The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/1753-9269.htm

Aggressive bidding strategies in real estate auctions – a structural equation modelling (SEM) approach

Simen Dalland, Randi Hammervold, Henrik Tangen Karlsen, Are Oust and Ole Jakob Sønstebø
NTNU Business School, Norwegian University of Science and Technology, Trondheim, Norway

Received 12 September 2020
Revised 22 December 2020
18 February 2021
Accepted 7 March 2021

Abstract

Purpose – This paper aims to study aggressive bidding strategies in real estate auctions – a structural equation modelling (SEM) approach.

Design/methodology/approach – The authors use two data sets to study aggressive bidding strategies. First, the results from a survey with 1,803 participants examining real estate auctions are used to identify bidding strategies and related motivations. Second, the authors apply SEM by using data from 1,078 exclusive auction journals from real estate sales in Norway to study both the direct and indirect price effects of the bidding strategies.

Findings – The authors define four aggressive bidding strategies: high opening bid, high bid increase (jump bids), short acceptance deadline and short response time. The authors find that all four strategies yield a higher sales price. Bidders can actively influence the behaviour of the other participants and cool the potential auction fever, thus reducing the final price premium.

Originality/value – This paper gives households, investors and policymakers a better understanding of how bidding strategies affect real estate auctions and the final price.

Keywords SEM, Housing, Aggressive bidding, Bid strategies, English auctions

Paper type Research paper

1. Introduction

Auctions have always been an important price mechanism, especially for heterogeneous products and investment goods, such as real estate. In recent years, several papers have studied different aspects concerning bidding strategies in real estate auctions. Hungria-Gunnelin (2013) looks at the number of bidders in real estate auctions, and in 2016, she looks at jump bids and auction speed (Hungria-Gunnelin, 2018). Additionally, Khazal *et al.* (2020) and Sommervoll (2020) study jump bidding, and Sønstebø *et al.* (2021) study opening bid strategies. Different aspects and strategies of real estate auctions are likely to interact with and influence each other. The aim of this paper is to apply structural equation modelling (SEM) to better understand how these aspects and strategies work together. We also focus on time as a possible part of an aggressive bidding strategy.

In the Scandinavian countries, as well as Scotland, Ireland, Australia and New Zealand, auctions have a central place in the real estate market, even for non-distressed properties and in non-boom market cycles (Hungria-Gunnelin, 2013). Buying a home is one of the momentous events of one's life, and the final price is typically several times the bidder's

Journal of European Real Estate Research
Vol. 14 No. 2, 2021
pp. 229-245
© Emerald Publishing Limited
1753-9269
DOI 10.1108/JERER-09-2020-0049

annual income [1]. Thus, even small differences in the final sales price will have great economic significance for the bidder.

Hungria-Gunnelin (2013) finds that the number of participants in an auction has a positive effect on the final price. Hungria-Gunnelin (2018) finds that jump bidding has the predicted effect of reducing competition by scaring off bidders. However, a higher average bid increment leads to a higher selling price. Furthermore, the results show that a fast auction in terms of the average time between bids acts to increase the probability of so-called auction fever, as both the number of bidders and the selling price are positively correlated with the speed of the auction. Khazal *et al.* (2020) finds that auctions containing jump bids achieve 2.8%–9.3% higher price premiums compared to strictly straightforward-bidding [2] auctions, whereas Sommervoll (2020) finds a price premium of 1%–2% for jumps that do not end the auction and a final jump premium of 9%–10%. Finally, Sønstebø *et al.* (2021) conclude that high opening bids increase the final house price. These findings from real estate auctions are in line with classic auction theory; in the case of an English auction, bids should be raised by small increments (Vickrey, 1961; Milgrom and Weber, 1982; Bikhchandani and Riley, 1991).

In this paper, we apply two data sets to study aggressive bidding strategies. First, the results from a survey with 1,803 participants regarding real estate auctions are used to identify bidding strategies and related motivations. Second, by using data from 1,078 exclusive auction journals from real estate sales in Norway, we examine the effect of aggressive bidding strategies on the price premium. We define four aggressive bidding strategies: high opening bid, high bid increase (jump bids), short acceptance deadline and short response time. We apply SEM to estimate and test a model. To the best of our knowledge, we are the first to apply this technique to real estate auctions.

The paper is organized as follows. Section 2 provides an overview of the existing literature and details of the Norwegian real estate auction process. Section 3 gives a description of the data as well as a presentation of the survey data results, whereas Section 4 explains the methodology. Section 5 presents the results. Finally, Section 6 provides the discussion and concluding remarks.

2. The Norwegian auction process

In Norway, the seller of a second-hand dwelling usually employs a real estate agent, and the agent typically arranges an English auction (Khazal *et al.*, 2020). All bids are sent to the agent in written form, and the agent informs the seller about the bids. Before the agent informs the seller, he/she needs to obtain valid identification and signatures from the bidders (Norwegian Association of Real Estate Agents, 2014).

