Opening Bid Strategies in English Auctions

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Abstract

Existing residential homes in Norway are sold by English auctions. This provides an exclusive opportunity to examine opening bid strategies for high-valued objects. Using unique data from surveys and auction journals, we find that the direct price effect of a high opening bid is stronger than the intimidation effect. A higher opening bid is associated with an overall higher price premium in OLS and fixed-effects regressions. Our results have implications for both buyers and sellers in situations where auctions and auction-like sales mechanisms are used, and for policy makers regarding auction process rules and market regulations.

1 Introduction

For most people, buying a home is the largest and most important investment in their lifetime. Concurrently, in much of the world, existing residential properties are sold via auctions or modified auctions. Hence, attaining knowledge about how auctions and strategies work is crucial. The present study evaluates the effect of different opening bid strategies in an open ascending-bid (English) auction. In Norway, nearly all existing residential properties are sold by English auction, providing an exclusive opportunity to examine opening bid strategies for high-valued objects in a strongly regulated auction setting with private investors.

Although privately negotiated sales are the most common method of selling residential dwellings, there are several countries where auctions have a central place in the real estate market. Even in countries dominated by private sales, auctions often have an important place in urban areas where housing is in high demand. Moreover, in countries where both private and auction sales are prominent, including Scotland, Ireland, Australia, and New Zealand, auctions are more often used in boom market periods for heterogeneous properties when precise valuation is challenging, and for properties in areas with high demand such as urban areas (Gan, 2013). Chow et al. (2015) find that when the Singaporean market is booming, properties sold through auction achieve a higher premium compared with negotiated sales. Additionally, bidding wars with an inherent auction-like dynamic sometimes occur in negotiated sales where there are several potential buyers. Bidding wars have traditionally been associated with booming markets, and have become more frequent in the United States during the last decade. However, Han and Strange (2014) find that the frequency does not revert to the mean after a bust, and suggest that bidding wars may also be a consequence of buyer irrationality. Thus, the importance of optimal bidding strategies in a formal auction setting

may also carry over to other housing sales mechanisms, such as auction-like modified bid sales that are very common for high value institutional real estate in the US and other developed markets.

We use two unique datasets to study opening bid strategies. First, results from a survey regarding real estate auctions are used to identify bidding strategies and related motivations. We find that the opening bid distribution has a negative skew, a positive kurtosis and a mean slightly below the asking price, and that stronger bidder competition is associated with a more aggressive opening bid strategy. Second, by using exclusive auction journal data from property sales in Norwegian cities. we examine the effect of opening bid strategies on the price premium. To do this, we apply two main techniques. First, we compare the sales price with estimates of what the price normally would have been: the estimated value. By estimated value we mean the best estimate for the price of the dwelling before the auction takes place. We estimate this value in three ways: first, by using the asking price set by the real estate agent; second, by using a standard hedonic pricing model; and third, by using a repeat sales model. Although all valuation techniques have their weaknesses, there is no reason to believe that the three valuation techniques should have a bias that is correlated with a high opening bid. Finally, we take full advantage of the panel structure of the dataset, applying fixed-effects models. To our knowledge, we are the first to study opening bids in English auctions by applying fixed-effects models. We find that signaling and intimidation in the form of placing a high opening bid have a negative impact on the number of bidders. However, by opening an auction with a high bid, the bidder has given an irreversible signal of a high valuation. Even if some potential bidders are intimidated and stay out of the auction, other potential bidders who already have a high valuation of the dwelling remain. A high opening bid will strengthen these remaining bidders' belief that the dwelling has a high value, and they may even perceive that the

signal means that their own valuation is too low, therefore adjusting their valuation upwards accordingly. Thus, the auction may end at a premium.

To our knowledge, we are the first to examine the signaling effect of the opening bid itself, and to use auction journals in combination with original survey data. Our results have implications for both buyers and sellers in situations where auctions and auction-like sales mechanisms are used, and for policy makers involved in formulating auction process rules and market regulations. While our focus is residential property, the results should be of interest to commercial real estate investors where auction-like structures are becoming more common.

The paper is organized as follows. Section 2 provides an overview of existing literature and details of the Norwegian real estate auction process; a description of the data is presented in Section 3; and Section 4 explains the methodology. We present the results in Section 5, followed by a discussion and concluding remarks in Section 6.

2 Background

2.1 Previous literature

There are several auction institutional designs (see for instance Weinstein et al. (2009) for a discussion on bidder's choice cap rate auctions, Zhang (2017) on bidding functions in first-price sealed-bid auctions, and McCabe et al. (1990) on a comparison of multiple-unit auctions), but the open ascending-bid type, commonly referred to as the English auction, probably remains the most popular mechanism (Krishna, 2003).

In contrast to the traditional ratchet solution suggested by Vickrey (1961), whereby bids are sequentially increased by marginal amounts (also called straightforward bidding), Daniel and Hirshleifer (2018) note that placing bids that are higher than necessary as an intimidation/signaling strategy to reduce the number of contenders can be profitable. When bidding costs are incurred in an individual private value model, rival bidders perceive the high bidder's valuation to be greater than their own, and their cost-effective strategy is to quit bidding. Avery (1998) argues that in an affiliated valuations model, intimidation strategies can be economically rational and may result in two competition-reducing effects. First, the bidder indicates that he or she values the auctioned good the most. Second, the bidder indicates that if a rival places a subsequent higher bid and the aggressive bidder's response is to quit bidding, the rival may have overbid and thereby become a victim of the winner's curse. Hence, the successful use of a high opening bid will lead competitors to drop out early and the auction is won at a relatively low price.

As illustrated in Levin and Pryce (2007), a higher number of bidders increases the probability of a higher maximum bid. Consequently, intimidation strategies may increase the expected buyer revenue. Conversely, Isaac et al. (2007) argue that neither irrationality nor signaling are required for bidders to deviate from the straightforward strategy. However, in their model, which allows for impatience and strategic bidding, placing high bids can be more efficient than straightforward bidding in some cases and it may increase seller revenue.[1] In an experimental study, Isaac et al. (2005) find no evidence of effective signaling behavior, and argue instead that placing high bids is the result of impatience. Grether et al. (2011) also argue that intimidation strategies can be advantageous when time costs are considered. In an empirical analysis of Internet auctions for used cars in Texas and New York, they find evidence of both impatience and intimidation effects.

Placing initial bids with a high premium is a common occurrence in takeover bidding, a type of ascending auction with asymmetric information. The information acquired from the high opening bid affects other potential bidders' decisions to engage in the competition, especially when entry is costly. Fishman (1988) relates this preemptive bidding to the strategy of signaling a higher valuation, and develops a theoretical model where, in equilibrium, a high opening bid deters other bidders from engaging in the bidding process. However, in an empirical study of takeover offers for public companies in the United States, Dimopoulos and Sacchetto (2014) find that takeover premiums are largely determined by target resistance, rather than preemptive bidding. Target resistance can be likened to the seller of a property rejecting bids lower than the asking price.

