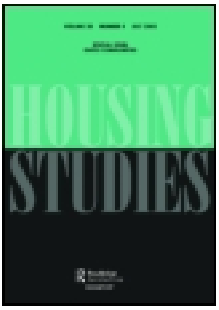

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Expectation Adjustment in the Housing Market: Insights from the Scottish Auction System

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ABSTRACT *This paper examines price expectation adjustment of house buyers and sellers to rapid changes in the housing market using data from Scotland where houses are sold through 'first-price sealed-bid' auctions. These auctions provide more information on market signals, incentives and the behaviour of market participants than private treaty sales. This paper therefore provides a theoretical framework for analysing revealed preference data generated from these auctions. We specifically focus on the analysis of the selling to asking price difference, the 'bid-premium'. The bid-premium is shown to be affected by expectations of future price movements, market duration and high bidding frequency. The bid-premium reflects consumer's expectations, adapting to market conditions more promptly than asking price setting behaviour and final sale prices. The volatile conditions of the recent housing market bubble are fully reflected in the bid-premium, whereas the asking and sale prices are much less prone to rapid movements.*

KEY WORDS: Housing markets, price expectations, auctions, bid-premium

Introduction

Price expectations adjustment by buyers and sellers to rapid changes in the housing market is an increasingly important issue given the recent volatile conditions of the housing boom and subsequent bust. Housing auctions can be helpful in examining this issue as they provide more information on market signals, incentives and behaviour of market participants than private treaty sales. The issue of housing auctions and sale mechanism has been theoretically and empirically examined in the literature (Lusht, 1996; Stevenson & Young, 2004; Stevenson *et al.*, 2010) including the probability of resulting in a sale (Ong *et al.*, 2005) and the effects on the final sale price (Dotzour *et al.*, 1998; Mayer, 1998). In market boom conditions and locations where demand is high relative to supply, the seller will be in a stronger bargaining position relative to the buyer. Glaeser *et al.*

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(2008) and Goodman and Thibodeau (2008) indicate that housing market bubbles are exacerbated where housing supply is price inelastic.

Setting an asking price is crucial in marketing a house. The asking price affects the number of viewings by potential purchasers per time period (Arnold, 1999). Setting a low asking price might attract more prospective buyers, but also lowers perceived valuation (Horowitz, 1992; Knight *et al.*, 1994). Higher asking prices may generate higher bids, but also may reduce the probability of finding a buyer whose valuation of the property is above the seller's reservation price. Sellers wish to maximise sale price and complete their transaction in as short a time period as possible (Yavas & Yang, 1995). Nonetheless, the role of market agents is important (Smith *et al.*, 2006), having a significant effect on the expectations of the seller and on setting the asking price. The sale probability can also be affected by the length of time the house has been on the market, the distribution of offers and the seller's reservation price (Haurin, 1988; Pryce & Gibb, 2006; Yavas & Yang, 1995; Zuehlke, 1987). Pryce (2011) also finds that the degree of overpricing is positively correlated with market duration.

This paper examines the consumers' speculative behaviour, focusing on the demand side of the housing market and its selling mechanisms. We take advantage of the Scottish system's uniqueness, where the vast majority of the house sales are conducted in first-price sealed-bid auctions,[1] with the bids usually being above the asking price. A theoretical framework is developed for analysing the data generated from these auctions, including and distinguishing between the different incentives and signals for the seller and buyer. This is accomplished by focusing on a specific price component, i.e. the difference between asking and final selling price, henceforth called the 'bid-premium'. The analysis of the different information contained in asking prices and selling prices provides the basis for examining the bid-premium. We examined whether this price component behaves differently to selling and asking prices, especially through the period of high inflation in the housing market and the subsequent market reaction to the first signs of trouble.

The characteristics of the first-price sealed-bid auctions are discussed along with Scottish market conditions before the theoretical framework and modelling section. The paper structure is as follows: Section 2 discusses the first-price sealed-bid auction system and the housing market in Scotland, the theoretical framework is developed in Section 3 and data issues are illustrated in Section 4. The modelling and results are discussed in Section 5 followed by the concluding section.

The Auction Sale Mechanism and the Scottish Housing Market

Auctions are a popular house sale mechanism in Ireland (Stevenson *et al.*, 2010), Australia (Lusht, 1996) and New Zealand (Dotzour *et al.*, 1998), predominantly at the premium end of these markets. These countries employ open outcry auctions in contrast to Scotland's first-price sealed-bid auctions. Auctions are primarily used in the context of foreclosure and bankruptcy sales in the USA (Mayer, 1998) and Singapore (Ong *et al.*, 2005). To our knowledge, there is no equivalent to the Scottish house sale system; therefore, one can reasonably expect that housing market participants in Scotland exhibit behavioural differences to participants in countries where different auction mechanisms or private treaty sales are used.

Game theory provides paradigms of distinctive revenue outcomes in specific cases, normally depending upon the private or common value of the commodity and the risk attitudes of the involved parties. However, we have not found in the literature a game theory model that fully captures the complexities of the Scottish housing market. Nevertheless, looking at this literature can provide some helpful insights.

For example, a common issue with both sealed-bid and open outcry auctions, where bidders are uncertain about the commodity value, is that the highest bidder often overestimates the value and overbids. The seller will strictly prefer the first price to the open outcry auction, with the former yielding a higher expected price, when risk-averse bidders with private values[2] are assumed (Milgrom & Weber, 1982). This is not generally true in a common values[3] setting, where less aggressive bids are induced, because the value of the object is affected by the information held by other bidders (Menicucci, 2004). Even in the case of risk-neutral individuals with private values, the laboratory analysis of Kirchkamp *et al.* (2009) found that an outside substitute option significantly magnified the revenue premium of the first-price auction because overbidding in first-price auctions is more prominent with outside options than without.

The analysis of Milgrom and Weber (1982) predicted that for first-price and open outcry auctions with bidders' risk-neutral common value, providing full information is the best policy for the seller. Neugebauer and Perote (2007), in a first-price auction with private values experiment, found that feedback information on winning bids triggers an immediate response in bidding behaviour. Subjects anchor on the winning bid as if it was the price to be paid in the market. Hence, subjects learn to bid on the basis of this winning bid rather than by reflecting on their values. In contrast to the bidding behaviour, in the no information feedback treatment, Neugebauer and Perote (2007) found that the revelation of the lagged winning bid triggers an immediate response in terms of higher bidding. This is highly relevant to the Scottish housing market because house price levels in local markets are determined by the winning bid and not the whole range of bids.