The real estate agent is responsible for facilitating proper settlement of the auction. The asking price is regulated by law to reflect the true market price and the seller's reservation price. Real estate agencies that are found to have been under-pricing properties will face sanctions. As strategic price setting is not allowed, the asking price is considered a good estimator of the market value. The agent shall not communicate bids with an acceptance deadline shorter than at 12:00 p.m. on the first business day after the last advertised viewing (Sønstebø *et al.*, 2021). After the first deadline, the bidders should set an acceptance deadline that gives the agent enough time to inform the seller and other bidders about the bids. The acceptance deadline is set by the bidder to limit the validity period of the bid and is disclosed by the broker to all participants along with the bid. Without an acceptance deadline, the seller would be able to legally accept the bid at a later time when the bidder may not still be interested. Bids that discriminate or exclude other bidders from the auction or bids set with an acceptance deadline that is obviously too short for the agent to conduct the auction in a

proper manner will be discouraged by the agent. The seller is not bound to sell, but can make counteroffers to specific bidders (i.e. the high bidder) if he/she feels the current bid is too low, which are legally binding and comes with an acceptance deadline set by the seller [3]. Dummy bids, i.e. bids on behalf of the seller to entice further bidding, however, are not allowed. As far as necessary, the agent shall keep the bidders informed about new and higher bids (Regulation on Real Estate, 2007).

When the auction has come to an end, or if it ends without a completed transaction, the bidders who have participated can request a copy of the auction journal in anonymized form. The buyer and seller shall also have a copy of the auction journal after the trade has been completed (Norwegian Association of Real Estate Agents, 2014).

3. Data

The data we use in this paper are from two independent data sets. The first is a survey conducted in Trondheim, Stavanger and Oslo, which are three of the largest cities in Norway. This data set is included to illustrate bidders' perception and strategical use of the acceptance deadline and response time. The second data set, with which we conduct our statistical analyses, is a collection of auction journals obtained from two of the largest real estate agencies in Norway. The collection contains data from two counties: Trøndelag and Møre og Romsdal.

3.1 Survey data

In December 2016 and January 2017, we conducted a survey in three of the largest Norwegian cities, namely, Oslo ($N = 602$), Trondheim ($N = 600$) and Stavanger ($N = 601$), where we asked respondents questions about strategic bidding behaviour in auctions [4]. The purpose of the survey was to map bidders' knowledge and attitudes regarding auction participation. We wanted to investigate whether there is consensus on how bidders perceive acceptance deadlines, and whether deadlines and response times are used actively as strategic measures in real estate auctions. We found that these two parameters indeed are looked upon as important variables in auctions and that further analysis of the strategic effects is needed.

The respondents described what they considered to be a short acceptance deadline and a long acceptance deadline in one of three different scenarios regarding the dwelling's asking price and one of two different scenarios regarding the number of bidders. The asking prices the respondents had to relate to were either NOK 2,000,000, NOK 3,000,000 or NOK 4,000,000. Furthermore, the number of potential bidders was either two or 15. The number of respondents in each scenario is 300 or 301. Figures 1 and 2 present the results of these questions.

Regarding what the respondents consider to be a short acceptance deadline, the dominant response options are "30 minutes or less" or "1 hour or less". This result applies to all the scenarios. The result of what the respondents consider to be a long acceptance deadline seems to be more normally distributed in all scenarios. In the cases with two bidders, the most popular answer is "One day or more", but it seems that the asking price plays a larger role in the cases with 15 bidders.

Another section of the survey comprised a number of statements the respondents were asked to agree or disagree on a scale from one to seven. One of the statements, Statement 5, was as follows: "In order to obtain a home at the lowest possible price, it is generally advisable to place bids with short acceptance deadline." Another relevant statement for this study, Statement 6, was as follows: "In order to obtain a home at the lowest possible price, it

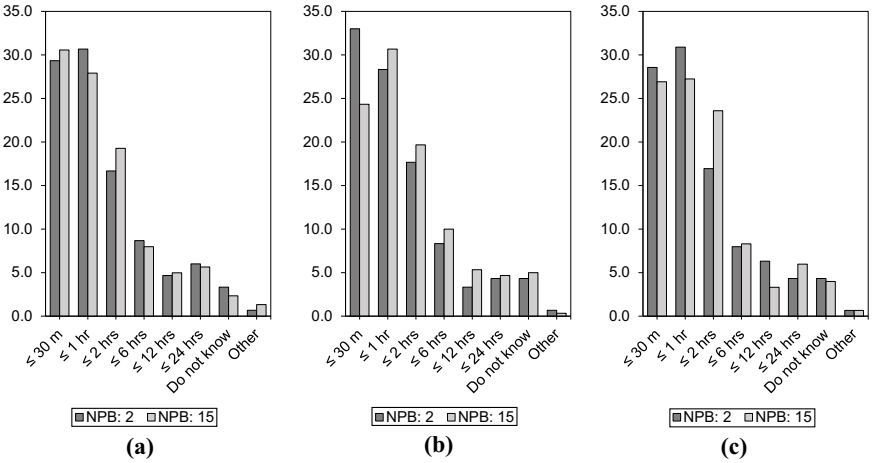


Figure 1.
Question: "What do you consider to be a short acceptance deadline?"