Behavioral economists have attempted to explain aspects of auction prices and bidder behavior in the light of irrationality (Rothkopf and Harstad, 1994; Shi and Kabir, 2018), anchoring, and the quasi-endowment effect. Drawing from the works of Tversky and Kahneman (1974; 1979; 1991), anchoring is a cognitive bias whereby bidders strongly associate the true value of an auction item with an initial reference point such as the asking price or the initial bid. In this regard, a low (high) opening bid may result in a low (high) sales price (Dodonova and Khoroshilov, 2004; Beggs and Graddy, 2009). Anchoring is also a widely studied area in real estate, and there is substantial literature that suggests a potential anchoring effect (see for example Northcraft and Neale, 1987; Diaz III and Wolverton, 1998; Diaz III and Hansz, 2001; Genesove and Mayer, 2001; Black et al., 2003; Seiler et al., 2008; Bokhari and Geltner, 2011; Bucchianeri and Minson, 2013; Arbel et al., 2014; Cardella and Seiler, 2016; Zillante et al., 2019; and Shie, 2019). Han and Strange (2016) discuss the role of the asking price in housing transactions through a search model and find that a

lower asking price increases the number of potential bidders (NPB), but only up to a point where the higher possibility of a bidding war prevents more searching. Gonçalves (2013) finds that setting the reserve price too high reduces the likelihood of sale, but that the reserve price increases the seller revenue conditional on sale. See also Hidvegi et al. (2006) for a model of optimal buy prices in English auctions. The quasi-endowment effect suggests that bidders become more attached to auction items the longer they participate in an auction, particularly as a lead bidder, resulting in a higher willingness to pay (WTP) (Heyman et al., 2004; Wolf et al., 2005).

Few empirical studies have examined bidding strategies in real estate auctions. In two studies from the Swedish market, evidence shows that signaling a high valuation in the early stages of the competition reduces the number of bidders, but there is no indication that intimidation strategies reduce the sales price (Hungria-Gunnelin, 2013, 2018). Because of structural issues regarding Swedish real estate auctions – for instance, the lack of regulation by law and the possibility of both seller- and buyer-side collusion – these results may not be representative for markets with a higher degree of regulation, such as the Norwegian market (see for example Graham and Marshall (1987) for a model of collusive behavior in English auctions). Olaussen et al. (2018) suggest that the current market regime and, by extension, the number of potential bidders (NPB) may be the reason why we sometimes observe aggressive bidding behavior; a higher number of possible competitors can be an incentive for bidders to apply intimidation strategies.

2.2 The Norwegian auction process

Norwegian real estate auctions and agents are regulated by the Marketing Act (2009), the Regulation on Real Estate (2007), and the Industry Norm (2014). The seller employs a real estate

agent, who acts as both an independent third party and auctioneer. Only lawyers or companies with a special permit can sell dwellings through a real estate agency, and agents are required to have a real estate agent bachelor's degree, which includes subjects in business, marketing, and law, in addition to two years' work experience with a real estate company. The auction involves no reservation price, but the asking price must be set high enough that the seller is willing to accept it, and it must reflect the true market price. While a seller sometimes contributes to the final discussion regarding the asking price, in most cases, trust lies in the agent's judgment, using a sales comparison method of dwellings that are similar in type, size, location, and standard to determine the price level they believe the market is willing to pay.

Properties are marketed in newspapers, on real estate agents' websites, and on websites for classified advertisements, such as Finn.no. Advertisements contain the asking price and also specific dates for open house viewings, details of dwelling and residential characteristics, pictures, and a valuation report. Interested parties who sign up at the viewing receive information about the standing bid and the corresponding deadline during the auction, regardless of whether they bid. As the auction has no physical location, bidders are required to submit their offers in writing to the agent, which is usually done via e-mail or text message. The bidder's credentials and signature are mandatory for submission of the first bid. As all bids are binding, potential buyers are advised not to bid on several properties at the same time to avoid unintentionally becoming the legal owner of more than one dwelling. Although neither vendor bidding nor dummy bids are allowed, regulations permit binding counter offers from the seller.[2] Furthermore, there are no size restrictions on either the opening bid or the subsequent bid increases. For each bid, the participants are required to set a validity period of their own choosing, during which time the bid has to be accepted or rejected by

the seller. However, no offers can be placed with a deadline shorter than 12:00 noon of the day following the last announced showing. Ultimately, the winner is the sole remaining bidder, who pays the price equal to the highest bid.[3]

3 Data

We make use of two datasets in this paper. The first set contains results from a survey used to gain greater understanding of bidder behavior and to define variables, and the second is a sample of auction journals, used in the regression analysis. The datasets are presented in the following two sections.

3.1 Survey data on opening bid strategies

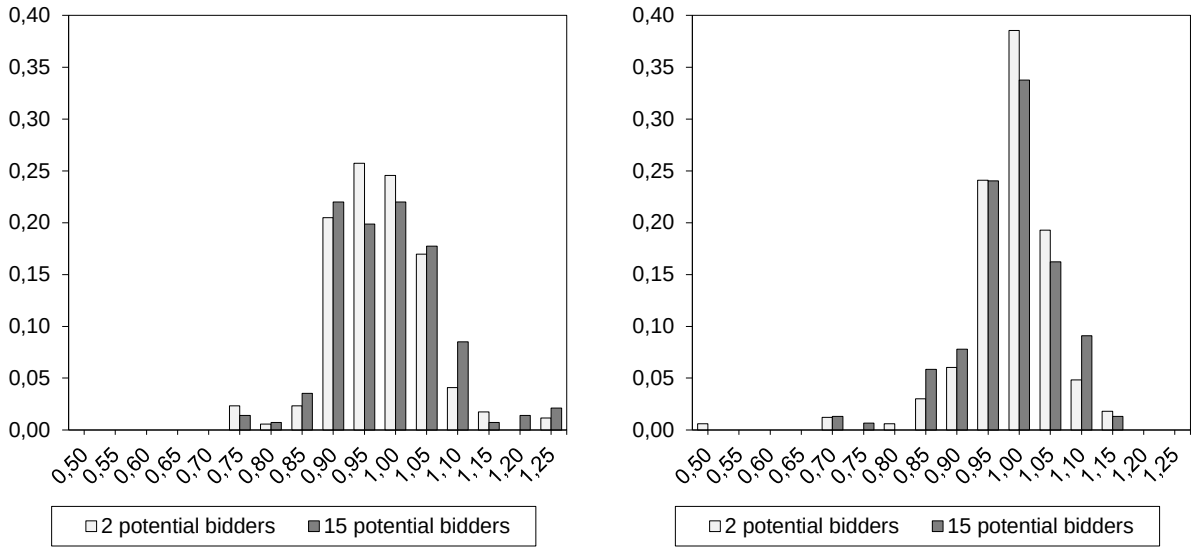
In December 2016 and January 2017, we conducted a survey in three of the largest Norwegian cities: Oslo, Trondheim, and Stavanger. In the survey, 1,803 random sampled people from the adult (18+) population of the three cities were asked about different aspects of strategic behavior in auctions for existing dwellings. The survey is described in greater detail in Sønstebø (2017). Its purpose was to map bidders' knowledge and their use of bid size and the timing of bids as strategic tools. One section of the survey consisted of a hypothetical auction for a desirable dwelling. Six subsamples of respondents were presented with a unique combination involving one of three different asking prices and one of two scenarios regarding the number of potential bidders (NPB). The dwelling's asking price was either NOK 2,000,000, NOK 3,000,000, or NOK 4,000,000, and the NPB was either two (low) or 15 (high).[4] In addition, the respondents' maximum WTP was defined and stated as 115 percent of the asking price in each scenario. When given a choice between specifying an opening bid or waiting, more than half of the respondents (967, or 54

