespective of the number of bidders. The normal length of an auction is only a day or two.

[5] One common reason for not accepting the highest bidder is that the broker, seller or both are not convinced that the highest bidder will get financing for the purchase of the apartment.

markets in which private sales form the dominant price mechanism. Stevenson et al. (2010), who have studied the difference between auctioned sales and private negotiations in Dublin, where English auctions are common, put forward (but do not test) the hypothesis that the measured underpricing in auctioned sales is at least partly due to the belief of the brokers that this pricing strategy entices more people to apartment showings and thereby increases the number of bidders.

The aim of this study is to empirically test whether the number of bidders in English auctions has an effect on the sales price of residential real estate. A hedonic pricing model is estimated, by using data from 512 condominium apartments in Stockholm, Sweden, that were sold between January and November 2010. The dataset includes selling price and the number of bidders in each transaction, as well as other control variables such as *spatial information*, *condominium fee*, *apartment size*, *number of rooms* and *sale date*.

Auctions in a real estate context have been empirically analyzed in previous literature and a number of studies confirm that the number of bidders increases the probability of the success of the auction, i.e. that the property is sold. However, very little empirical work has directly examined the effect of the number of bidders on the sales price. This paper contributes to the literature by empirically quantifying this effect in English auctions of residential real estate. The results show that the number of bidders who participate in an auction have both a statistically and an economically significant effect on the transaction price. 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. Hence, the results are also of interest for markets in which private negotiation is the commonly used pricing mechanism.[6] For example, the average increase in sale price of attracting an extra bidder in Stockholm would more than compensate for the cost of extra marketing of a home for sale in most markets. Such a cost may be, for example, home staging, or above-average advertising quality, e.g. by improving the layout of the advertisement with high-quality photos taken by professional photographers, together with a good description of the unit, published in newspapers and on the internet. A broker or a private seller who is successful in attracting simultaneous interest in a home for sale will be likely to increase the selling price in any market, independent of the type of sales mechanism.

[6] It is interesting to notice that there is a fast-developing interest in selling non-distressed commercial as well as residential properties through auctions arranged by specialized property consultants in several European countries, including England, Ireland, Germany, Spain and Sweden. For example, one of the biggest players in real estate auctions in Great Britain, Allsop, arranges six auctions per year, offering between 100-200 properties per auction (Engström, 2012).

2. Earlier Studies

A significant number of theoretical studies on auctions exists. In Vickrey's (1961) seminal work, the dynamics of auctions in imperfectly competitive markets are analyzed. Vickrey derives both a number of auction equilibria and a revenue equivalence theorem, which demonstrate that a particular pricing rule entices bidders to reveal their true willingness to pay, maximizing revenues for the seller. Riley and Samuelson (1981) show that the outcome from different types of auction rules (e.g. English and Dutch auctions) are equivalent if the seller announces that s/he will not accept bids under some properly chosen minimum "reserve price". Milgrom and Weber (1982) point out that it is in the interest of the seller to reveal every piece of information that s/he has on the good, including the identity and the number of participants in the auction. McAfee and McMillan (1987) disagree with this "transparency" of information, and assume that bidders are risk-averse and have independent private values (IPVs). They test for the probability of the selling price rising after information is released and conclude that the seller is better off if s/he conceals information with regards to the number of bidders.

Early empirical papers focused on the IPV auction type. In the IPV model, the good being auctioned has a different value for each participant, each of whom knows the value of the object with certainty. In other words, bidders observe their own valuation and the values of other bidders have no significance at all (see for e.g., Myerson, 1981; Riley and Samuelson, 1981). In more recent years, studies on common value auctions (CVA) have been carried out by several researchers. Unlike the IPV, in the CVA model, the value of the auctioned item is the same for all bidders.

Residential properties carry elements of both the IPV and CVA models. A bidder may purchase a house with the purpose of increasing, for example, his/her status (a private value element), at the same time as s/he is making an investment in the case of resale (a common value element). Therefore, papers with regards to both private and common value auctions have been considered as starting references for this study. The usage of open-bid English auctions applied to the sales of residential properties, in which bidders submit successively higher bids, is common practice in Sweden (Azasu, 2006). We can find similar price mechanisms in only a very few markets across the globe, such as Australia, Scotland and Singapore (Lusht, 1996; Chow et al., 2011) and in neighboring countries of Sweden, such as Denmark and Norway.