Notes: Responses to the three different scenarios. (a) Asking price – NOK 2,000,000; (b) asking price – NOK 3,000,000; (c) asking price – NOK 4,000,000. Numbers in percentages. NPB = number of potential bidders. There are small significant differences between the three cities, but these are so minor that we have chosen to present the joint results

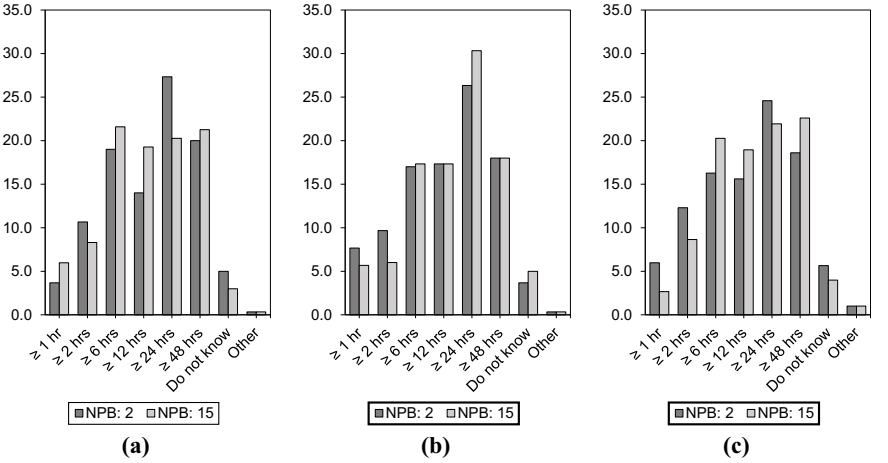


Figure 2.
Question: "What do you consider to be a long acceptance deadline?"

Notes: Responses to the three different scenarios. (a) Asking price – NOK 2 000 000; (b) asking price – NOK 3 000 000; (c) asking price – NOK 4 000 000. Numbers in percentages. NPB = number of potential bidders. There are small significant differences between the three cities, but these are so minor that we have chosen to present the joint results

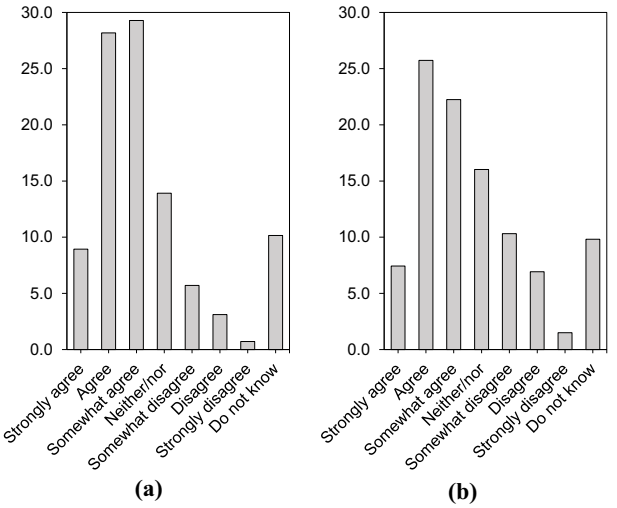
is generally advisable to respond quickly to others' bids." Figure 3 shows the results from these statements.

Statement 5 claims that it is advisable to place a bid with a short acceptance deadline, whereas Statement 6 claims that it is advisable to respond quickly to others' bids. In other words, the statements claim that an aggressive approach lowers the sales price. The majority of answers agree or somewhat agree to both statements, respectively, 28.2% and 29.3% on Statement 5 and 25.7% and 22.2% on Statement 6. The options with the lowest rate on both statements were "disagree" and "strongly disagree". Combining these time factors as a strategy to obtain the lowest possible price seems to be a very popular strategy among the respondents in this survey.

3.2 Auction journal data

Our data contain 2,257 auctions of second-hand dwellings from two counties in Norway, Trøndelag and Møre og Romsdal. The collection of auction journals was registered from 2014 to 2016 by two of the largest real estate agencies in Norway. These auction journals contain information about the address of the properties for sale, the final sales price and the property's asking price. In cases where the asking price is not given, this information is acquired from *Eiendomsverdi*.no. The journals also contain information about all the bids in the auction, such as timestamp, deadline and ID number for each bidder.

As the main aim of this paper is to study the time factors of an aggressive bidding strategy, we exclude observations that are not viable as indicators in this analysis. This means that observations with no time information of bids are excluded and that only



Notes: Statement 5: "In order to obtain a home at the lowest possible price, it is generally advisable to place bids with short acceptance deadline." Statement 6: "In order to obtain a home at the lowest possible price, it is generally advisable to respond quickly to others' bids." There are no significant differences among the three cities

Figure 3.
Statements

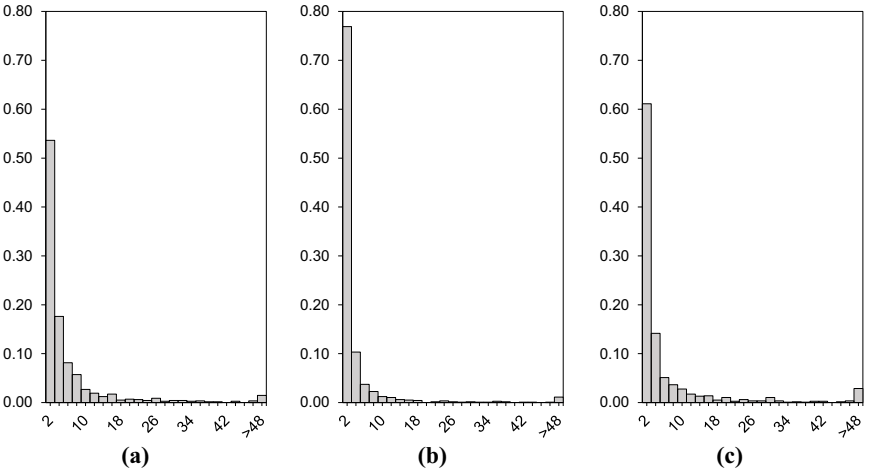


Figure 4.
Distribution of acceptance deadline and response time

Notes: The figures show the distribution of the average acceptance deadline including (a) Excluding; (b) the first bid; and the average response time; (c) in hours

competitive auctions containing two or more bidders are considered. After taking this into account, we end up with a data set of 1,078 observations.