We can assume that most house buyers are uncertain about the value of the house they are buying. However, there are periods in the housing market when buyers expect future price appreciation, and conversely when they think that prices will decrease. Hence, house value uncertainty can move in a particular direction given the market circumstances. In times of price inflation, we expect an exacerbation of higher value bids and the reverse when price levels fall.

Auctions in Housing Markets

The use of auctions in the housing market hinges on the fundamental question of whether there is a premium to the seller. Empirical evidence broadly indicates that there is an auction premium in markets operating through open outcry auctions. Lusht (1996) and Newell *et al.* (1993) argue for such a premium in the Melbourne and Sydney markets, whereas Dotzour *et al.*'s (1998) findings for Christchurch, New Zealand, support this notion. Stevenson *et al.* (2010) also found that auctioned properties tend to sell at a premium in Dublin.

The importance of the number of bidders in obtaining higher prices at an open outcry auction in real estate is underlined by Lusht (1996), Ong (2006) and Stevenson *et al.* (2010), while Ooi *et al.* (2006) report that the number of bidders impacts upon sale prices in the context of sealed-bid auctions. In the Scottish system, Levin and Pryce (2007) argue that during boom periods, extreme bids for houses can be observed, where the highest bid will be significantly higher than the mean of the distribution of bids for the property.

Pryce (2011) applies a multiple fractional polynomial estimation to examine the degree of overpricing in Glasgow. The degree of overpricing is defined as the percentage difference between the asking price and the 'expected selling price' (a hedonic price estimate). He finds that market conditions can affect selling strategy and that sellers may opt for setting a fixed price when the market is relatively weak.

The Scottish System

In Scotland, the sealed-bid auction is the dominant mechanism through which buyers and sellers reach a price. Auction participants submit a bid on the basis of a professional valuation and an 'offers-over' price set by the seller. Pryce and Gibb (2006) state, 'the offers-over price is typically set so that the auction will produce a successful outcome' (p. 380). The asking price is not legally binding, and the reservation price is often not revealed by the seller. The asking price is set by the vendor in consultation with his/her real estate agent at a level that will attract potential buyers and generate a bidding process. The signal sent by the offers-over asking price in the Scottish system is different from systems in other countries. In England and the US, for example, most houses transact below their asking prices; thus, the asking price is seen as a ceiling price.

Unlike the open outcry auction, the date of a sealed-bid auction in Scotland is not pre-set and is only set when the seller's solicitor receives two or more 'notes of interest' (Pryce & Gibb, 2006; Pryce, 2011). The bids are revealed to the seller after the 'closing date' for offers has elapsed. At the time of bid submission, the potential buyers do not know the number of auction participants, but they are aware of the number of 'notes of interest'. Hence, the bidders have an indication of the level of interest that exists for the property.

The seller is not required to set a closing date and can enter into private negotiations with the first interested party. The 'private treaty' or 'fixed price' selling mechanism can also be adopted at the start of the marketing process. This may occur because, first, the seller may require a quick sale. Choosing a fixed price reduces buyer uncertainty. Second, the seller may consider that there is a low probability of the auction attracting many bidders due to property characteristics, location and/or general market conditions (Pryce, 2011). This is consistent with Mayer (1995).

House price inflation in the Scottish housing market in the run-up to 2007 was partly triggered by the perceived investment potential of housing (Smith *et al.*, 2006). Smith *et al.* (2006) have argued that the behaviour of market agents contributed to the significant house price inflation in Edinburgh between 1996 and 2003. Market agents did not know what potential buyers should offer when the market was experiencing rapid change. This would further increase the probability of overbidding, which in conjunction with perceived investment potential, may have contributed to the price inflation witnessed in the housing market.

Theoretical Framework

This section demonstrates the conceptual differences in incentives and behaviour between sellers and buyers specifically in the Scottish housing auction system.

The first step in the modelling process is to employ the hedonic pricing (HP) method to determine the factors affecting the selling price. HP considers housing as a composite commodity, with the neighbourhood[4] characteristics of the locality being important along with the structural characteristics of the property. This is a popular method in real-estate research (Pryce & Gibb, 2006; Watkins, 2001; Zuehlke, 1987).

The price P of the house i, in the mth residential location is given by:

$$P_{im} = f(X_{im}), \tag{1}$$

where X_i are the structural and neighbourhood characteristics of house, i, in the neighbourhood m. We employed the common log-linear transformation as it provides the best fit to the data:

$$\ln(p_i) = a_i + X_i\beta + T_i c + \varepsilon_i, \tag{2}$$

where β is a vector of the coefficients for the characteristics of house i, T is a time dummies indicator matrix controlling for the nominal aspect of sales prices and c is a vector of parameters capturing this nominal price evolution.

At the level of individual auction, the selling price p of house j can be decomposed into:

$$p_j = k_j + b_j, \tag{3}$$

where k_j is the asking price and b_j is the difference between the selling and asking price, or bid-premium in this research context. The seller sets an asking price, k_j, that maximises his/her expected value of the bid-premium. This is conditional on the matrix of housing attributes, X_j, and housing market conditions at time t_j^* as perceived by the seller:

$$k_j = \{X_j, t_j^* : \max[E(b_j)]\}. \tag{4}$$

The asking price here is a function of housing attributes, a common assumption in HP. The asking price reflects the common value of a combination of housing attributes held in the market place up until t_j^*. t_j^* is very important because by putting the house on sale, the seller expects that given the perceived current market conditions he/she will receive at least the reservation price that is not necessarily k_j, but is less than p_j. We do not speculate about the information available to or the process used by sellers to assess market conditions.

Price setting is *not* done in a vacuum or completely governed by strategic behaviour of individuals with private values. If the seller hopes to maximise the selling price, he/she has to price according to the housing market conditions and a perception of a common value in the market, often conforming to 'expert advice'. Conversely, if the seller has a high private value for the house and does not conform, the probability of sale will be significantly reduced, which will be reflected in the time on the market (TOM) or will be unsuccessful and not available in our observed sales data. Any strategic behaviour of setting the asking price by a rational seller can only affect and will aim to maximise the number of auction participants h_j and minimise TOM ξ_j:

$$\left\{\max[E(b_j)]|X_j t_j^*\right\} \Rightarrow \max(h_j) + \min(\xi_j). \tag{5}$$

There may be a perception of a strategic benefit to setting an asking price below the reservation price. However, this is a balancing act as the attributes X_j of the house and the market conditions are common knowledge for auction participants. A very low asking price that is disparate to similar properties or to the perceived common value of X_j in the market at t_j^*, can also signal a lower bargaining position (e.g. unseen problems with the property, financial issues, time constraints) of the seller. Hence, setting a very low asking price, much below the reservation price may not necessarily attract more bidders or reduce TOM (see for example Campbell *et al.*, 2009; Haurin *et al.*, 2008).