A number of papers have studied commercial real estate auctions, mainly on land parcels (see Tse et al., 2011, for a recent study). In their paper, Tse et al. examine the outcome of open-bid English auctions of rights to develop residential real estate projects in Hong Kong. Auction data, such as the number of bidders and the number of bids by each bidder, are included in the regression. These are found to have a significant positive effect on the size of the winning bid compared to three different measures of reference price.

Only a few papers have studied how auction data affect sale price in residential markets. Ong et al. (2005) analyze the sales probability of residential real estate in Singapore sold by auction. One of the explanatory variables is the *number of bidders*; however, the effect on sale price is not specifically analyzed. Instead, the dependent variable is binary: successful auction or not. The number of bidders is found to positively affect the success of an auction. Amidu and Agboola (2009) examine sale-price determinants as well as their effect on the size of the auction premium in a first-price sealed bid auction of 120 residential properties owned by the federal government in Ikoyi, a neighborhood in Lagos, Nigeria, and observe that the number of bidders is positively correlated with the auction winning bid and premiums[7]. Chow et al. (2011) also analyze the residential real estate market in Singapore, where they compare sales revenues from auctions to negotiated sales. The authors conduct both a theoretical and an empirical study of these relationships. They are able to observe with their theoretical simulations that when demand in the market is stronger, i.e. when there are a large number of bidders, the expected selling price is relatively higher under the auction mechanism than the negotiated sales mechanism, taking into consideration the different segments of buyer (private) valuations. For the empirical part of the study, Chow et al. (2011) utilize a database that contains information on attempted auction sales by sellers and the transaction price and sales mechanism in cases where sales succeed. The dataset used in the empirical model contains 3,022 successful sales for the period 1995Q3 to 2006Q4, of which 777 observations are auction sales. Although the dataset does not specifically contain the number of bidders for each transaction – and therefore Chow et al. do not analyze the effect of the number of bidders on price – a binary dummy variable is included, but only in the probit equation, adding to it the information that concerns whether there were bidders in the previous auction attempt, in order to model the choice of sales mechanism for the property.

The introduction of internet auctions, such as eBay and Amazon[8], has contributed significant data for auction studies. Some of those papers have, one way or another, analyzed the effect of number of bidders on final auction price. Lucking-Reiley et al. (2007) test the impact of specific online auction data from eBay, such as feedback ratings from sellers, minimum bids, reserve price, and time on market, on price. Although they did not directly analyze the

[7] *Auction premium* is defined in Amidu and Agboola (2009) as the percentage difference between the highest bid price and the reserve price of the property, divided by the reserve price.

[8] eBay and Amazon mostly offer independent private value auctions, with the difference that eBay auctions have a fixed closing time, while Amazon auctions extend the closing time automatically in response to late bids (Roth and Ockenfels, 2002).

effect of the number of bidders on price, they conclude that one of the explanations that time on market has a positive correlation to price could be that longer auctions allow for more accumulation of potential bidders. Bapna et al. (2009), on the other hand, directly observe the impact of the number of bidders (as a percentage of participants) on online auction price and their results are consistent with the hypothesis that a higher proportion of participators in an auction will lead to higher prices in that auction. The focus of these studies has been mainly on how online auction rules influence the behavior of bidders and bidding strategy. The implications that can be drawn from this part of the literature must be further analyzed, however, as they are based on auctions of items with much lower value than properties.

3. The Empirical Model

The standard approach of measuring the effect of a certain attribute on property price is to model price by a hedonic equation, where *attribute of interest* is one of the explanatory variables.

The hedonic model is generally represented by the following equation:

$$\text{Price} = f\,(\text{Housing Attributes, Other Factors})$$

A substantial number of researchers have attempted to explain the value of real property through empirical studies by using this approach. Contrary to what many believe, Court (1939) was not the precursor of hedonic models (with an application to the automobile industry). A study by Colwell and Dillmore (1999) shows that, almost a century ago, Haas (1922) wrote a monograph where he applied a hedonic model to estimate the value of farmland. The authors also pinpoint that, a few years later, Wallace (1926) analyzed the value of farmland in Iowa by using the same method, but it was only in 1966 that the estimation of the value of utility-generating characteristics was included in the model, with a natural application to housing (Lancaster, 1966). Later, Rosen (1974) utilizes a hedonic model, giving focus to price determination instead of utility.