From the descriptive statistics in Table 1, we can see that the average acceptance deadline including all bids has a mean of 320 min and that the mean of the average response time is 384 min. In our data, the first bid often has a longer acceptance deadline than the other bids in the auction. This may be caused by the rule that prevents acceptance deadlines shorter than 12:00 p.m. the first business day after the last advertised viewing (Sønstebø *et al.*, 2021). We therefore decided to also include the average acceptance deadline excluding the first bid, which resulted in a mean of 198 min.

Furthermore, we present figures showing the distribution of the average acceptance deadline, the average response time, the average bid increase and the opening bid ratio.

Variable	Mean	SD	Min	Max	Obs.
Sales price (NOK)	2,711,529	1,266,672	171,000	11,000,000	1,152
Asking price (NOK)	2,624,070	1,158,720	300,000	9,900,000	1,086
Opening bid (NOK)	2,377,131	1,121,055	170,000	800,000	1,144
Sales price/asking price (%)	105.6	8.54	46.22	166.67	1,086
Opening bid/asking price (%)	92.53	8.60	20.20	108.79	1,078
Avg. bid increase (NOK)	55,463	78,736	0	1,400,000	1,152
Avg. acceptance deadline – all bids (minutes)	320	697	15	7,965	1,152
Avg. acceptance deadline – ex. first bid (minutes)	198	678	10	9,029	1,152
Avg. response time (minutes)	384	1217	0	22,116	1,152
Number of bids	8.43	5.28	2	39	1,152
Number of bidders	2.77	1.14	2	11	1,152

Table 1.
Descriptive statistics

Notes: 2014: €1 = NOK 8.35, 2015: €1 = NOK 8.94, 2016: €1 = 9.29 NOK (Norges Bank, 2020). Owing to random missing values, the number of observations differ somewhat

Figure 4 presents the distribution of the average acceptance deadline and the average response time, where (a) and (b) represent the average acceptance deadline including all bids and excluding the first bid, respectively. The interval with the highest proportions of observations is 0–2 h across all three distributions.

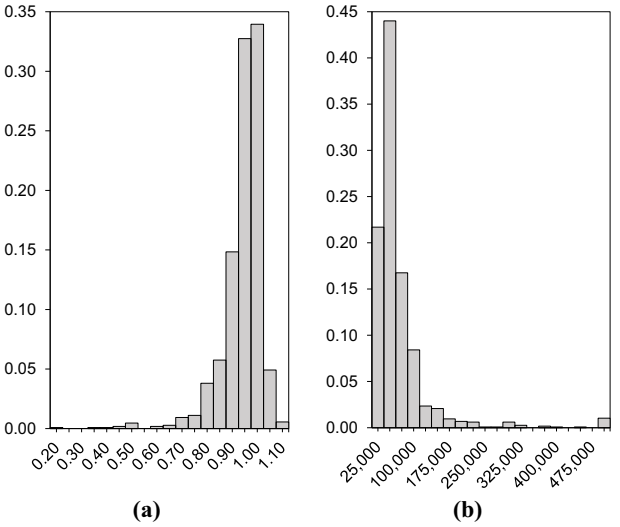
Figure 5 presents the distribution of the opening bid to asking price ratio and the average bid increase. We observe that there are very few observations with an opening bid ratio either lower than 0.80 or higher than 1.00, and most auctions have an average bid increase that is equal to or below NOK 100,000.

4. Methodology

To study the effect of an aggressive bidding strategy, we compare the sales price with the estimated value of the dwelling, i.e. the asking price. We extend this study compared with earlier studies by applying SEM to estimate and test a model.

SEM is a combination of regression equations and factor analysis, which is used to analyse structural relationships between observed variables and latent variables. The regression models test the strength and direction of relationships between observed and latent variables and how these fit with the hypotheses set for the paper. The limitations of using SEM involve constructing a correct model that fits the analysed data, and it may be hard to define correct latent variables that fit the model (Bowen and Guo, 2011, p. 6).

In this study, we decided to use path analysis only using observed variables and not using latent variables (as the variables in our models are directly observable). Our models are simultaneous structural equations estimated with maximum likelihood (Jöreskog *et al.*, 2016, p. 105). During this type of analysis, the relationship between two variables can be both a direct relationship and an indirect relationship with one or more mediating variables. The total effects are the combined effects from all pathways, namely, the direct and indirect effects (Suhr, 2008, p. 1). In cases with only direct or indirect effects between two variables,



Notes: The figures show the distribution of the opening bid to asking price ratio (a) The average bid increase in NOK; (b)

Figure 5.
Distribution of opening bid to asking price ratio and bid increase

the total effect corresponds to the one effect that is present. The models are estimated by applying maximum likelihood, with chi-square tests and some goodness of fit indices to examine whether the models fit the data well.

Our dependent output variable, the price premium p_i of dwelling i, is defined as the natural logarithm of the ratio of sales price (P_i) to estimated value (V_i), where the estimated value equals the asking price:

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

As mentioned earlier, the asking price is a good estimator of the market value. The regulatory authorities have control mechanisms in place to ensure that brokers do not strategically under-price and will punish those that do. Additionally, the asking price is also the seller's reservation price. As such, there is no reason to suspect any systematic bias in the estimated value.