Looking at the incentives of the buyer, he/she would aim to minimise the bid-premium. The available signals to the buyer, given his/her decision to participate in an auction for the house j with attributes X_j, are the number of auction participants h_j, TOM ξ_j, the asking price k_j and the market conditions at t_j. This is expressed as:

$$\{\min[E(b_j)]|k_j, t_j, h_j, \xi_j\}. \tag{6}$$

The housing attributes X_j are common knowledge among auction participants, and the asking price k_j internalises X_j. In this first-price sealed-bid auction, it is the expectation that potential buyers with a reservation price below k_j will not participate in the auction. The very few observations in which the bid-premium is negative in our data are attributed to data error or problematic asking price setting behaviour by the seller.

The market conditions at the time of the auction t_j can be different from the conditions at asking price setting time t_j^*. It is very important when there are rapid price movements in the market, such as the recent volatile conditions in the housing market. In our data, the time between setting the asking price and selling the house, or TOM, is about 52 days on average. In conditions of high market inflation, one will expect increased disparity between asking and sales prices just due to this reason. Conversely, a shock in the market, say a rapid deflation, will decrease this gap.

TOM is another important signal to the buyer as longer TOM can be considered as a disadvantage for the seller. This can be interpreted by the buyer as either the specific combination of attributes X_j is not widely sought after in the current market conditions or the asking price setting by the seller was too high. In either case, the seller will tend towards a lower price offer, ceteris paribus. Conversely, a house that just came into the market can be considered a bargain, pushing potential buyers to higher offers especially where there is interest by many market participants.

This leads to the other important signal, the number of auction participants h_j. The buyer would strictly prefer less or no competition from other potential buyers. Rephrasing, there is a strict preference from the buyer's perspective to a private treaty directly negotiating with the seller than a first-price sealed-bid auction. Hence, the auction system in Scotland is geared towards sellers in properties and/or market conditions that attract interest by multiple prospective buyers. Gibb (1992) suggests that the seller can use the sealed-bid system to capture the buyer's economic rent. In the data section below, in times of economic downturn, the percentage of private treaty sales is very high, whereas after 2004, it drops to an unprecedented low, well below 10 per cent. This is also consistent with the literature that finds a premium in markets operating through auctions (Dotzour *et al.*, 1998; Lusht, 1996; Newell *et al.*, 1993; Stevenson *et al.*, 2010).

The second stage of the two-stage model of bid-premium is derived by Equation (4), being shaped by buyer behaviour. However, because the bid-premium is conditional on the asking price, we expect the asking price to be endogenous to the bid-premium as more expensive houses will exhibit higher bid-premiums in absolute value and lower percentage difference between asking and selling price. Hence, the first stage model is derived by Equation (2) that reflects the seller's behaviour in setting the asking price that is conditional to the vector of the housing attributes. The two-stage model of bid-premium

(b_i) is given as:

$$\ln(b_i) = a_i + gk_i + T_i c + \lambda h_i + \eta \xi_i + u_i, \qquad (7)$$

$$\ln(k_i) = a_i + Z_i \beta + T_i^* c + \varepsilon_i, \qquad (8)$$

where Z_i is a matrix of housing characteristics uncorrelated with the error term u_i. T_i and T_i^* are time dummies indicator matrices for the time of sale and the time of asking price setting. h_i is the number of auction participants, ξ_i is TOM and k_i is the asking price. g, γ and η are the coefficients of asking price, number of auction participants and TOM, respectively.

Even though our approach has a similar starting point to Pryce (2011), there are several differences. Most importantly, the percentage difference is examined between the asking price and the 'expected selling price' that is a hedonic price estimate. A priori assumptions are made about the asking price setting behaviours of the sellers, who explicitly use this percentage difference between asking and selling prices in their area to determine their asking price. However, it is difficult for sellers to accurately calculate this difference as they are often looking at houses with different characteristics. Another assumption is the dominating role of the real estate agents who get most sellers to conform to 'local market conventions' that dictate the asking/selling price percentage difference in specific areas. However, there are no data to test the effects of different estate agents and whether they are imposing different local market conventions. We also point to the relevant observation of Smith *et al.* (2006) that market agents did not know what potential buyers should offer when the market was experiencing rapid change. Lastly, there is the issue of asking price endogeneity to asking/selling price percentage that cannot be directly addressed given the type of variables of our data set.

Data

Data Description

The data used in this study cover the housing market in Aberdeen, in North East Scotland, and were provided by Aberdeen Solicitors Property Centre. The dataset contains information on asking and selling prices, structural characteristics of the property, location and duration on the market. The Geographical Information System was used to derive spatial variables such as distance to the central train station and the airport, dwelling density and socioeconomic characteristics on the level of census output area (COA). While the dataset runs from 1984, this study focuses on the period from 2004 to 2007, with the dataset containing 19 290[5] transactions across the city. The reason for focusing in this timeframe is a significant shift in market behaviour after 2004, compared to previous years, as shown in Section 4.2.

Only 6.8 per cent (1320) of the houses were sold through private treaty. This was a very small part of the sample, not allowing analysis that has any statistical significance on the choice of sale mechanism. This is also observed in Stevenson *et al.* (2010), where the inverse Mills Ratio (Lee, 1982) derived from a probit model was not statistically significant in their hedonic price models. Hence, there was no sample selection bias due to the endogeneity of sale mechanism selection even though 25.9 per cent of their sample was sold through private treaty.

The subsequent discussion and modelling is focused on the 17 354 house sales in which the sale price exceeded the asking price dropping, except the private treaty sales, 3.2 per cent of the data with negative bid-premia. These observations constitute outliers that either reflect data error or unrealistic expectations and poor understanding of the auction process or properties with unique and rare characteristics that do not provide any insight to the process under examination. We recognise that there might be a possibility of selection bias because the private treaty option exists not only at the start of the selling process, but at any point prior to sale. However, we do not have any information to test this, and the percentage that opted for private treaty in our study period was very small. In any case, this study focuses and only produces estimates for houses sold through first-price sealed-bid auctions. A description of each variable is found in Appendix A, with Appendix B providing descriptive statistics.