Following Rosen's model, Malpezzi et al. (1980) consider housing to be a bundle of individual characteristics and assume that consumers derive utility from them, and that the value of these utilities can be priced. The authors price individual attributes of houses by using multiple regression analysis on a pooled sample of many dwellings. Nevertheless, a problem may arise by using this model, as the derived values tend to be not the same for all price ranges of houses. For this reason, the hedonic model is usually estimated in a semi-log form, with the natural log of price used as the dependent variable. In this form, coefficient estimates represent the percentage change in price for a one-unit change in the given variable. Moreover, a semi-log model helps to minimize the problem of heteroscedasticity (Follain and Malpezzi, 1980).

A number of recent studies have given focus to the relationship between *time on market* and *selling price*. These two variables have been interchangeably used as explanatory variables. Usually, when *time on market* is included in a selling price estimation model, this variable tends to be statistically significant and negatively correlated to price. In other words, a longer time taken to sell a house means a lower selling price (see for e.g., Haag et al., 2000; Johnson et al., 2001; Knight, 2002). The opposite relationship between *price* and *time on market* is not that straightforward: some studies show that a high selling price leads to a longer selling time, while others show exactly the opposite (see for e.g., Jud et al., 1996; Rutherford et al., 2001; Anglin et al., 2003; Björklund et al. 2006; Wilhelmsson, 2008). It is important to mention that none of the above-mentioned studies have analyzed *time on market* from a real estate auction perspective. The present study does not, however, treat this relationship, as the variable *time on market* is not available in the dataset. Nonetheless, it would have been interesting to observe the relationship between *time on market*, *number of bidders* and *selling price* in an auction context.

By following the commonly used semi-log approach of assuming a semi-logarithmic functional form, the natural log of the price of a condominium apartment per square meter is modeled as follows:

$$\begin{aligned}\ln\left(p\_sqm\right) = {} & \alpha + \beta_1 fee\_sqm + \beta_2\left(fee\_sqm\right)^2 + \beta_3 size + \beta_4\left(size\right)^2 + \beta_5 room \\ & + \beta_6\left(room\right)^2 + \beta_7 room\_size + \beta_8\left(room\_size\right)^2 + \beta_9 bidder \\ & + \beta_{10}\left(bidder\right)^2 + \beta_{11} d\_vasa + \beta_{12} d\_soder + \beta_{13} d\_kung + \beta_{14} dist\_hoet \\ & + \beta_{15} d\_dist\_sture + \lambda' month + \varepsilon\end{aligned} \tag{1}$$

where:

fee_sqm = monthly condominium fee per square meter;
size = living area in square meters;
room = number of rooms[9];

[9] Note that, in Sweden, the number of rooms in an apartment includes the number of bedrooms and living rooms. So, for example, a 1-room apartment is a studio, with common space for the bedroom and living room, a small kitchen and a bathroom; a 2-room apartment contains one separate bedroom and one living room, with a kitchen and bathroom; a 3-room apartment has two bedrooms and one living room, and depending on its size, may have a bathroom and separate lavatory, and so on. The configuration of the apartments may vary in terms of number of bathrooms, depending on the living area, but this figure is not available as a search criterion in Sweden. In other words, the kitchen and the bathrooms are never included in the figure for number of rooms. In the U.S., for example, the number of rooms is specifically divided into the number of bedrooms and bathrooms.

room_size = average size of the rooms of the object, i.e. the living area divided by the number of rooms;
bidder = number of bidders;
d_vasa = dummy variable for objects located in the Vasastaden neighborhood;
d_soder = dummy variable for objects located in the Södermalm neighborhood;
d_kung = dummy variable for objects located in the Kungsholmen neighborhood;
dist_hoet = the distance, in meters (in a direct line), from all objects in the sample to the city center, Hötorget;
d_dist_sture = the distance, in meters (in a direct line), from the objects specifically located in the Östermalm district to the sub-city center, Stureplan; and
λ'_{month} = vector of parameters; $\lambda' = [\lambda_1, ..., \lambda_{10}]$ which represents the coefficients on the time dummy variables (*month*) for the months from February to November 2010.

A description of all the untransformed variables can be found in Table 1. The quadratic term was calculated for each of the discrete variables, with the exception of the average size of rooms[10].