percent) chose the former option. Note that when the subsamples with high and low NPB were considered separately, a higher proportion chose to place an opening bid in the scenarios with a low NPB (57 percent versus 51 percent).

To shed light on whether opening bids are adjusted to different price levels. Exhibit 1 presents the respondents' opening bids relative to the asking price, across the three different asking prices and two different numbers of potential bidders (NPB=2 and NPB=15). First, we observe that opening bids appear to be somewhat normally distributed in all scenarios, with a mean slightly below 1 and few observations with a ratio lower than 0.75 or higher than 1.25. After running a skewness and kurtosis test (Appendix, Exhibit A2), we reject normality and find that the total distributions are slightly negative skewed with a high kurtosis, suggesting a higher chance of low extreme values than high ones, and that observations are centered around the mean. This indicates that bidders consider the relative value when choosing their initial bid and that they are more likely to submit a low opening bid than a high one. Second, a higher NPB seems to correspond with a higher opening bid ratio, especially in the scenarios with the lowest and highest asking price, implying that stronger competition is associated with a more aggressive bidding behavior. This relation is confirmed in a simple regression controlling for socio-economic and locational factors (Appendix, Exhibit A3).

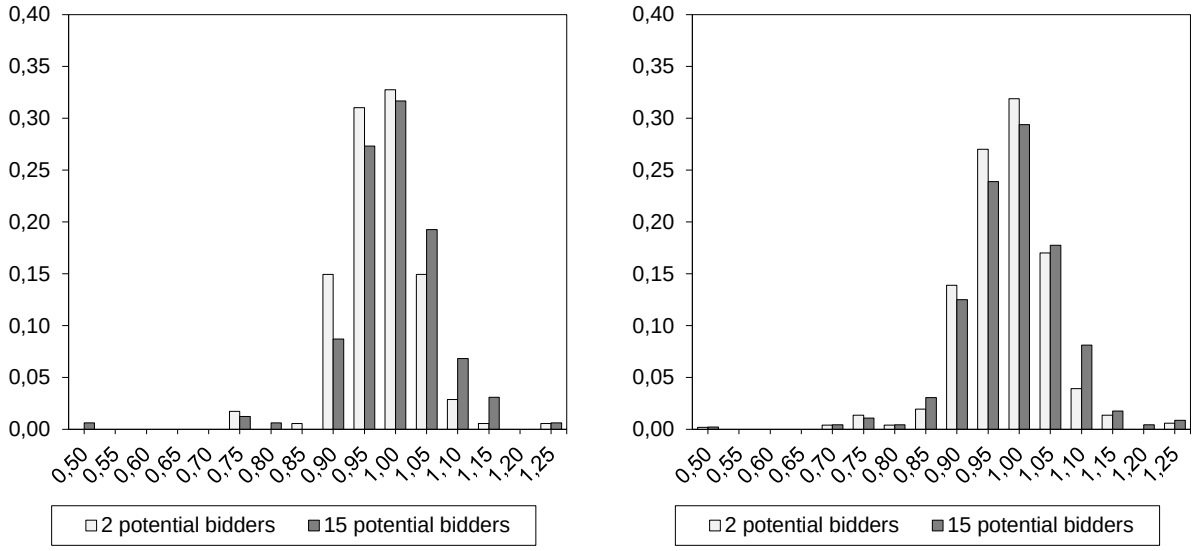
Exhibit 1. Distribution of the opening bid to asking price ratio.

(a) Asking price: NOK 2,000,000 **(b) Asking price: NOK 3,000,000**



(c) Asking price: NOK 4,000,000

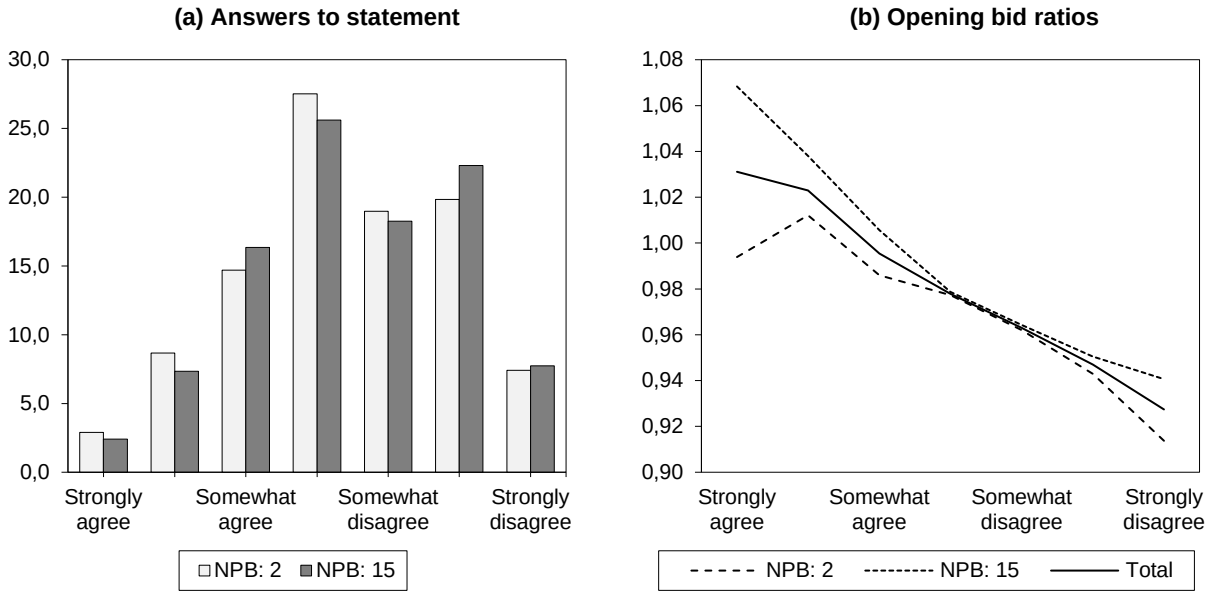
(d) Total



Notes: The survey defined and stated the respondents' willingness to pay (WTP) as 115 percent of the asking price in each scenario under two different numbers of potential bidders (NPB=2 and NPB=15). (a) NOK 2,000,000 scenario: N = (171; 141). (b) NOK 3,000,000 scenario: N = (166; 154). (c) NOK 4,000,000 scenario: N = (174; 161). (d) Total: N = (511; 456).