Short and Long Term Bid-premium Movements Relative to Asking Price

Figure 1 illustrates both the bid-premium as a percentage of the asking price each year from 1985 to 2007 and the percentage of all houses sold by private treaty. Falling oil prices in the mid-1980s caused the supply of houses on the market to rise relative to demand. The bid-premium increased to approximately 10 per cent by 1992 as demand rose relative to supply. At the same time, the percentage of private treaty sales fell from over 20 per cent to less than 10 per cent. Although the nation's economy had gone into recession in 1990–1991, this was not the case in the local housing market or in the local economy of Aberdeen (see Harris *et al.* (1986) and Jones and Maclennan (1986) for a discussion of the Aberdeen economy and housing market). The bid-premium fell after 1992 and remained below 5 per cent between 1995 and 2001. Private treaty sales accounted for between 20 and 25 per cent of all sales during this period. After this period, we saw significant

Figure 1. The bid premium (%) and private treaty sales (per cent of total); yearly 1985–2007.

increases in the bid-premium. From 2003 onwards, the bid-premium was in excess of 10 per cent and rose to almost 35 per cent of the asking price by 2006, although the rate of increase in the bid-premium decreased between 2006 and 2007. Private treaty sales fell to a historic low during this later period. This signified a significant shift to consumer behaviour that could be partly explained by the increasing perceived investment potential in the housing market as argued by Smith *et al.* (2006).

Looking at the 2004–2007 period in detail at quarterly intervals, Figure 2 shows that bid-premium does not fall below 15 per cent of the asking price at any point, while private treaty sales fluctuate just over 5 per cent between 2004 and 2006 and remain below 10 per cent until 2007, third quarter. From the beginning of 2005, we observe a strong positive trend until the peak in the first quarter of 2007 at around 35 per cent of the asking price, which is remarkable in a historic context.

Early signs of bad debt in the financial sector appear in the third quarter of 2007, which was the first indication that something was seriously wrong with the housing market. Hence, the bid-premium percentage falling and the private treaty sales proportion increasing after the second quarter of 2007 is no surprise. Nevertheless, this still does not show a return to the pre-2004 situation. The bid-premium percentage is still above 20 per cent, and private treaty sales proportion does not exceed 15 per cent.

It is clear that the distribution has shifted to the right from the first quarter of 2004 to the first quarter of 2007. The bid-premium to asking price ratio in the first quarter of 2007 is statistically significantly[6] higher than that in 2004, with the mean in 2007 (42.7 per cent) being almost two standard deviations to the right of the mean in 2004 (18.6 per cent).

Neither in the short nor in the long term, shown in Figures 1 and 2, was there any significant institutional change in the selling system. There is no evidence that the new sellers' surveys, required by the end of the time period, impacted on pricing strategy.

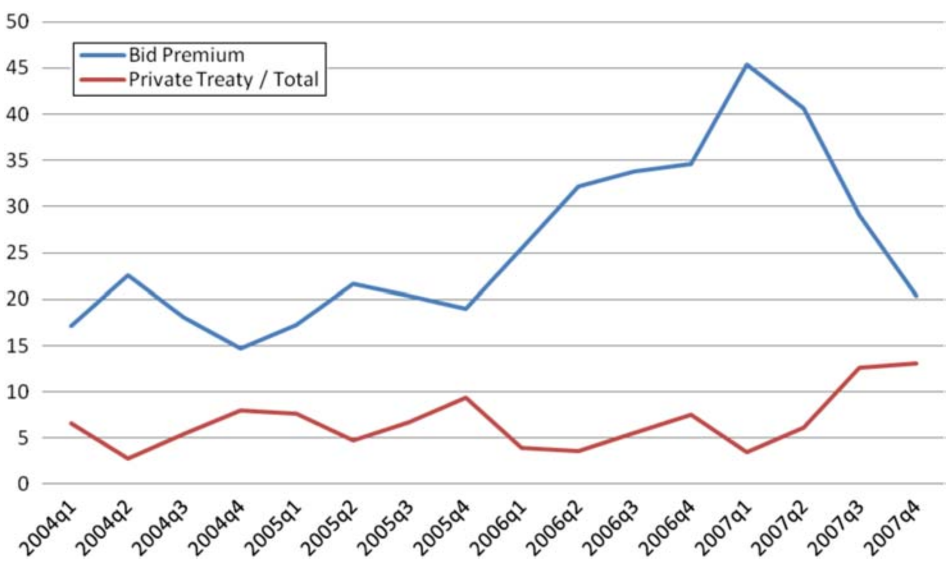

Figure 2. The bid premium (per cent) and private treaty sales (per cent of total); quarterly 2004–2007.

However, the cycles in the local Aberdeen economy might have also been dictated by investment in the offshore oil and gas industry. Waves of new investment coincide with periods of house price inflation such that the local housing market often performs differently from the national economy (Wilson *et al.*, 2011). Thus, market conditions significantly affect the amount of bids offered over the asking price. This also drives the inverse relationship between the bid premium and the proportion of private treaty sales that shifted radically after 2004.

Estimation and Results

This section presents the results of empirical estimation, starting with the HP models. A discussion of the methodological considerations and the results of the two-stage bid-premium model follow. The section concludes by bringing together the HP and the two-stage bid-premium model results over the study period.

HP Models

Except for the HP model in Equation (2), we also estimated an HP model where the dependent variable is the asking price instead of the selling price. The justification for this is to explore the factors affecting the asking price setting behaviour. The only difference in specification between the two models is the replacement of the sale period dummy matrix with one for the period when the house was entered onto the market.

The sale and asking price HP model results are presented in Appendices C and D, respectively. Both models have a very good overall fit, explaining 82 per cent of the data variation. Almost all coefficients have the expected signs a priori and most are statistically significant at the 95 per cent level. The results of the two models are very similar, with the selling price HP model providing only marginally better overall data fit. This is in line with the argument in Section 3 that compared to the sale price, the asking price k_i accurately captures the arguments in Equation (3) and in the second stage internalises the housing attributes X_i.

Double glazing would be expected to have a positive effect on house price; yet, its coefficient is negative in our models. This may be attributed to this variable capturing noise effects[7] and/or locational characteristics not captured by other variables as double glazing is also less likely in some larger older properties that tend to be concentrated in the most expensive locations.