In order for standard ordinary least squares (OLS) to yield unbiased coefficient estimates, all attributes that affect price must be captured by the explanatory variables. Alternatively, omitted explanatory variables must be uncorrelated with both the included variables and the error term. These are rather strong assumptions when estimating hedonic property price regressions and it is not plausible to believe that they are completely fulfilled. The remedy for an omitted variable problem is of course to add the omitted variable to the model. However, due to data availability problems and lack of knowledge of all relevant variables, a true model is seldom achieved. Potential omitted variables in this research would be, for e.g., *quality of the apartments*.

Another potentially serious estimation problem is the so-called spatial autocorrelation, that is, residuals (or prices) are spatially correlated due to unobserved geographically related characteristics; see for e.g., Wilhelmsson (2002) for a review of spatial models applied to real estate economics. He stresses the importance of including a spatial structure when estimating housing values through hedonic modeling. The author emphasizes that spatial effects in the form of spatial dependency and spatial heterogeneity cause coefficient parameters to become inefficient and inconsistent. The occurrence of spatial correlation in the residuals is tested by the calculation of Moran's I,

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[10] Most of the quadratic explanatory variables are not significant on conventional levels. However, pairwise F-tests of the combined effect of the linear and the quadratic terms, e.g. $size + size^2$, show prob-values below 1% in all cases.

where the spatial weight matrix is defined as the inverse square distance between apartments, given a specified distance band.

4. Data and Descriptive Analysis

Data in terms of transactions were gathered from the website *e-bud*[11], where data on both ongoing and finished auctions of residential apartments and houses in Sweden are available. The website works as a tool for brokers to make sales more transparent. To be able to place bids on auctions at *e-bud*, potential buyers must first register their interest with a responsible broker. Such registration usually occurs during the showing of an apartment unit, when all potential buyers have the opportunity to make a simultaneous inspection of a unit. There are usually two showings of an apartment, with a few days in between. The auction usually starts the day after the second showing. A potential buyer does not have to be registered on *e-bud* to place a bid. S/he can instead call the broker who registers his/her bid online. Hence, *e-bud* does not work as other online auction sites such as eBay and Amazon since one does not have to be directly registered with the auction site.

The empirical analysis is based on 512 closed transactions of condominium apartment units in inner-city Stockholm during the period January–November 2010. The dataset includes price, property attributes, condominium fee, geographical location, brokerage firm, and the actual number of bidders that participated in the auction. Descriptive statistics are found in Table 1.

In order to control for geographical variation in condominium prices, dummy variables have been created. These variables are based on the geographical zones used by the Association of Swedish Real Estate Agents (Mäklarsamfundet) in their publicly published price statistics[12]: Södermalm, Vasastaden, Kungsholmen and Östermalm (see Figure 1). A rationale for this subdivision is that different types of households traditionally favor different locations within the city center. For example, Östermalm, the most expensive area, attracts above-average income, wealthy, “conservative” households, while the Södermalm area attracts younger households with, on average, lower incomes and less wealth.

As can be seen in Table 1, Östermalm (*Location 1*) is under-represented in the sample, with only 10 percent of the total number of observations. Moreover, approximately 70 percent of the sales in the sample are for small apartments (1- and 2-rooms).

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[11] www.ebud.nu

[12] The price statistics are based on monthly averages of price per square meter and can be found on http://www.maklarstatistik.se/.

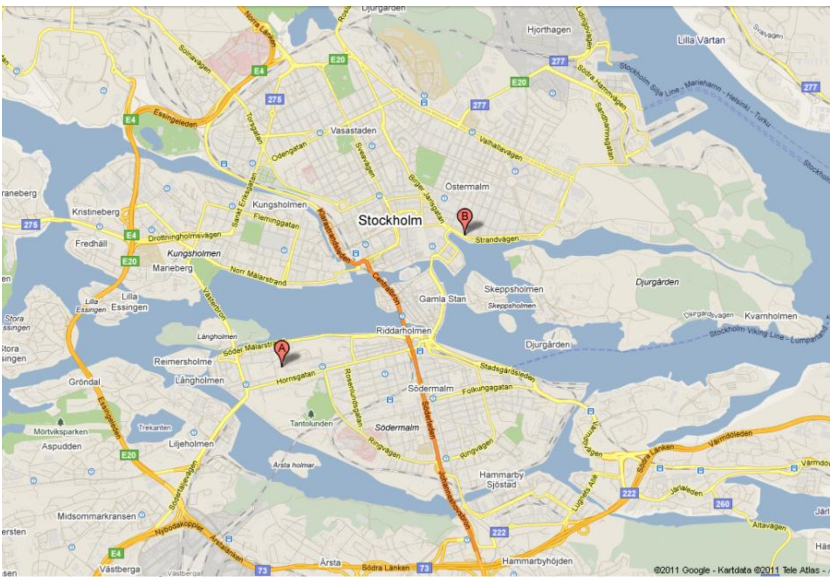
Changes in general price level during the time period under study are captured through monthly time dummy variables.