Another section of the survey consisted of a number of statements with which all respondents were asked to agree or disagree on a seven-point Likert scale. One such statement was as follows: "In order to obtain a home at the lowest possible price, it is generally advisable to place a high opening bid." Exhibit 2 presents the responses to this statement, as well as the average opening bid ratio from respondents on each measure of agreement with the statement.

Exhibit 2. Statement and opening bid ratios.



Notes: (a) All 1,803 responses to the statement "In order to obtain a home at the lowest possible price, it is generally advisable to place a high opening bid." (b) Average opening bid to asking price ratios of the 967 respondents specifying an opening bid in the hypothetical auction scenario, distributed among the corresponding answers to the statement. NPB: Number of potential bidders. Dashed line: Scenarios with 2 potential bidders. Dotted line: Scenarios with 15 potential bidders. Solid line: All scenarios.

While more respondents are inclined to disagree than to agree, a plurality are indifferent to or have no clear opinion on the statement. Among participants specifying an opening bid, the overall pattern is clear: a higher inclination to agree with the statement corresponds to a higher opening bid ratio, with a Pearson's correlation of 0.36 (significant at the 1-percent level). Furthermore, when comparing the NPB scenarios, we find that for each measure of agreement to the statement, the average opening bid ratio is higher when the NPB is high. This substantiates the notion that higher competition may lead to a more aggressive bidding behavior.

3.2 Auction journal data

The dataset for the opening bid strategy analysis consists of 2,551 auction journals from two of the largest real estate broker agencies in the Trondheim area. The sample comprises sales observations from January 2014 to June 2016 in the neighboring counties of Møre og Romsdal and Trøndelag, in which Trondheim is the largest city. An auction journal contains the address of the property, the sales and asking prices, all bids placed in the auction (including potential counter bids from the seller), the time each bid is placed, and the deadlines. All bidders are anonymized, but separated by individual ID numbers. After removing certain types of property such as commercial dwellings, garages, farms and plots of land, in addition to observations with missing values, 2,257 observations are used in the analysis.

From the descriptive statistics in Exhibit 3, we observe that, on average, the ratio of opening bid to asking price is about 94 percent, while the properties sell for about two percent higher than the asking price. The average number of bids is about five, whereas the average number of bidders is slightly less than two. The average time of a property on the market is 28 days, but a high standard deviation and a maximum value of 680 days indicates a great deal of variation.

Exhibit 3. Auction journal data descriptive statistics.

Variables	Mean	SD	Min	Max
Sales price (NOK)	2,662,830	1,225,711	350,000	13,200,000
Asking price (NOK)	2,609,491	1,177,483	300,000	12,000,000

Opening bid (NOK)	2,459,178	1,132,563	265,000	11,000,000
Sales price / asking price (%)	102.05	7.39	75.00	166.67
Opening bid / asking price (%)	93.96	6.50	62.02	145.45
Number of bidders	1.92	1.24	1	11
Number of bids	5.36	4.95	1	39
Time on market (days)	27.70	46.00	0	680
Age (years)	40.96	29.05	0	306
Size (m^2)	95.42	50.21	16	396
Number of bedrooms	2.42	1.26	0	13
Type of dwelling (%):				
Freehold apartment	24.32	42.91	0	1
Freehold detached	20.56	40.42	0	1
Freehold semi-detached	7.84	26.89	0	1
Freehold townhouse	5.76	23.30	0	1
Leisure home	1.33	11.45	0	1
Cooperative townhouse	3.72	18.93	0	1
Cooperative apartment	36.47	48.14	0	1
Transaction period (%):				
Quarter 1	36.87	48.25	0	1
Quarter 2	17.10	37.66	0	1
Quarter 3	9.39	29.18	0	1
Quarter 4	36.64	48.19	0	1
Year 2014	30.17	45.91	0	1
Year 2015	30.79	46.17	0	1
Year 2016	39.04	48.79	0	1

Notes: Number of observations = 2,257. Sales observations are clustered in 273 zip codes and 36 real estate agent offices. NOK 1 ≈ US$0.11 or €0.10 (exchange rate per January 2020).

We also make use of property specific information from the Norwegian property register, made available online by various providers. Our data is collected from Eiendomsverdi.no. This register includes important property characteristics, such as construction year, geographical location, type of property, dwelling size, and time on market, in addition to all previous sales of a dwelling. By using the address, sales date, and price, we are able to combine the data from the two sources.

4 Methodology

A key issue for assessing the effect of any bidding strategy is to be able to compare the sales price with the estimated value of the dwelling. As mentioned, by estimated value we mean the best estimate for the price of the dwelling before the auction takes place. To determine the relationship between the opening bid strategy and the price premium, we apply three different techniques to

estimate the price of a dwelling. The price premium p_i of dwelling i is defined as the natural logarithm of the ratio of sales price to estimated value:

$$p_i = \ln(P_i/V_i), \tag{1}$$

where P_i is the sales price for dwelling i and V_i is the corresponding estimated value measure. In other words, p_i is the percentage return on a sale with respect to the estimated value. For the estimated value, we first use the asking price set by the real estate agent. Second, we apply a valuation based on a standard hedonic pricing model. To improve our prediction model, we expand the sample of properties to 26,868 by adding dwellings sold during the same time period and in the same geographical locations as the properties from the auction journal sample. The log prices, $\ln(P_i)$, are then regressed on a set of dwelling attributes, X, such as age, size and type of dwelling, in addition to controls for locational (zip code), real estate agent (offices), yearly and quarterly variation, C (Appendix, Exhibit A1):

$$\ln(P_i) = \alpha + \delta' X + \omega' C + \epsilon_i. \tag{2}$$

A disadvantage of the hedonic model is that the accuracy of the price estimate depends on a large number of dwelling characteristics, some of which are difficult to observe. This problem becomes smaller if the valuation is based on previous sales. We start with calculating a repeat sales index, introduced by Bailey et al. (1963), which avoids this problem by estimating dwelling prices based on previous transactions of the same dwelling, thereby automatically controlling for idiosyncratic characteristics. One drawback of this approach is that a substantial amount of data is lost because

we only consider dwellings sold more than once. Hence, older dwellings are favored over newer ones with a lower probability of multiple sales. The repeat sales prediction model contains 2,134 pairs of sales observations, of which 1,185 are matched with the auction journal data and used in the main analysis. The following model is applied:

$$\ln(P_i^t / P_i^s) = \sum_{t=0}^{T} \gamma^t D_i^t + \mu_i^t, \quad (3)$$

where the dependent variable is the natural logarithm of the ratio of the most recent sales price of dwelling i, P_i^t, to the previous sales price of the same dwelling, P_i^s. D is a dummy variable that takes the value 1 in the period of the most recent sale, −1 in the period of the previous sale, and 0 otherwise. To account for the possibility that the residual variance increases with increasing time intervals between sales, we apply the weighted repeat sales (WRS) method developed in Case and Shiller (1987). While the influence of time-varying attributes is an issue that the hedonic valuation does not control for, using the WRS repeat sales method we reduce this problem, as observations with a higher time interval between sales, and thus a higher possibility of quality upgrading, are weighted lower. However, the issue may still not be completely resolved. Nevertheless, since the seller and real estate agent observe the time-varying information, we assume that this information is also incorporated into the asking price. Thus, more credibility should be given to the asking price valuation when comparing the three methods.