We did not include TOM in the HP models as it would raise theoretical issues. If we were to include TOM, it would be the only variable exhibiting noticeable differences between asking and sale price HP models. The TOM coefficient would be statistically significant in both models, negative in the selling price HP and positive in the asking price HP. This denotes the negative effect of a longer marketing period on sale price and that houses with higher asking prices take longer to sell, ceteris paribus.

Methodological Considerations in the Bid-premium Model

The two-stage model is specified according to Equations (7) and (8) in Section 3. The model includes dummy variables for each quarter, from 2004 to the end of 2007, with the fourth quarter of 2007 being the base category. The discussion in Section 4.2 also confirms that the change of market conditions over time affects bid-premium levels. TOM is included in the bid-premium model as it is an important signal to the buyer.

The number of auction participants should have a significant effect on the price achieved in an auction, but unfortunately, we do not have any available data on the number of bids per auction. Dwelling density is employed as a proxy for this factor given that in areas with denser population, we expect higher concentration of bidders, ceteris paribus. A corollary to this is, as Green *et al.* (2005) show, supply elasticity and population density are negatively related. Therefore, in densely populated areas where housing supply is price inelastic, we expect exacerbation of over bidding and of housing market bubbles (Glaeser *et al.*, 2008). The dwelling density variable might also be capturing this effect; hence, it is included in the model.

As seen in Equation (8), the asking price is also expected to be endogenous to the bid-premium as houses with higher asking prices will attract higher bids and bid-premiums. This endogeneity then needs to be tested and the asking price instrumented, if that is the case. The selection of appropriate instruments was an iterative procedure of testing a combination of housing characteristics that would be uncorrelated with the error term u_i in Equation (7). We examined attributes with the least variation between asking and sale HP models and found these to be neighbourhood/socioeconomic characteristics. The best results were achieved by using as instruments the variables distance to airport, unemployment in the area, garden, areas with a majority of social or privately rented houses, with 30 per cent of people having no qualifications and the majority of households not owning a car.

Most of the neighbourhood/socioeconomic data were only available at the COA level of spatial disaggregation as seen in Appendix A. We employed a generalised method of moments estimator with cluster-robust errors to account for this in our two-stage model (Baum *et al.*, 2007; Hansen *et al.*, 1996; Wooldridge, 2002). The results of this model are presented in Table 1, but first, we examine the statistical test for endogeneity and instrument suitability before the results are discussed.

We can reject at the 99 per cent level, the hypothesis of the asking price not being endogenous to the bid-premium (Hausman, 1978; Hayashi, 2000). Under-identification is also rejected at this level (Kleibergen & Paap, 2006), meaning that excluded instruments are correlated with the endogenous regressor k_i. The null hypothesis of no over-identification cannot be rejected, which denotes that the instruments are uncorrelated with the error term u_i in Equation (7) and were correctly excluded from estimating that Equation (Hayashi, 2000). The value of the Kleibergen–Paap rk Wald statistic (Kleibergen & Paap, 2006) when compared to the Stock–Yogo weak identification critical values (Stock & Yogo, 2005) allows us to reject weak identification or that the instruments are only weakly correlated with the endogenous regressor.

Bid-premium Model Results

The performance of this model in Table 1 was not expected to rival the HP models as strategic behaviour and overbidding may be a frequent occurrence in housing auctions, and proxies are employed in the two-stage model to account for unavailable information. Nevertheless, the overall goodness of fit is excellent for this type of model, explaining 56 per cent of the data variation. Almost all coefficients are statistically significant at the 99

Table 1. GMM two-stage bid-premium model

Variable	Coefficient	SE[a]	t-Stat	$p > t$
Asking price	1.005	0.027	37.70	0
2004 q1	−0.600	0.034	−17.46	0
2004 q2	−0.308	0.031	−9.95	0
2004 q3	−0.505	0.031	−16.11	0
2004 q4	−0.674	0.034	−20.07	0
2005 q1	−0.532	0.033	−15.94	0
2005 q2	−0.319	0.028	−11.21	0
2005 q3	−0.351	0.029	−12.24	0
2005 q4	−0.364	0.030	−11.97	0
2006 q1	−0.128	0.029	−4.37	0
2006 q2	0.030	0.027	1.10	0.271
2006 q3	0.085	0.026	3.31	0.001
2006 q4	0.145	0.027	5.27	0
2007 q1	0.366	0.026	13.94	0
2007 q2	0.390	0.026	14.96	0
2007 q3	0.192	0.026	7.52	0
Dwelling density	0.0015	0.000	7.23	0
TOM	−0.0027	0.000	−5.43	0
Constant	−1.367	0.326	−4.20	0
Adj. R^2: 0.5646	N: 17 354	$F(18, 1663)$: 645.38		Prob > F: 0.0

Instrumented variable: asking price
Instruments: DIST_AIR UNEMP GARDEN SOCIAL_R PRIVRENT VACANT0 No_quals NOCARD

Statistical tests on endogeneity and instrument identification	Value	p-Val.
Underidentification test (Kleibergen–Paap rk LM statistic) χ^2 (8)	3420.9	0
Weak identification test (Kleibergen–Paap rk Wald) F statistic	712.9	
Stock–Yogo weak ID test critical values		
5% maximal IV relative bias	20.3	
10% maximal IV size	33.8	
Hansen J statistic (overidentification test of all instruments) χ^2 (7)	8.3	0.31
Endogeneity test of endogenous regressors, χ^2 (1)	67.2	0

[a] Cluster adjusted standard errors on COA, no. of clusters: 1664.

per cent level. Furthermore, all proxy variables behave according to expectations, as is fully demonstrated below.

The asking price has the greatest significance on the bid-premium. The period of sale has also a very significant effect, as is demonstrated by the dummy variables for the quarter of sale. Signs on the quarterly dummies go from negative to positive by the second quarter of 2006, and values increase to a maximum in the second quarter of 2007 before going down in the subsequent quarter. The time period effects are plotted and compared with HP price estimates, enabling interesting comparisons in Section 5.4.

The dwelling density coefficient is statistically significant and positive in the two-stage model. This variable does not reflect here the negative effect of population density on house prices as in the HP models. It seems indeed to be a successful proxy for the high concentration of auction participants and/or inelastic house supply in areas with denser populations, both of which were expected to have a positive effect on the bid-premium. TOM is negative and highly significant in the model.

Comparing Hedonic Prices and Bid-premium Levels over the Study Period

The bid-premium levels are plotted over time in Figure 3, along with HP selling and asking price estimates. The *x*-axis in Figure 3 signifies the quarter of the sale for the bid-premium and HP sale price models, whereas for the HP asking price model, it signifies the quarter in which the property went on the market.