Table 1 Descriptive Statistics

	Abbreviation	Unit	Average	Std. Dev.
Sale price	s_price	Swedish crown, SEK	3,141,543	1,463,051
Living area	size	Square meters	58.20	27.91
Rooms	room	Number of rooms	2.04	0.97
Bidder	bidder	Number of bidders	4.27	2.08
Location 1	d_oster	Binary, 1 if located in Östermalm	0.10	0.29
Location 2	d_vasa	Binary, 1 if located in Vasastaden	0.19	0.39
Location 3	d_soder	Binary, 1 if located in Södermalm	0.37	0.48
Location 4	d_kung	Binary, 1 if located in Kungsholmen	0.34	0.47

Note: The number of observations total 512.

Figure 1 Map of Inner-city Stockholm



Source: Google Maps, 2012.

5. Results

The regression results are presented in Table 2. Panel A shows the results for the case in which the *number of bidders* is not included as an explanatory variable, while Panel B shows the results when this explanatory variable is included.[13] The model in Panel A explains prices fairly well and the adjusted R-squared is 0.54. All explanatory variables except for the squared variables of *condominium fee*, *living area* and *room size* are significant at the 10 percent level or less (time dummy variables are not reported). Inclusion of the squared variables, however, increases the explanatory power of the model. As expected, the coefficient for *condominium fee* is negative. An increase of the monthly fee per square meter by 1 SEK (the average fee in the dataset is 47 SEK) decreases the price by approximately 100 SEK per square meter, which is about 0.2 percent of the price per square meter of the average apartment[14].

The geographical dummy variables all show significant negative coefficients, which confirm that the Östermalm area (the omitted dummy variable) is the most expensive area in inner-city Stockholm. Furthermore, the distance to the city center is also negatively significant, as is the local sub-center dummy variable for Östermalm. Local sub-center dummy variables for the other areas were tested, but not found to be significant, and therefore discarded.

The results in Panel A also indicate that small apartments, on average, are priced higher per square meter than midsize and large apartments. The effect is shown in Figure 2, which also illustrates an interesting relationship between price per square meter, living area and number of rooms: as the living area increases (holding the number of rooms constant), the willingness of households to pay decreases. Furthermore, one can see the effect of the size of the rooms becoming suboptimal. For example, 2-room apartments are more highly priced per square meter than 1-room apartments when total living area exceeds approximately 30 square meters.

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[13] The standard errors in Table 2 are heteroscedasticity-consistent. The regressions were also run without applying White's heteroscedasticity-consistent standard errors. The results reveal that the robust standard errors are all similar to those in the non-robust regressions.

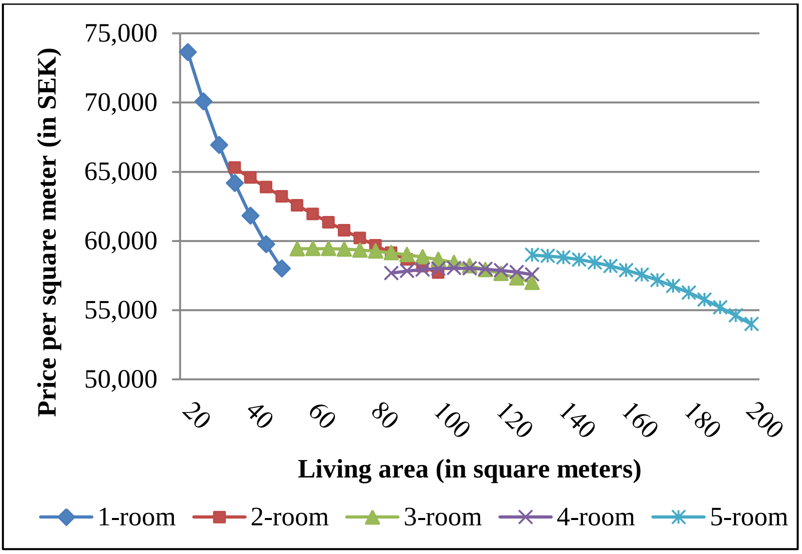
[14] A back-of-the-envelope calculation, which assumes that the long-term borrowing cost (as of 2010) of a 4.5% interest rate (after tax) plus a risk adjustment of 2%, i.e. 6.5%, approximates to the true cost of capital yields that the condominium fee is capitalized at approximately 35% of the price.
Assuming a perpetual constant fee in real terms and a long-term inflation rate of 2%, a 1 SEK increase in monthly fee (12 SEK per year) would reduce the price by 12/(6.5%-2%) = 267 SEK per square meter if the fee was fully capitalized. According to the regression model, the reduction in price of 100 SEK per square meter for an increase of 1 SEK per square meter implies a capitalization of 100/267 = 37.5% of the change in the fee in the price. This number is quite similar to the ones estimated by Jonsson and Lundström (2004) and Gebro and Olsson (2011).