Based on the strategic tools available for bidders to manipulate, i.e. the size of bids, the corresponding acceptance deadline and the response time, we define four aggressive bidding strategies: high opening bid, high bid increase (jump bids), short acceptance deadline and short response time. Extant earlier literature has shown that although a high opening bid and high bid increases have negative effects on the number of bidders, these strategies along with the number of bidders have positive effects on the final price.

As there is no incentive for the seller to accept a bid until the corresponding acceptance deadline is nearly over because the bid is binding and because it is possible that a higher bid may still come, the deadline produces a safe time window for competing bidders to consider the decision of continuing bidding or to disengage. Therefore, there is also no incentive for a rational bidder to place a new bid before the deadline is nearly over. Similarly, high bid increases may seem intimidating and might force bidders to harder contemplate whether to continue or to disengage. With a high number of bidders, however, there is a higher possibility that someone will respond faster. We therefore hypothesize the following:

H1. The average response time is positively influenced by the average acceptance deadline.

H2. The average response time is positively influenced by the average bid increase.

H3. The average response time is negatively influenced by the number of bidders.

If short acceptance deadlines yield short response times, this might be a source for auction fever, which is thought to involve less rational behaviour leading to higher prices. We therefore hypothesize the following:

H4. The price premium is negatively influenced by the average response time.

H5. The price premium is negatively influenced by the average acceptance deadline.

A correlation matrix of the variables from our SEM models is given in Appendix Table A1.

4.1 Main model

In our main model (Figure 6), we place rather few restrictions on the model. The model is a recursive pathway model, where all paths eventually end up at the price premium dependent variable. The model is estimated twice: once with the average acceptance deadline including all bids, and once with the average acceptance deadline excluding the first bid, which is

sometimes placed right after the viewing and can therefore have a rather long acceptance deadline because of the regulations mentioned in Section 2.
Three equations, main model:

$$\ln(Number\ of\ bidders) = \gamma_{11}\ln(Opening\ bid\ ratio) + \gamma_{12}\ln(Avg.\ bid\ increase) + \varepsilon_1 \tag{2}$$

$$\ln(Avg.\ response\ time) = \gamma_{21}\ln(Avg.\ acceptance\ deadline) + \gamma_{22}\ln(Avg.\ bid\ increase) + \beta_{23}\ln(Number\ of\ bidders) + \varepsilon_2 \tag{3}$$

$$Price\ premium = \gamma_{31}\ln(Avg.\ acceptance\ deadline) + \gamma_{32}\ln(Opening\ bid\ ratio) + \gamma_{33}\ln(Avg.\ bid\ increase) + \beta_{34}\ln(Number\ of\ bidders) + \beta_{35}\ln(Avg.\ response\ time) + \varepsilon_3 \tag{4}$$

4.2 Alternative model

As there is no established model for studying aggressive bidding strategies in real estate auctions, we believe that we should test several models to assess the robustness of the results. We therefore offer an alternative model (Figure 7) that excludes the average acceptance deadline from equations (3) and (4) and focuses on hypotheses *H2–H4*.

Three equations, alternative model:

$$\ln(Number\ of\ bidders) = \gamma_{11}\ln(Opening\ bid\ ratio) + \gamma_{12}\ln(Avg.\ bid\ increase) + \varepsilon_1 \tag{5}$$

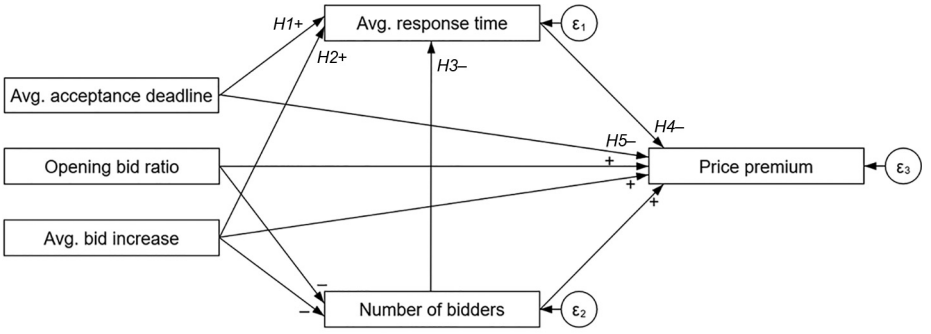


Figure 6.
Main model with the average acceptance deadline, opening bid ratio, average bid increase and average response time as the strategy variables, and the price premium as the dependent output variable

Notes: Signs refer to the hypothesized positive (+) and negative (−) relationships. All variables are log-transformed (notation excluded)

$$\ln(Avg.\ response\ time) = \gamma_{21}\ln(Avg.\ bid\ increase) + \beta_{22}\ln(Number\ of\ bidders) + \varepsilon_2 \quad (6)$$

$$Price\ premium = \gamma_{31}\ln(Opening\ bid\ ratio) + \gamma_{32}\ln(Avg.\ bid\ increase) + \beta_{33}\ln(Number\ of\ bidders) + \beta_{34}\ln(Avg.\ response\ time) + \varepsilon_3 \quad (7)$$

5. Results

In this section, we present the estimations of the SEMs. The results consist of pathway models presented by direct and indirect effects from an independent or a dependent variable to a dependent variable, where the estimated regression coefficients indicate the strength of relationships between variables. Goodness of fit statistics and tests are also included to examine whether the models fit the data well. In Table 2, we present the estimation of the SEM model using the average acceptance deadline including all bids (Panel A) and excluding the first bid (Panel B).