Figure 3 also includes the estimates of a separate HP model on private treaty/negative bids prices data. As mentioned in Section 4, there were self-selection and outlier issues with this small proportion of data; thus, they were dropped from the main model. The detailed model results are found in Appendix E. The results of this private treaty/negative bids model do not diverge significantly from the HP sale price model, even though the sample size is comparatively very small. Nonetheless, these estimates should be treated with caution, and the results are included in Figure 3 for demonstration purposes only.

Three phases of price movements and market conditions can be distinguished in Figure 3:

(1) The period of relatively lower house price inflation from the beginning of 2004 to the end of 2005.
(2) The high inflation period from 2006 to the second quarter of 2007.
(3) The beginning of the deflation in the final two quarters of 2007.

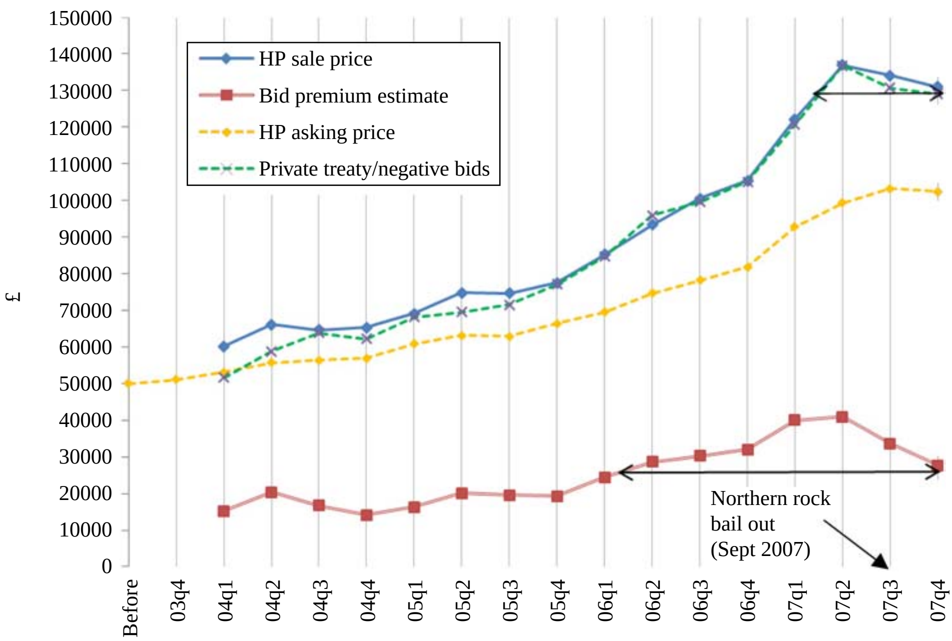

Figure 3. Hedonic prices and bid-premium levels.

In the first phase, we did not see any significant differences between the asking price and the sale price estimate. The bid-premium did not exhibit a positive trend as all the other HP estimates did.

The sale prices inflated rapidly in the second phase, whereas asking price increases were not as steep. Only after the beginning of 2006 did the sale price estimates start to significantly diverge from the asking prices. The first quarter of 2006 seemed to begin the final and extreme phase of the bubble in the housing market in Aberdeen. The bid-premium had a positive trend during this phase. The sale price and bid-premium levels reached their maximum level in the second quarter of 2007.

The first shock in the housing market came in the third quarter of 2007 when the 'Northern Rock' bank was bailed out by the UK government. Immediately after this incident, was a 32 per cent fall in the bid-premium levels from the second to the fourth quarter of 2007. The level of the bid-premium in the fourth quarter 2007 adjusted downwards to the level of the first quarter of 2006. Nevertheless, the sale prices suffered only a marginal reduction during the last two quarters of 2007. This deflation did not even adjust the prices to the levels of first quarter of 2007, let alone 2006. Asking prices did not even register any reductions during the third phase, illustrating the significant lags in the housing market.

In the second and third phases, the asking price seemed to lag by two to three quarters behind the sale price levels. These lags were due to the price setting behaviour of the sellers, who could not adjust their expectations to the rapid changes in the market conditions. A contributory factor in the slow adjustment may be the heterogeneous and segmented character of the housing market, which may often be in disequilibrium (Tu, 2003). Overbidding seems to have been the 'engine' of the rapid price increase in the second phase, which is consistent with experiments by Neugebauer and Perote (2007) on auction feedback information. This increase and the resulting price levels were retained even though the bid-premium levels fell significantly in the second half of 2007.

Conclusions

This paper has examined the adjustment of buyers' and sellers' expectations to rapid changes in the market through the unique opportunity provided by the Scottish real estate sale mechanism. The Aberdeen dataset included information on asking price and the winning bid in 'first-price sealed-bid' housing auctions. A bid-premium model was developed, drawing form the literature and HP modelling, because we were not aware of any bid-premium models or anything equivalent in the literature.

The review of game theory literature demonstrated the potential for overbidding in 'first-price sealed-bid' auctions and also showed no incentive for the seller not to disclose his/her reservation price. The significant effect of a high number of auction participants to the final sale price was also underlined in the literature. TOM was seen in the literature as important in influencing bidders' strategy and final transaction prices.

Following from the above, the bid-premium model was specified as a function of the asking price, expectations of future price movements, TOM and higher bidding frequency. The model results were excellent, explaining nearly 56 per cent of the data variation. Even though proxies were employed to account for unavailable information, almost all coefficients are statistically significant and of the expected signs.

A distinction between the two price components, asking price and bid-premium, was demonstrated in this analysis. The bid-premium reflects the buyers' preferences that rapidly adjust to the general economic climate, resembling at times the volatility of financial markets. This is consistent with the argument of Smith *et al.* (2006) that housing has been recently regarded as a potential investment, which is implied by the significant shift in consumer behaviour after 2004. In particular, the second phase of price movements illustrates the investment driven mentality of consumers, where the housing-market/-auction participants consistently overbid in expectation of continuously increasing future payoffs. The bid-premium rapidly adjusts downwards at the first sign of trouble in the market, with the speed of this adjustment being quite uncharacteristic of the housing market. Conversely, the asking price component seems to reflect the more conservative behaviour of sellers, whose expectations lag behind any rapid price movements, but retain the 'momentum' even after the 'engine is switched off'.