Table 2 Regression Results with Heteroscedasticity-consistent Standard Errors

	Panel A		Panel B	
	Coefficient	t-value	Coefficient	t-value
Property Attributes				
Condominium fee per square meters	-0.00271	(-2.14)	-0.00222	(-1.95)
Condominium fee per square meters (squared)	9.87e-06	(0.84)	0.00001	(1.02)
Living area	0.00841	(1.71)	0.00735	(1.67)
Living area (squared)	0.00002	(-1.23)	0.00002	(-0.94)
Rooms	-0.37323	(-2.59)	-0.32470	(-2.52)
Rooms (squared)	0.03251	(2.16)	0.02453	(1.82)
Room size	-0.02197	(-1.61)	-0.01949	(-1.55)
Room size (squared)	0.00010	(0.65)	0.00008	(0.56)
Spatial Characteristics				
Location 1 (Östermalm)	(omitted)			
Location 2 (Vasastaden)	-0.18241	(-6.10)	-0.16895	(-5.66)
Location 3 (Södermalm)	-0.24332	(-7.47)	-0.22524	(-7.11)
Location 4 (Kungsholmen)	-0.21562	(-7.05)	-0.19949	(-6.65)
Distance to city center	-0.00005	(-7.89)	-0.00005	(-8.66)
Distance to sub-city center	-0.00012	(-4.48)	-0.00010	(-4.17)
Auction Information				
Number of bidders	-	-	0.03934	(5.39)
Number of bidders (squared)	-	-	-0.00186	(-2.89)
Constant	12.09577	(44.67)	11.83133	(47.08)
Adjusted R-squared *	0.5415		0.6214	

Note: * Obtained from the regression run without heteroscedasticity-consistent standard errors.

Figure 2 Estimated Sale Price of an Apartment in the Östermalm District as a Function of Number of Rooms and Size.[15]



Panel B shows the result when *number of bidders* are included as an explanatory variable. Inclusion of such auction data significantly increases the explanatory power of the model, with the adjusted R-squared increased to 0.62, which can be considered as a rather good fit for a model that explains price per square meter. The coefficient estimates for variables other than *bidder* are similar to those in the model that omits bidders.

Both the linear and the squared bidder terms are significant at the 1 percent level with the expected signs. That is, the linear term is positive and the quadratic term is negative, which indicate the declining marginal effect of increasing the number of bidders. The effect of the number of bidders is also strongly economically significant. Starting at one bidder, the increase in price when adding one more bidder is 3.9 percent and the corresponding increase when going from five to six bidders is 1.9 percent (the average number of bidders in the data is 4.3, the minimum is 1 and the maximum is 12). As a further illustration, increasing the number of bidders for an average apartment from one to six, the expected selling price increases by 14 percent. This effect is in line with the results obtained in Tse et al. (2011), who find that one extra

[15] The same sale price estimation was done for the coefficients obtained in Panel B, but this time, the number of bidders and its quadratic term were added as explanatory variables. No significant changes were observed. The only differences are that the estimated price per square meter slightly increases for smaller apartments and slightly decreases for large apartments, in comparison to Panel A.

bidder, on average, increases the ratio of the winning bid to the ex ante market value by approximatelly 3 percent, measured by a linear bidder term only.