Both models presented in Table 2 have a good fit – the chi squares are 1.01 and 0.44, whereas the *p*-values are 0.6033 and 0.8027. Additionally, as the root mean square error of approximation (RMSEA), comparative fit index (CFI), standardized root mean square residual (SRMR) and the close fit test show results indicating a good adjusted model, we conclude that there is no need for re-specification.

One of the benefits with SEM is that the model allows us to study both direct effects, indirect effects and total effects, something that is crucial when we want to understand how these auction aspects and strategies work together. Whether we include the first bid in the average acceptance deadline or not does not change the main intermediation of the results (Table 2). Additionally, the alternative model in Table 3 yields very similar results.

The number of bidders has a negative effect on the average response time, supporting *H3*, and a positive effect on the price premium both through the direct and indirect effect. Average response time has a negative effect on the price premium, supporting *H4*, and implying that the sale price becomes higher in auctions with short response times. This result indicates that it is not advisable to exhibit aggressive behaviour in regard to a fast response to previous bids. The results are more in line with an auction fever than an endowment effect.

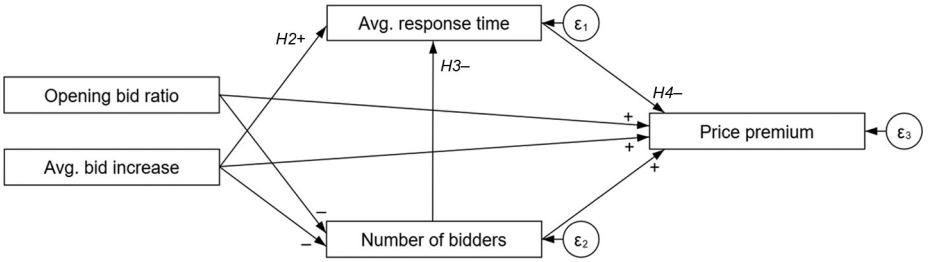


Figure 7.
Alternative model with the opening bid ratio, average bid increase and average response time as the strategy variables, and price premium as the dependent output variable

Notes: Signs refer to the hypothesized positive (+) and negative (−) relationships. All variables are log-transformed (notation excluded)

Table 2.
SEM results, main model

Variables	No. of bidders			Avg. response time			Price premium		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Panel A									
Number of bidders	–	–	–	−0.7215*** (0.0838)	(no path)	−0.7215*** (0.0838)	0.1034*** (0.0058)	0.0118*** (0.0020)	0.1152*** (0.0058)
Avg. responsetime	–	–	–	–	–	–	−0.0163*** (0.0020)	(no path)	−0.0163*** (0.0020)
Avg. bidincrease	−0.0506*** (0.0157)	(no path)	−0.0506*** (0.0157)	0.2005*** (0.0414)	0.0365*** (0.0121)	0.2370*** (0.0427)	0.0283*** (0.0029)	−0.0091*** (0.0019)	0.0192*** (0.0035)
Opening bid ratio	−0.0085 (0.0934)	(no path)	−0.0085 (0.00934)	(no path)	0.0061 (0.0674)	0.0061 (0.0674)	0.2302*** (0.0173)	−0.0010 (0.0108)	0.2292*** (0.0204)
Avg. acc. deadline, all	–	–	–	1.0010*** (0.0231)	(no path)	1.0010*** (0.0231)	0.0128*** (0.0026)	−0.0163*** (0.0021)	−0.0035** (0.0016)
Adjusted *R*2	0.0105	–	–	0.6577	–	–	0.3856	–	–
Overall adj. *R*2	0.7118	–	–	–	–	–	–	–	–
Observations	1,078	–	–	–	–	–	–	–	–
Goodness of fit statistics	Chi^2, (= 0) 1.01	*p*-value, (> 0.05) 0.6033	RMSEA, (< 0.05) 0.000	CFI, (>0.97) 1.000	SRMR, (< 0.05) 0.009	Close fit, (> 0.10) 0.952	df2	–	–
Panel B									
Number of bidders	–	–	–	−0.8019*** (0.1132)	(no path)	−0.8019*** (0.1132)	0.1081*** (0.0058)	0.0073*** (0.0016)	0.1154*** (0.0058)
Avg. response time	–	–	–	–	–	–	−0.0091***0.0015)	(no path)	−0.0091*** (0.0015)
Avg. bid increase	−0.0506*** (0.0157)	(no path)	−0.0506*** (0.0157)	0.3422*** (0.0556)	0.0406*** (0.0138)	0.3828*** (0.0567)	0.0277*** (0.0030)	−0.0090*** (0.0020)	0.0188*** (0.0035)
Opening bid ratio	−0.0085 (0.0934)	(no path)	−0.0085 (0.00934)	(no path)	0.0068 (0.0749)	0.0068 (0.0749)	0.2281*** (0.0175)	−0.0010 (0.0108)	0.2272*** (0.0206)
Avg. acc. deadline, ex. 1st	–	–	–	0.8033*** (0.03445)	(no path) –	0.8033*** (0.03445)	0.0022 (0.0021)	−0.0073*** (0.0013)	−0.0051*** (0.0018)
Adjusted *R*2	0.0105	–	–	0.3789	–	–	0.3725	–	–
Overall adj. *R*2	0.4625	–	–	–	–	–	–	–	–
Observations	1,078	–	–	–	–	–	–	–	–
Goodness of fit statistics	Chi^2, (= 0) 0.44	*p*-value, (> 0.05) 0.8027	RMSEA, (< 0.05) 0.000	CFI, (>0.97) 1.000	SRMR, (< 0.05) 0.004	Close fit, (> 0.10) 0.982	df2	–	–

(*continued*)

Table 2.