Further, we apply two specifications for the opening bid strategy: in addition to the log of the ratio of opening bid to asking price, we construct categories based on the average opening bid ratios of respondents agreeing or disagreeing to the statement in Exhibit 2. We create two dummy variables

that take the value 1 if the opening bid ratio is in the interval (0.95, 1] (*Medium*) or (1, ∞) (*High*), respectively, and 0 otherwise. In this specification, observations with a ratio equal to or lower than 0.95 serve as the reference group.

Although it is difficult to investigate the arguments that impatience, signaling, and intimidation are factors motivating high opening bids, the supposed effects that signaling and intimidation have on the number of bidders can be examined. According to the literature, signaling and intimidation strategies are used to reduce competition (Avery, 1998; Hungria-Gunnelin, 2018; Daniel and Hirshleifer, 2018). The following Poisson model regresses the number of bidders N_i participating in each sales observation i on the opening bid strategy and a number of control variables:

$$N_i = e^{\alpha+\gamma O_i+\vartheta T_i+\varphi U_i+\delta' X+\omega\prime C},$$

or

$$\ln(N_i) = \alpha + \gamma O_i + \vartheta T_i + \varphi U_i + \delta' X + \omega' C, \quad (4)$$

where N is Poisson distributed with a mean and variance λ, and O_i is the opening bid ratio. T_i is the time on market, measured as the number of days. Intuitively, properties with a longer time on market should attract more bidders but given the Norwegian auction process with fixed dates for viewing and bidding, a longer time on market is also likely to be associated with an overall low interest. U_i is the underprice ratio, measured as the natural logarithm of the predicted market value, estimated in equation (2), divided by the asking price. An underpriced dwelling may attract more bidders with a lower reservation price. X is a vector of dwelling attributes, and C is the locational, agent, yearly and quarterly controls. The corresponding coefficients are represented by γ, ϑ, φ,

and the vectors δ and ω. Finally, the relationship between the opening bid strategy and the price premium is examined through our main regression model:

$$p_i = \alpha + \gamma O_i + \delta' X + \omega' C + \epsilon_i, \quad (5)$$

where the three premium specifications from (1) are regressed on the opening bid strategy and the control variables for attributes, location, agent and time from equation (4).

In order to take full advantage of the panel structure of our dataset, we apply two different estimators to search for causal relationships, where each makes use of transformation techniques to account for unobserved effects. Since unobserved effects are likely to correlate with the included explanatory variables, the fixed-effects transformation is applied to exclude the time-invariant component of the error term. During the fixed-effects transformation, the variables are time-demeaned for each unit, which makes the estimator explore the relation between the transaction price and the opening bid size *within* a unit. Hence, the coefficient for the high opening bid dummy reports the change in the mean transaction price if the auction starts with a high opening bid rather than a low opening bid. We use the same opening bid dummy variables from earlier, taking the value 1 if the opening bid ratio is in the interval (0.95, 1] (*Medium*) or (1, ∞) (*High*), respectively, and 0 otherwise. We estimate both fixed- and random-effects models, although the fixed-effects model seems more reasonable because of unobserved effects such as architectural and aesthetic quality, which are likely to be constant over time and therefore be correlated with the included explanatory variables. The Hausman specification test (Hausman, 1978) confirms the suitability of the fixed-effects model.

The classical difference in differences (DiD) estimator involves two periods, one treatment group and one control group. In our case, we operate with more than two periods as the time at which dwellings are subject to the high opening bid differ. We therefore generalize the DiD estimation (see, e.g., Bertrand et al. (2004)) and estimate an equation of the form

$$Y_{st} = \theta_s + \delta_t + \beta T_{st} + \varepsilon_{st}, \tag{6}$$

where Y is the natural logarithm of the sales price, θ is the fixed effects for groups, and the term δ represents the year dummy coefficients. Each group, s, comprises all observed sales of the same dwelling. As in the repeat sales valuation, we have 1,185 groups of dwellings with at least one observed previous sale. T is a binary variable equal to 1 if the treatment is in place in treatment group s in year t. The term β measures the estimated impact of the high opening bid, and ε_{st} is the error term. Since we include both group and year fixed effects, the generalized DiD is a two-way fixed-effects model. As an additional quality adjustment of this model, we estimate the same equation with the natural logarithm of the sales price / asking price as the dependent variable. At the expense of a slightly reduced sample size due to some missing values for historical asking prices, this specification additionally allows us to control for the possible influence of time-varying factors, as this information is assumed to be included in the asking price.

Selection bias may arise when studies ignore houses that do not sell, which in some ways may be different. While this is a potential problem in the construction of real estate price indexes, as shown in Jud and Seaks (1994), the issue is often handled using the two-stage Heckman approach when

the proportion of unsold dwellings is substantial (Heckman, 1979). In the Norwegian market there is no auction journal data available for unsold houses, and these properties do therefore not appear in our study. There is neither any documentation of the number of properties that are withdrawn from the market, most likely because the number is small. However, it is unusual for advertised properties to not sell in the Norwegian market. Rather, properties that are not sold after the first viewing will typically remain in the market until they are sold, which is reflected in the higher time on market for some dwellings. For instance, in the auction journal sample, only 1.33 or 0.31 percent of the dwellings have a time on market longer than six months or a year, respectively, indicating that all dwellings on the market are sold eventually. Additionally, Haurin and Hendershott (1991) suggest that the possibility of selection bias is higher in a bust market when fewer houses are sold, whereas our transaction data is from a normal market period. Thus, we consider the probability of selection bias low in this study.

5 Results

We first consider the effect of an intimidation/signaling strategy on the number of bidders, reporting the Poisson estimations of equation (4) in Exhibit 4. The opening bid coefficient is negative and significant at the one-percent level, indicating that a higher opening bid yields a lower number of auction participants. Controlling for locational, agent, yearly and quarterly effects in column (b), and time on market in column (c), the impact is even stronger. We see that on average, dwellings with a longer time on market achieve a slightly lower bidder turnout, which indicates that the negative effect of overall low interest dominates the positive effect of longer exposure time. Finally, after controlling for the positive influence of underpriced dwellings in column (d), we find a slight reduction in the opening bid coefficient. While a higher number of *potential*

bidders may be associated with a higher opening bid ratio, a higher opening bid may lead to a lower number of *active* bidders. However, a one percent increase in the opening bid ratio only leads to a −0.008 log unit change, or approximately a 0.8 percent decrease, in the number of bidders. Hence, all else being equal, it would require a large increase in the opening bid to deter a bidder from entry. Also, note that the R-squared is relatively low in all four specifications, suggesting that important variables for predicting bidder turnout are unobserved in the model.