To test if the effect on price by the number of bidders varies with geographical location, the regression in Panel B was also separately run for the four neighborhoods. The results reported show that the effect is stable, i.e. price significantly increases (at the 1 percent level or less) with the number of bidders, and the coefficients are similar to those in the full model. For two of the neighborhoods, however, the model shows a better fit when only including the linear bidder term. [16]

To control for differences on the effect of number of bidders on price per square meter for each neighborhood, a regression was run (see Table 3), where location dummies interact (are multiplied) with the number of bidders. The results reveal an increase in goodness of fit of the model by 0.99 percent compared to the adjusted R-squared in Panel B of Table 2, and show that the effect of the *number of bidders* is more linear in Östermalm, Vasastaden and Kungsholmen than in Södermalm, since they all have a negative coefficient for the linear interaction term and a positive coefficient for the squared term (although only the terms for Kungsholmen are significant at the 10 percent level or lower).

In order to test for spatial autocorrelation, a row-standardized inverse distance weight matrix was created by using a distance band of 800 meters. Moran's I was estimated and a statistic of 2.674 implies that the null hypothesis of no spatial autocorrelation is rejected. Spatial regressions were run both as a spatial error model (SEM) and a spatial autoregressive (SAR) lag model, since spatial dependence can stem from both neighborhood spillover effects, i.e. the price of a particular apartment can be affected by the attributes of neighboring apartments, and omitted neighborhood attributes that make the error terms spatially correlated.

The spatial regression results for the log-linear model are found in Table 4. As evident, the coefficient estimates of the SEM and the SAR models are rather similar, and they are, furthermore, similar to those of the non-spatial regressions. Hence, the results of the model do not seem to be sensitive to the occurrence of spatial dependency and choice of spatial model.

[16] Similar regression models to the ones presented in Table 2, Panels A and B were run, this time including dummy variables for the different brokerage firms in the dataset (unreported), grouped by size of firm (small, medium and large). No statistically significant difference between the groups was found, which implies that there are no differences among the groups in terms of their performance in obtaining a higher sale price per square meter.

Table 3 Regression Results in Which Location Dummies are Interacted with Number of Bidders with Heteroscedasticity-consistent Standard Errors

	Coefficient	t-value
Property Attributes		
Condominium fee per square meters	-0.00201	(-1.72)
Condominium fee per square meters (squared)	8.46e-06	(0.82)
Living area	0.00772	(1.67)
Living area (squared)	0.00002	(-0.94)
Rooms	-0.32633	(-2.41)
Rooms (squared)	0.02355	(1.64)
Room size	-0.02053	(-1.58)
Room size (squared)	0.00009	(0.62)
Spatial Characteristics		
Location 1 (Östermalm)	(omitted)	
Location 2 (Vasastaden)	-0.17157	(-1.77)
Location 3 (Södermalm)	-0.35111	(-3.96)
Location 4 (Kungsholmen)	-0.23804	(-2.70)
Distance to city center	-0.00005	(-8.80)
Distance to sub-city center	-0.00011	(-4.05)
Auction Information		
Number of bidders	0.05831	(5.34)
Number of bidders (squared)	-0.00287	(-3.16)
Number of bidders at Södermalm	(omitted)	
Number of bidders at Södermalm (squared)	(omitted)	
Number of bidders at Östermalm	-0.04813	(-1.43)
Number of bidders at Östermalm (squared)	0.00390	(1.10)
Number of bidders at Vasastaden	-0.03542	(-1.51)
Number of bidders at Vasastaden (squared)	0.00138	(0.68)
Number of bidders at Kungsholmen	-0.03254	(-2.07)
Number of bidders at Kungsholmen (squared)	0.00219	(1.70)
Constant	11.90847	(44.25)
Adjusted R-squared*	0.6313	

Note: * Obtained from the regression run without heteroscedasticity-consistent standard errors.