Variables	No. of bidders			Avg. response time			Price premium		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total

Notes: The table shows the main model with direct, indirect and total effects estimates (maximum likelihood). In Panel A, all bids are included in the average acceptance deadline, whereas in Panel B, the first bid is excluded. Price premium = ln (sales price/asking price). All variables are log-transformed. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$

Table 3.
SEM results, alternative model

Variables	Number of bidders			Avg. response time			Price premium		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Number of bidders	–	–	–	−0.8204*** (0.1387)	(no path)	−0.8204*** (0.1387)	0.1088*** (0.0058)	0.0067*** (0.0015)	0.1155*** (0.0058)
Avg. response time	–	–	–	–	–	–	−0.0082*** (0.0013)	(no path)	−0.0082*** (0.0013)
Avg. bid increase	−0.0506*** (0.0157)	(no path)	−0.0506*** (0.0157)	0.4097*** (0.0680)	0.0415*** (0.0147)	0.4512*** (0.0689)	0.0274*** (0.0030)	−0.0092*** (0.0020)	0.0182*** (0.0035)
Opening bid ratio	−0.0085 (0.0934)	(no path)	−0.0085 (0.0934)	(no path)	0.0070 (0.0767)	0.0070 (0.0767)	0.2269*** (0.0013)	−0.0010 (0.0108)	0.2260*** (0.0205)
Adjusted R^2	0.0105	–	–	0.0686	–	–	0.3688	–	–
Overall adj. R^2	0.1916	–	–	–	–	–	–	–	–
Observations	1,078	–	–	–	–	–	–	–	–
Goodness of fit statistics	Chi^2, (= 0) 5.46	p-value, (> 0.05) 0.0194	RMSEA, (< 0.05) 0.064	CFI, (>0.97) 0.992	SRMR, (< 0.05) 0.018	Close fit, (> 0.10) 0.243	df1	–	–

Notes: The table shows the main model with direct, indirect and total effects estimates (maximum likelihood), excluding the average acceptance deadline. Price premium = ln (sales price/asking price). All variables are log-transformed. Standard errors in parentheses. $*p < 0.10$, $**p < 0.05$ and $***p < 0.01$

The average bid increase has several pathways towards the price premium. First, it reduces the number of bidders, an intimidation effect similar to what was found in the study of Khazal *et al.* (2020). Second, high bid increases seem to increase the response time, supporting *H2*. Finally, when looking at the effect on the price premium, there is a positive direct effect, whereas the indirect effect is negative, caused by a reduced number of bidders and longer response time. Nevertheless, the total effect from the average bid increase on the price premium is positive and significant.

Additionally, the opening bid ratio has several pathways towards the price premium. First, there is an intimidation effect on the number of bidders. This effect is only significant in the alternative model (Table 3), where the average acceptance deadline is excluded. Second, there is a non-significant indirect effect reducing the response time through the reduced number of bidders. Finally, the effect on the price premium is significant and positive. Here, the direct effect is positive, whereas the indirect effect is non-significant.

The average acceptance deadline has two pathways: one direct pathway and one pathway through the average response time. The effect on the average response time is significant and positive, supporting *H1*. This result is perhaps not surprising but is nevertheless important. When including all bids, the coefficient is close to 1, and when excluding the first bid, the effect is near 0.8. Hence, the bidders or the real estate agent use much of the extra time that they are given by a longer acceptance deadline. This means that an auction participant can influence the behaviour of the other participants, cool the potential auction fever and consequently reduce the final price premium. Looking at the effect on the price premium, the direct effect is only significant when all bids are included. This might indicate that the first bidder is able to avoid some competition by setting a shorter deadline on the opening bid. We have run a second alternative model where we create a pathway from the average response time to the number of bidders that further indicates this. The indirect and total effects are nevertheless negative and significant in both cases, supporting *H5*. The acceptance deadline is important because it influences the response time, which again influences the price premium. Again, we see that our results indicate that bidders should seek a non-aggressive bidding strategy.

When the asking price is correctly set, there should be no problem with reverse causality from using the sales price to asking price ratio as the dependent variable. On the other hand, although we argue that under-pricing is not used systematically in this market, the possible existence of strategic pricing could have consequences for our results. If the asking price is perceived to be low, this could affect the number of bidders and the price premium. To mitigate this potential issue, we have run additional models with different indicators for under-pricing: the spread between asking price and predicted asking price (hedonic estimate); the spread between asking price and predicted market value (hedonic estimate); and dummy variables indicating whether the asking price is lower than the respective estimates. In these four specifications, we have included pathways between the under-pricing variable and number of bidders and price premium, respectively. The results are nearly identical to the main results, with no substantial changes in any of the coefficients or the goodness of fit indicators.

We have also replicated the SEM estimation results using a hedonic valuation approach for the price premium and the results are for most part in line with our main results. For example, in the main model, all effects are similar except for the acceptance deadline total effect on the price premium, which is no longer significant due to equal but opposite direct and indirect effects. However, the hedonic valuation is based on quite a low number of observations and the observations are covering an area with large price variations. We therefore trust the valuation with basis in the asking price, which should reflect the real

estate agent's true expectations about the house value, more than the valuation based on the hedonic method. These results are available from the authors upon request.

6. Conclusion

In this paper, we have studied the price effect from the use of aggressive bidding strategies in real estate auctions by applying SEM. The models allow us to study both direct effects, indirect effects and total effects, something that is crucial when we want to understand how these aspects and strategies work together in auctions. To the best of our knowledge, we are the first to apply this technique to real estate auctions.