Exhibit 4. Poisson estimations of Number of bidders.

Variables	(a)	(b)	(c)	(d)
Opening bid ratio (ln)	−0.5597***	−0.6777***	−0.8083***	−0.7733***
	(0.2087)	(0.1810)	(0.1740)	(0.1688)
Time on market	No	No	−0.0039***	−0.0037***
			(0.0004)	(0.0004)
Underprice (ln)	No	No	No	0.4012***
				(0.0830)
Constant	0.5794**	0.4159	0.5667**	0.6558**
	(0.2505)	(0.2676)	(0.2638)	(0.2638)
Dwelling attributes	Yes	Yes	Yes	Yes
LAT	No	Yes	Yes	Yes
Adjusted R^2	0.004	0.041	0.050	0.052
Observations	2,257	2,257	2,257	2,257

Notes: Dwelling attributes include size, number of bedrooms, age and type of dwelling. LAT (location, agent, time) controls for location (273 zip codes), real estate agent (36 offices), year and quarter. The location, agent and quarter variables are jointly significant at the 1%-level, while year is jointly non-significant. Dependent variable: Number of bidders. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

While an aggressive opening bid strategy may prevent potential bidders from entering the auction, the main question is whether the intimidation effect is stronger than the direct price effect of initiating the auction at a higher price level. In Exhibits 5 and 6, we report the price premium estimations of equation (5), starting with the interval specification of the opening bid strategy. In the columns of multiple-bid auctions, we have removed sales from single-bid auctions in order to

check whether high premiums are driven by single bidders' high private valuations. Descriptive statistics of these subsamples are reported in the Appendix, Exhibit A4.

Exhibit 5. Price premium estimations with opening bid ratio intervals.

	Premium (asking price)		Premium (hedonic)		Premium (repeat sales)	
Variables	All auctions	Multiple-bid auctions	All auctions	Multiple-bid auctions	All auctions	Multiple-bid auctions
Opening bid ratio:						
Medium (0.95, 1]	0.0261***	0.0318***	0.0401***	0.0431***	0.0105	0.0131
	(0.0031)	(0.0034)	(0.0083)	(0.0086)	(0.0124)	(0.0132)
High (1, ∞)	0.0679***	0.0887***	0.0542***	0.0673***	0.0419**	0.0791***
	(0.0051)	(0.0067)	(0.0137)	(0.0172)	(0.0197)	(0.0246)
Constant	−0.0077	−0.0001	0.1931***	0.2599***	0.1914**	0.1740*
	(0.0256)	(0.0279)	(0.0689)	(0.0719)	(0.0970)	(0.1029)
Dwelling attributes	Yes	Yes	Yes	Yes	Yes	Yes
LAT	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.175	0.201	0.142	0.167	0.200	0.206
Observations	2,257	1,958	2,257	1,958	1,185	1,065

Notes: Observations with an opening bid / asking price ratio equal to or lower than 0.95 serve as the reference group. Dwelling attributes include size, number of bedrooms, age and type of dwelling. LAT (location, agent, time) controls for location (273 zip codes [231 for repeat sales]), real estate agent (36 offices [35 for repeat sales]), year and quarter. Dependent variable: Premium (asking price): ln(*sales price / asking price*); Premium (hedonic): ln(*sales price / hedonic price estimate*); Premium (repeat sales): ln(*sales price / repeat sales price estimate*). In the regressions for multiple-bid auctions, we have not included sales from single-bid auctions. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

First, we concentrate on the columns in Exhibit 5 with all auctions included. Using the observations with an opening bid ratio lower than or equal to 0.95 as the reference group, a higher opening bid seems to yield a higher asking price premium. The coefficient on the *High* variable is positive and significant at the one-percent level in both the asking price valuation and the hedonic valuation, and significant at the five-percent level in the repeat sales valuation. Considering the *Medium* variable, we find a lower, but significant premium in the asking price valuation and hedonic valuation. In the repeat sales valuation, however, the positive coefficient is not significant.

Considering multiple-bid auctions only, we find that the coefficients are higher all over, and now the coefficient for the *High* opening bid variable is significant at the one-percent level in the repeat sales valuation. This implies that our results are not driven by single bidders with a high private valuation, but rather lend support to the hypothesis that the signaling effect confirms other bidders' high valuations and increases the price premium further.

Exhibit 6 reports the price premium estimations using the opening bid ratio as the strategy variable. By first considering the columns that include all auctions, we find that a one percent increase in the opening bid ratio is associated with an increased price premium of about 0.30 percent in the asking price valuation, 0.40 percent in the hedonic valuation, and 0.17 percent in the repeat sales valuation. Considering multiple-bid auctions only, we again find higher (but not significantly) coefficients in every specification, corroborating the above results.

Exhibit 6. Price premium estimations with opening bid ratio.

	Premium (asking price)		Premium (hedonic)		Premium (repeat sales)	
Variables	All auctions	Multiple-bid auctions	All auctions	Multiple-bid auctions	All auctions	Multiple-bid auctions
Opening bid ratio (ln)	0.3038***	0.3315***	0.3998***	0.4689***	0.1735*	0.2510**
	(0.0210)	(0.0240)	(0.0563)	(0.0609)	(0.0887)	(0.0987)
Constant	0.0198	0.0331	0.2342***	0.3096***	0.2113**	0.2047**
	(0.0256)	(0.0283)	(0.0688)	(0.0717)	(0.0978)	(0.1041)
Dwelling attributes	Yes	Yes	Yes	Yes	Yes	Yes
LAT	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.179	0.187	0.150	0.180	0.201	0.203
Observations	2,257	1,958	2,257	1,958	1,185	1,065

Notes: Dwelling attributes include size, number of bedrooms, age and type of dwelling. LAT (location, agent, time) controls for location (273 zip codes [231 for repeat sales]), real estate agent (36 offices [35 for repeat sales]), year and quarter. Dependent variable: Premium (asking price): ln(*sales price / asking price*); Premium (hedonic): ln(*sales price / hedonic price estimate*); Premium (repeat sales): ln(*sales price / repeat sales price estimate*). In the regressions for the multiple-bid auctions, we have not included sales from single-bid auctions. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Based on the results in Exhibit 4, directly including the number of bidders as a control variable in the estimation of equation (5) may yield biased results because of possible endogeneity with the opening bid strategy. Comparing the price effect of a high opening bid to that of a low opening bid given a fixed number of auction participants is problematic, because the number of bidders may itself be affected by the bidding strategy. Nevertheless, given the seemingly small impact that an aggressive opening bid has on the number of bidders, and the low explanatory power of the Poisson model, we investigate this addition to the estimations of equation (5) while interpreting the results carefully. We run three additional specifications for each valuation method where we include the number of bidders, the number of bidders squared, and an interaction variable between the number of bidders and the opening bid ratio, respectively. The results are reported in the Appendix, Exhibit A5.