Table 4 Spatial Regression, in Price per Square Meter as a Dependent Variable (Spatial Error – SEM and Spatial Autoregressive Lag Models – SAR)

	SEM		SAR	
	Coefficient	z-value	Coefficient	z-value
Property Attributes				
Condominium fee per square meters	-0.00201	(-1.52)	-0.00195	(-1.49)
Condominium fee per square meters (squared)	8.42e-06	(0.66)	8.86e-06	(0.70)
Living area	0.00671	(1.97)	0.00723	(2.14)
Living area (squared)	-0.00001	(-1.10)	-0.00002	(-1.26)
Rooms	-0.30199	(-2.92)	-0.31434	(-3.05)
Rooms (squared)	0.02230	(2.03)	0.02363	(2.16)
Room size	-0.01804	(-1.93)	-0.01841	(-1.98)
Room size (squared)	0.00007	(0.66)	0.00007	(0.65)
Spatial Characteristics				
Location 1 (Östermalm)	(omitted)			
Location 2 (Vasastaden)	-0.16711	(-5.05)	-0.13763	(-4.43)
Location 3 (Södermalm)	-0.22684	(-6.30)	-0.18226	(-5.14)
Location 4 (Kungsholmen)	-0.20063	(-5.98)	-0.16366	(-5.06)
Distance to Hötorget	-0.00005	(-7.29)	-0.00004	(-4.97)
Distance to Stureplan	-0.00010	(-4.08)	-0.00009	(-3.78)
Auction Information				
Number of bidders	0.03807	(5.27)	0.03921	(5.47)
Number of bidders (squared)	0.00176	(-2.62)	-0.00185	(-2.77)
Constant	11.78912	(59.03)	9.53705	(9.55)
Moran's I	2.674		2.674	
Lambda / rho	1.56		2.34	

Although the results of the performed regressions indicate the robustness of the explanatory variable *number of bidders*, it should be noted that the dataset does not include variables that can be used to control for the quality of buildings and apartments, such as the age of the building, level of maintenance of buildings and refurbishment of apartments[17]. As discussed in

[17] One may argue that the size of the condominium fee is related to the quality of the building/apartment. However, it would be difficult to disentangle the relationship that one should expect. On the one hand, a low fee may indicate a wealthy condominium that can afford an above- average level of maintenance, which results in above-average quality of the building. On the other hand, a low fee might just be the effect of the

the model section, omitted variables may lead to biased coefficient estimates if they are correlated with included variables. The focus of this study is the effect of the number of bidders on sale price and hence any correlation between the quality of the units for sale and number of bidders may bias the conclusions that are drawn in this respect. It may be, for example, the case that high-quality apartments on average attract more bidders. However, the economic theory does not provide any guidance as to the sign or degree of correlation that can be expected. It may equally well be the case that (less expensive) low-quality apartments attract more bidders. Any correlation between the number of bidders and quality is a feature of the particular property market and the time period under study.

6. Conclusion

Condominium apartments in Sweden are normally sold by auction; therefore, the unfolding of an auction can be expected to affect the selling price of properties. According to a common view among Swedish brokers, a key variable for the outcome of an auction is the number of bidders that participate.

By using 512 transaction prices for condominium sales in inner-city Stockholm, the effect of the number of bidders on final auctioned price has been studied. The estimated hedonic equations show a significant positive relationship between *number of bidders* and *sale price*. The result supports the view among brokers that it is important to attract as many potential bidders as possible to the showing of an apartment in order to increase the number of bidders, which, in turn, increases the selling price. As a means of achieving a high number of visitors to a showing, brokers use underpricing when setting list prices, since this strategy supposedly increases the number of visitors.

The results of the study, however, cannot validate the arguments for using underpricing – that underpricing attracts more potential buyers to a showing, and this in turn, actually leads to more bidders. The study only provides evidence that an increased number of bidders positively affect the sale price. In order to more explicitly study underpricing, both an unbiased market value estimate that can serve as a benchmark when determining the level of under/overpricing and also a tally of the number of potential bidders at each showing are required for each transaction.[18]

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condominium neglecting maintenance in order to keep the fee low. The size of the fee is furthermore related to the age of the condominium and hence how much of the original debt is amortized. That is, the size of the fee is related to the amount of debt carried by the condominium.

[18] Ong et al. (2005) use turnout, i.e. the number of people who visit an auction, as proxy for number of bidders and hence hypothesizes that the number of visitors is positively correlated to the number of actual bidders.

Another interesting extension of this study would be to use more elaborate auction data, such as those used by Svensson et al. (2010), who have analyzed the sales of gift cards and concert tickets auctioned on eBay and Tradera, controlling for auction length and its effect on price. For the analysis, they even consider the number of bids by individual bidders and bid amount intervals, among other auction variables. Such an empirical study that considers bidder behavior and strategy in a residential property context would be beneficial for the understanding of the price setting mechanism in the private housing market.

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