The results show that as Gibb (1992) suggests, the sealed-bid auction helps the seller to capture the buyer's surplus. Perhaps surprising is the extent and size of the bid-premium during the recent market boom. Undoubtedly, liquidity played a role and a key policy question may be whether or not the government should place a cap on loan-to-value or loan-to-income ratios. This itself may produce other distributional consequences, which themselves may require further research before any policy change.

In other countries with different selling systems, boom periods are also fuelled by liquidity and expectations for future price rises. Similar policy responses as suggested above may be appropriate for consideration.

Interestingly, the results also show the lagged change in sellers' expectations in the face of the market downturn. Thus, as the stock of unsold properties increases, market duration increases before prices begin to adjust downwards. This may lead to protracted adjustment in the housing market, and there may be few if any housing policy levers to enable a faster return to equilibrium.

For future research, the development of a game theory model specifically for the Scottish housing market, fully capturing its complexities would be very helpful in analysing sellers' and buyers' behaviour. The theoretical framework and empirical estimation here can be extended to determine how certain behaviours of real-estate agents affect asking price setting and impose different local market conventions. This paper looks at the behaviour concerning individual observations of auction results, but does not examine spatial effects in relation to price setting or final sale price. The next step is to explicitly model the spatial effects by combining our approach with the methodological framework in Thanos *et al.* (2012) and Dubé and Legros (2011, 2012) that specifically accounts for spatial dependence in disaggregate house sale data.

Notes

[1] The first-price sealed-bid auction is one in which the buyer making the highest bid claims the object and pays only the amount he has bid (Milgrom & Weber, 1982).

[2] Each bidder knows the value of the object to herself, but does not know the values of the object to the other bidders that are independent to her value.

[3] 'The common value theory allows for statistical dependence among bidders' value estimates, but offers no role for differences in individual tastes' (Milgrom & Weber, 1982, p. 1095).

[4] That includes accessibility, socioeconomic and environmental attributes.

[5] After dropping by 1258 transactions due to incomplete data or errors.

[6] The *t*-stat of 22.43 rejects, at the 99 per cent level, the null hypothesis of the difference between the means of the two distributions being zero.

[7] Noise insulation is expected in areas with noise pollution problems, unfortunately we could not obtain noise data to confirm this.

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Appendix A: Description of the variables used in the HP models

Variable name	Variable description
Sprice[a]	Selling price[a]
askpri[a]	Asking price[a]
Bid_Premium[a]	The difference between the asking and selling price[a]
LNPRICED	Natural logarithm of Sprice
LNASKPRI	Natural logarithm of askpri
LNBID	Natural logarithm of Bid_Premium
DIST_AIR	Distance to airport in kilometres
DIST_STA	Distance to central train station in kilometres
DENSCHIL	Children density – children aged 0–15 years per hectare
UNEMP	The percentage of all 16–74-year olds who are unemployed COA
DETACHED	1 for detached houses, 0 otherwise
NODETACH	1 for terraced or semi-detached house, 0 otherwise
FLAT	1 for flats, 0 otherwise
BASEMENT	1 for basement flat, 0 otherwise
FLOOR2	1 for second floor flat, 0 otherwise
FLOOR3	1 for third floor flat, 0 otherwise
FLOOR4PL	1 for fourth floor flat or higher, 0 otherwise
FLOORUNK	1 for missing information on the floor number of flat, 0 otherwise
BEDR1	1 for houses with 1 bedrooms, 0 otherwise
BEDR2	1 for houses with 2 bedrooms, 0 otherwise
BEDR3	1 for houses with 3 bedrooms, 0 otherwise
BEDR4	1 for houses with 4 bedrooms, 0 otherwise
BEDR5	1 for houses with 5 bedrooms, 0 otherwise
BEDR6PL	1 for houses with 6 or more bedrooms, 0 otherwise
BEDRUNK	1 for missing bedroom number, 0 otherwise
PUBROM3P	1 for 3 or more public rooms, 0 otherwise
BATH2	1 for 2 or more bathrooms, 0 otherwise
GARAGE	1 for a house with garage(s), 0 otherwise
HEATING	1 for a house with gas central heating, 0 otherwise
GARDEN	1 for a house with garden, 0 otherwise
DETACHDO	1 for COAs with more than 50% detached houses, 0 otherwise
FLATDOM	1 for COAs with more than 50% flats, 0 otherwise
NODETA_D	1 for COAs with more than 50% terraced or semi-detached houses
NODOM	1 for COAs that are not dominated from a specific house type, 0 otherwise
SOCIAL_R	1 for COAs with more than 50% of social rented houses, 0 otherwise
PRIVRENT	1 for COAs with more than 50% of privately rented houses, 0 otherwise
VACANT	1 for COAs with more than 20% of vacant household spaces, 0 otherwise
OLD0_4	1 for COAs with more than 40% of the population over 60, 0 otherwise
ONEHH0_6	1 for COAs with more than 60% of one person households, 0 otherwise
No_quals	1 for COAs with more than 30% of people (aged 16–74) who have no qualifications, 0 otherwise
CAR2D0_5	1 for COAs with 50% or more of the households owning 2 or more cars
NOCARD	1 for COAs with 50% or more of the households not owning a car
GLAZING	1 for double glazing, 0 otherwise
TOM	Time on the market (days)

Appendix Continued

Appendix A: *Continued*

Variable name	Variable description
DENSDWEL	Dwelling density, dwellings per hectare
Y04Q01 . . . Y07Q4	Dummy variables for each quarter from 2004 to 2007, 1 for the sales taking place in the specific quarter, 0 otherwise
DOM03Q04 . . . DOM07Q4	Dummy variables for Date on the Market (DOM) from the fourth quarter of 2003 to 2007, 1 for the house going in the market in the specific quarter, 0 otherwise
DOMBEFOR	1 for the house going in the market before the fourth quarter of 2003, 0 otherwise

[a] The selling and asking prices were adjusted to the price levels of the sale date or on the date the house went on the market, respectively. The Bid_Premium was adjusted to the price levels of the sale date. The official ONS deflator was used.