In addition to the SEM analysis based on 1,078 exclusive auction journals from real estate sales from Norwegian, we also present results from a survey in which 1,803 participants were asked questions about acceptance deadlines and response times in real estate auctions. We define four aggressive bidding strategies: high opening bid, high bid increase (jump bids), short acceptance deadline and short response time.

We find that all four of our aggressive bidding strategies yield a higher sales price. These results confirm earlier findings of a positive price impact from jump bids (Hungria-Gunnelin, 2018; Khazal *et al.*, 2020; Sommervoll, 2020) and high opening bids (Sønstebø *et al.*, 2021). Additionally, aggressive bidding strategies in the form of short acceptance deadlines and short response times yield higher prices. These results are very interesting given that the clear majority of the survey participants believed that to obtain a home at the lowest possible price, it is advisable to place bids with a short acceptance deadline and to respond quickly to others' bids. Bidders can actively influence the behaviour of the other participants and cool the potential auction fever and consequently reduce the final price premium. We also find that a higher number of bidders yields a higher price premium, similar to the study of Hungria-Gunnelin (2013).

Notes

1. On average, the final price is more than five times the Norwegian average annual earnings in our data period (Statistics Norway, 2016).
2. Bidding made with small increments.
3. Counteroffers from the seller occur almost exclusively when the current bid is below the asking price.
4. The sample is stratified based on gender and age groups within the three cities. The survey is described in greater detail in the study of Sønstebø (2017).

References

Bikhchandani, S. and Riley, J.G. (1991), "Equilibria in open common value auctions", *Journal of Economic Theory*, Vol. 53 No. 1, pp. 101-130.

Bowen, N.K. and Guo, S. (2011), *Structural Equation Modeling*, Oxford University Press.

Hungria-Gunnelin, R. (2013), "Impact of number of bidders on sale price of auctioned condominium apartments in Stockholm", *International Real Estate Review*, Vol. 16, pp. 274-295.

Hungria-Gunnelin, R. (2018), "An analysis of auction strategies in apartment sales", *Journal of European Real Estate Research*, Vol. 11 No. 2, pp. 202-223.

Jöreskog, K.G., Olsson, U.H., and Wallentin, F.Y. (2016), *Multivariate Analysis with LISREL*, Springer.

Khazal, A., Sønstebø, O.J., Olaussen, J.O. and Oust, A. (2020), "The impact of strategic jump bidding in residential English auctions", *Journal of Property Research*, pp. 1-24.

Milgrom, P.R. and Weber, R.J. (1982), "A theory of auctions and competitive bidding", *Econometrica*, Vol. 50 No. 5, pp. 1089-1122.

Norges Bank (2020), "Exchange rates", available at: www.norges-bank.no/en/topics/Statistics/exchange_rates/. (accessed 18 August 2020).

Norwegian Association of Real Estate Agents (2014), "Norges eiendomsmeglerforbund, regler for budgivning. (Norwegian association of real estate agents, bidding rules)", available at: www.nef.no/regler-for-budgivning/. (accessed 6 August 2020).

Regulation on Real Estate (2007), "Forskrift om eiendomsmegling", https://lovdata.no, available at: https://lovdata.no/forskrift/2007-11-23-1318 (accessed 20 May 2020).

Sommervoll, D.E. (2020), "Jump bids in real estate auctions", *Journal of Housing Economics*, Vol. 49, p. 101713.

Sønstebø, O.J., Olaussen, J.O. and Oust, A. (2021), "Opening bid strategies in English auctions", *Journal of Real Estate Research*.

Sønstebø, O.J. (2017), "Bidding round survey report", Working Paper. NTNU Business School, available at: www.ntnu.no/documents/1265696466/1266217446/Bidding+Round+Survey+Report.pdf/003674a1-0532-f550-73d6-0ca56f6fa745?t=1591261799664

STATISTICS NORWAY (2016), "Earnings, 2015", available at: www.ssb.no/en/arbeid-og-lonn/statistikker/lonnansatt/aar/2016-03-03. (accessed 10 June 2020).

Suhr, D. (2008), "Step your way through path analysis", *Western users of SAS software conference proceedings*, pp. 1-10.

Vickrey, W. (1961), "Counterspeculation, auctions, and competitive sealed tenders", *The Journal of Finance*, Vol. 16 No. 1, pp. 8-37.

Appendix

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Price premium	–	–	–	–	–	–
(2) Number of bidders	0.4816*	–	–	–	–	–
(3) Avg. response time	−0.2491*	−0.1930*	–	–	–	–
(4) Avg. acceptance deadline, all bids	−0.0853*	−0.0392	0.7913*	–	–	–
(5) Avg. acceptance deadline, ex. first bid	−0.1023*	−0.0124	0.5687*	0.8094*	–	–
(6) Opening bid ratio	0.2898	0.0302	−0.1274*	−0.1128*	−0.1084	–
(7) Avg. bid increase	0.0529	−0.1023*	0.1959*	0.1201*	0.0532*	−0.3208*

Notes: The table shows the Pearson correlation coefficients between bidding variables. All variables are log-transformed; *$p < 0.05$

Table A1. Correlation matrix, bidding variables

Corresponding author
Are Oust can be contacted at: are.oust@ntnu.no

For instructions on how to order reprints of this article, please visit our website:
www.emeraldgrouppublishing.com/licensing/reprints.htm
Or contact us for further details: **permissions@emeraldinsight.com**