As expected, the number of bidders has a significantly positive impact on the price premium, with an effect of 2.0 – 3.6 percent per additional participant, reported in columns (a), (d) and (g). Moreover, the impact seems to be diminishing with a higher number of bidders, indicated by the negative coefficients of the squared variable in columns (b), (e) and (h). We observe that the opening bid coefficients are robust to the inclusion of the controls, although slightly inflated compared to Exhibit 6. Considering the interaction variable in columns (c), (f) and (i), we find negative coefficients, indicating that the opening bid's impact on the price premium is weaker when the number of bidders is high. However, the coefficients are significant only in the asking price- and repeat sales valuations, and the results are not robust when controlling for outliers.[5] Note also that when the number of bidders is low, the opening bid coefficient is much higher when the interaction variable is included. As mentioned, these results may be unreliable due to the

possible endogenous relation between the two variables. Yet, it would be interesting to see how they would fare in a market with a higher average of bidders.

Exhibit 7. Opening bid fixed-effects models.

	Sales price		Premium (asking price)	
Variables	All auctions	Multiple-bid	All auctions	Multiple-bid
Opening bid ratio:				
Medium (0.95, 1]	0.0147 (0.0107)	0.0162 (0.0110)	0.0150** (0.0064)	0.0197*** (0.0066)
High (1, ∞)	0.0695*** (0.0173)	0.1100*** (0.0191)	0.0658*** (0.0109)	0.0882*** (0.0132)
Constant	14.8128*** (0.0110)	14.8058*** (0.0111)	0.0152*** (0.0051)	0.0152*** (0.0051)
Time dummies	Yes	Yes	Yes	Yes
R-squared				
Within	0.914	0.915	0.071	0.085
Between	0.2026	0.1906	0.0768	0.0953
Overall	0.5621	0.5590	0.0697	0.0847
Rho	0.8776	0.8770	0.3721	0.3734
Number of obs.	3,300	2,931	2,398	2,141
Number of groups	1,185	1,065	1,185	1,065

Notes: Time dummies 1985 to 2015 with 2016 as the reference year. Depended variable: Sales price: ln(*sales price*); Premium (asking price): ln(*sales price / asking price*). The *All auctions* regression includes all dwellings with more than one sale. In the *Multiple-bid auction* regression, the same dwellings are included, but we have not included sales from single-bid auctions. The reference group is a low opening bid. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Exhibit 7, we report the fixed-effects estimations of equation (6). We first look at the sales price specification. Considering all auctions, we find that a high opening bid increases the sales price by almost 7 percent. A medium opening bid has a coefficient of 1.5 percent, but it is non-significant. In the regression of multiple-bid auctions, the price estimate from a high opening bid increases to 11 percent. Additionally, the coefficient of the medium opening bid increases, but remains non-significant. For the asking price valuation we observe the same pattern, but with a slightly lower coefficient for high opening bids in the multiple-bid specification. Moreover, the coefficient of medium opening bids is now significant at conventional levels in both specifications. The results

indicate that a high opening bid yields a higher sales price and price premium, which are not caused by single bidders with a high private valuation of the dwelling. All the results are similar to and confirm the results in Exhibits 5 and 6.

6 Discussion and concluding remarks

In many countries, such as the United States, real estate auctions are traditionally associated with distressed sales and foreclosures, as a method for a last-resort sale (Dotzour et al., 1998). Mayer (1995) predicts that it could be profitable for the seller to arrange auctions in cases where multiple potential buyers signal their interest, particularly in a boom, but finds that auctioned properties in the US sell at a discount, and more so in a bust market (Mayer, 1998). Since many US studies are focused on bust periods, and auctions are not so widespread, the data and market used in our paper, where all dwellings are sold by English auction, allow for a better assessment of the auction process. In markets where auctions are more prevalent, such as in New Zealand and Australia, auctions in some cases generate the highest seller revenue (Dotzour et al., 1998) and sell at a premium over negotiated sales (Lusht, 1996). The frequency of selling by auctions, especially in high-demand urban areas, seems to have increased, and this raises the question about how different bidding strategies affect the price premium at the end of the auction. One fundamental strategy is to use the opening bid size as a signal to competing bidders. The benefits from the use of low opening bids are in line with the assumptions of the classic literature, as suggested in Vickrey (1961), but modern auction theory, as outlined by Avery (1998) and Daniel and Hirshleifer (2018), suggests that high opening bids can be profitable for the buyer as well.

The survey results show quite strong evidence for the hypothesis that some bidders strategically place high opening bids in order to intimidate. However, the majority of bidders seem to be indifferent or think low opening bids are more advisable. In any case, it seems that stronger competition (more bidders) increases the likelihood of placing a higher opening bid for all respondents. However, as seen from the result of the auction journal data, the supposed intimidating effect does not seem to be very efficient in practice. While we find indications that signaling and intimidation have a negative impact on the number of bidders, supporting the notion that a high opening bid has a preemptive effect, the impact seems to be small with little economic importance. On average, a one percent increase in the opening bid ratio is only associated with a 0.8 percent decrease in the number of bidders. Results from our price premium estimations suggest that the direct price effect is stronger than the intimidation effect, as an aggressive opening bid strategy yields an overall higher premium. In view of the Norwegian real estate auctions being affiliated valuation auctions, the results are not supportive of the theoretical model of Avery (1998), where intimidation is economically rational and provides Pareto improvements. However, they are in accordance with empirical findings from Sweden (Hungria-Gunnelin, 2018).

One possible explanation for the intimidation approach not seeming to work in practice can be related to the signaling effect itself. While an intimidation strategy signals that the bidder has the highest valuation and likely has a preemptive effect on some of the competitors, other bidders may perceive a high opening bid as a signal that their own valuation is too low, therefore adjusting accordingly. Thus, the auction may end at a premium. Similarly, the opposite may apply in auctions where low opening bids are placed, and where the anchoring effect potentially comes into play and limits the price increase from the opening bid level. Since real estate auctions are

considered affiliated auctions, bidder valuations are not independent of each other, because of the common value component of the object, and the signaling and anchoring effects may both be results of rational bidder behavior. The existence of anchoring effects, as mentioned earlier, is well documented in the real estate literature (Shie, 2019). At the same time, one must consider the possible bidding costs in order to determine whether premature withdrawal is rational. In the Norwegian market, there are no costs for submitting bids other than the time cost of participation, which may not be enough to deter bidders to keep bidding up to their valuation.

Many market transactions involve some sort of auction or aspects of an auction. Therefore, it is important for both buyers and sellers to be aware of the different strategies and their outcomes. A question for future research is whether the results presented for real estate auctions carry over to other markets – e.g., markets with more homogeneous commodities or markets where the monetary transactions involved are less significant. In addition, in determining whether to set a fixed price or to sell by auction, sellers should be aware that different market conditions – e.g., boom versus bust markets – might also play a role. This is even more important for regulators, who may need to decide whether auctions should be allowed at all. If high opening bids drive prices up, the auction mechanism may work as a bubble accelerator in boom markets.

7 Appendix

Exhibit A1. Hedonic valuation model.

Variables	Coefficients
Size (ln)	0.6712***
	(0.0042)
Age (ln)	−0.1273***
	(0.0017)
Apartment	0.0778***
	(0.0106)
Detached	0.0519***
	(0.0106)
Semidetached	0.0343***
	(0.0110)
Townhouse	0.0318***
	(0.0115)
Leisure home	0.0788***
	(0.0130)
Coop apartment	0.0271***
	(0.0103)
Constant	12.0979***
	(0.0228)
Location (zip codes)	Yes
Real estate agent	Yes
Year dummies	Yes
Quarter dummies	Yes
Adjusted R^2	0.805
Observations	26,868

Notes: Controls for 487 zip codes and 168 real estate agent offices. Dependent variable: ln(*sales price*). Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Exhibit A2. Normality test of survey opening bid ratios.

	NPB: 2	NPB: 15
Mean	0.96	0.98
Standard dev.	0.07	0.08
Skewness	−0.67	−0.45
Kurtosis	7.96	7.07
Joint significance	***	***
Observations	511	456

Note: *** indicates rejection of the null hypothesis of normality at the 1%-level. NPB is the number of potential bidders.

Exhibit A3. Estimations of survey opening bid.

N potential bidders	0.0105**
	(0.0051)
Adjusted R^2	0.048
Observations	849

Notes: The regression includes controls for location, socio-economic factors and asking price level. Dependent variable: Opening bid/asking price. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Exhibit A4. Auction journal data descriptive statistics. Multiple- and single-bid auctions.

Variables	Multiple-bid auctions Mean	Multiple-bid auctions SD	Single-bid auctions Mean	Single-bid auctions SD
Sales price (NOK)	2,676,865	1,210,876	2,570,920	1,317,206
Asking price (NOK)	2,615,892	1,155,563	2,567,569	1,313,370
Opening bid (NOK)	2,442,114	1,101,034	2,570,920	1,317,206
Sales price / asking price (%)	102.37	7.60	99.95	5.38
Opening bid / asking price (%)	93.05	6.16	99.95	5.38
Number of bidders	2.06	1.27	1	0
Number of bids	6.03	4.98	1	0
Time on market (days)	26.78	44.27	33.71	55.75
Age (years)	41.01	28.67	40.62	31.49
Size (m^2)	95.07	49.98	97.71	51.73
Number of bedrooms	2.41	1.26	2.44	1.27
Type of dwelling (%):				
Freehold apartment	24.82	43.21	21.07	40.85
Freehold detached	20.94	40.70	18.06	38.53
Freehold semi-detached	7.66	26.60	9.03	28.71
Freehold townhouse	5.87	23.52	5.02	21.87
Leisure home	1.33	11.45	1.34	11.51
Cooperative townhouse	3.32	17.92	6.35	24.43
Cooperative apartment	36.06	48.03	39.13	48.89
Transaction period (%):				
Quarter 1	37.79	48.50	30.77	46.23
Quarter 2	16.70	37.31	19.73	39.86
Quarter 3	9.09	28.76	11.37	31.80
Quarter 4	36.41	48.13	38.13	48.65
Year 2014	29.93	45.81	31.77	46.64
Year 2015	30.34	45.98	33.78	47.38
Year 2016	39.73	48.95	34.45	47.60

Notes: Number of observations = 1,958 (Multiple-bid) and 299 (Single-bid). Sales observations are clustered in 273 zip codes and 36 real estate agent offices. NOK 1 ≈ US$0.11 or €0.10 (exchange rate per January 2020).

Exhibit A5. Price premium estimations with opening bid ratio and number of bidders.

Variables	Premium (asking price) (a)	(b)	(c)	Premium (hedonic) (d)	(e)	(f)	Premium (repeat sales) (g)	(h)	(i)
OB-ratio	0.3548***	0.3614***	0.5337***	0.4287***	0.4410***	0.4909***	0.1790**	0.1963**	0.6070***
	(0.0148)	(0.0147)	(0.0276)	(0.0558)	(0.0558)	(0.1057)	(0.0877)	(0.0880)	(0.1814)
Bidders	0.0363***	0.0511***	0.0313***	0.0206***	0.0478***	0.0188***	0.0217***	0.0481***	0.0123**
	(0.0008)	(0.0023)	(0.0010)	(0.0031)	(0.0086)	(0.0040)	(0.0047)	(0.0138)	(0.0058)
$Bidders^2$		−0.0023***			−0.0043***			−0.0039**	
		(0.0003)			(0.0013)			(0.0019)	
Inter.			−0.0815***			−0.0283			−0.1884***
			(0.0107)			(0.0409)			(0.0700)
Adj. R^2	0.593	0.603	0.605	0.169	0.174	0.169	0.218	0.221	0.224
Obs.	2,257	2,257	2,257	2,257	2,257	2,257	1,185	1,185	1,185

Notes: Controls for dwelling attributes and LAT (location, agent, time) included but not reported. Dependent variable: Premium (asking price): ln(*sales price / asking price*); Premium (hedonic): ln(*sales price / hedonic price estimate*); Premium (repeat sales): ln(*sales price / repeat sales price estimate*). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

8 Endnotes

[1] When minimum bid increments are stipulated, strategic bidding here means that bidder A attempts to force bidder B into a position that denies bidder B the possibility of increasing his/her bid further. See Isaac et al. (2007) for a more in-depth explanation.

[2] Vendor bids are not actual bids with the intention to buy, but rather announced bids on the behalf of the seller to indicate that the price is too low and to keep the bidding going. Dummy bids, on the other hand, are false bids to create the illusion of competition, made in collusion with the seller. Such bids are legal in some types of auctions. A counter offer introduces an element of the Dutch auction, as these offers usually lie between the current highest bid and the asking price.

[3] The seller can choose a lower bid as the winning bid, but assuming that involved actors are rational, this is mostly irrelevant. Moreover, for some dwellings, members of housing associations with the right of first refusal may decide to use their option of buying at the same price as the highest bid.

[4] NOK 1 ≈ US$0.11 or €0.10 (exchange rate per January 2020).

[5] In the asking price valuation, the interaction variable indicates that the estimated opening bid impact on the price premium is non-positive in auctions with more than six bidders. However, less than one percent of the auctions have more than six bidders. Controlling for outliers by using median regressions and/or truncating the sample shows that the impact is positive within the full range of bidders.

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