Appendix B: Descriptive statistics for the main variables used in the models

Variable	Mean	Std dev.	Min	Max
Sprice	134 145	100 149	22 607	1 856 789
Askpri	105 223	79 737	15 373	1 088 193
Bid_Premium	28 555	26 649	303	881 789
LNPRICED	28 555	26 649	303	881 789
LNBID	11.62	0.59	10.03	14.43
LNASKPRI	9.92	0.88	5.71	13.69
DIST_AIR	7.715	2.513	0.722	56.79
DIST_STA	3.196	2.753	0.095	65.61
DENSCHIL	2.360	2.033	0	19.81
UNEMP	0.100	0.300	0	1
DETACHED	0.273	0.445	0	1
NODETACH	0.001	0.032	0	1
FLAT	0.059	0.235	0	1
BASEMENT	0.005	0.070	0	1
FLOOR2	0.002	0.040	0	1
FLOOR3	0.334	0.472	0	1
FLOOR4PL	0.285	0.451	0	1
FLOORUNK	0.387	0.487	0	1
BEDR1	0.068	0.252	0	1
BEDR2	0.019	0.138	0	1
BEDR3	0.007	0.083	0	1
BEDR4	0.011	0.105	0	1
BEDR5	0.081	0.273	0	1
BEDR6PL	0.035	0.183	0	1
BEDRUNK	0.220	0.414	0	1
PUBROM3P	0.793	0.405	0	1
BATH2	0.521	0.500	0	1
GARAGE	0.066	0.248	0	1
HEATING	0.278	0.448	0	1
GARDEN	0.067	0.250	0	1
DETACHDO	0.078	0.269	0	1
FLATDOM	0.058	0.234	0	1
NODETA_D	0.048	0.215	0	1
NODOM	0.218	0.413	0	1
SOCIAL_R	0.181	0.385	0	1
PRIVRENT	0.077	0.267	0	1
VACANT	0.188	0.391	0	1
OLD0_4	7.715	2.513	0.722	56.79
ONEHH0_6	3.196	2.753	0.095	65.61
No_quals	2.360	2.033	0	19.81
CAR2D0_5	0.100	0.300	0	1
NOCARD	0.273	0.445	0	1
GLAZING	0.001	0.032	0	1
DENSDWEL	49.31	50.29	0.03	1053
TOM	46.47	55.23	2.00	2834

Appendix C: HP model on the sale price for positive bid-premium observations

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Variable	Coef.	SE[a]	t	Variable	Coef.	SE[a]	t
Y04Q1	−0.7818	0.0129	−60.40	HEATING	0.1369	0.0079	17.28
Y04Q2	−0.6872	0.0122	−56.37	GARDEN	0.0566	0.0116	4.89
Y04Q3	−0.7121	0.0113	−62.91	DETACHDO	−0.0131	0.0378	−0.35
Y04Q4	−0.6989	0.0120	−58.16	NODETA_D	−0.0211	0.0197	−1.07
Y05Q1	−0.6433	0.0122	−52.81	NODOM	0.0566	0.0255	2.22
Y05Q2	−0.5611	0.0113	−49.63	SOCIAL_R	−0.0527	0.0259	−2.03
Y05Q3	−0.5651	0.0115	−49.05	PRIVRENT	−0.1049	0.0281	−3.73
Y05Q4	−0.5265	0.0113	−46.43	VACANT0	−0.0330	0.0337	−0.98
Y06Q1	−0.4306	0.0128	−33.59	OLD0_4	0.1356	0.0228	5.95
Y06Q2	−0.3391	0.0109	−31.02	ONEHH0_6	−0.0210	0.0168	−1.25
Y06Q3	−0.2649	0.0109	−24.40	No_quals	−0.2496	0.0172	−14.47
Y06Q4	−0.2203	0.0114	−19.40	CAR2D0_5	0.1792	0.0296	6.06
Y07Q1	−0.0711	0.0123	−5.76	NOCARD	−0.1442	0.0162	−8.88
Y07Q2	0.0439	0.0109	4.01	GLAZING	−0.0788	0.0107	−7.34
Y07Q3	0.0228	0.0109	2.10	DENSDWE	−0.0007	0.0001	−5.30
DIST_AIR	0.0147	0.0023	6.48	Constant	12.1678	0.0315	386.09
DIST_STA	−0.0279	0.0025	−11.36				
UNEMP	−0.0098	0.0032	−3.05				
DETACHED	0.1268	0.0192	6.61				
NODETACH	0.0423	0.0145	2.91				
BASEMENT	−0.2550	0.0514	−4.97				
FLOOR2	0.0132	0.0099	1.34				
FLOOR3	0.0699	0.0439	1.59				
FLOOR4PL	0.0767	0.1177	0.65				
FLOORUNK	−0.0325	0.0058	−5.57				
BEDR1	−0.5249	0.0129	−40.81				
BEDR2	−0.1604	0.0093	−17.34				
BEDR4	0.1923	0.0141	13.69				
BEDR5	0.3934	0.0229	17.16				
BEDR6PL	0.6065	0.0375	16.17				
BEDRUNK	−0.8260	0.0273	−30.29				
PUBROM3P	0.2468	0.0110	22.53				
BATH2	0.1459	0.0186	7.85				
GARAGE	0.1582	0.0108	14.65				
Adj. R^2: 0.8211		N: 17 354		$F(48, 1663)$: 612.962017.61		Prob $>$ F: 0	

[a] Cluster adjusted standard errors on COA, no. of clusters: 1664.

Appendix D: The HP model on the asking price for positive bid-premium observations

Variable	Coef.	SE[a]	t	Variable	Coef.	SE[a]	t
DOMBEFOR	−0.7206	0.0345	−20.89	GARAGE	0.1508	0.0108	13.97
DOM03Q4	−0.6977	0.0222	−31.44	HEATING	0.1303	0.0080	16.30
DOM04Q1	−0.6591	0.0174	−37.93	GARDEN	0.0364	0.0121	3.01
DOM04Q2	−0.6119	0.0165	−37.06	DETACHDO	0.0076	0.0406	0.19
DOM04Q3	−0.5996	0.0168	−35.66	NODETA_D	−0.0253	0.0205	−1.23
DOM04Q4	−0.5897	0.0169	−34.85	NODOM	0.0639	0.0255	2.50
DOM05Q1	−0.5220	0.0171	−30.52	SOCIAL_R	−0.0439	0.0285	−1.54
DOM05Q2	−0.4845	0.0169	−28.67	PRIVRENT	−0.1044	0.0258	−4.05
DOM05Q3	−0.4880	0.0165	−29.56	VACANT0	−0.0220	0.0353	−0.62
DOM05Q4	−0.4328	0.0177	−24.52	OLD0_4	0.1361	0.0249	5.47
DOM06Q1	−0.3872	0.0173	−22.37	ONEHH0_6	−0.0185	0.0174	−1.06
DOM06Q2	−0.3151	0.0155	−20.28	No_noquals	−0.2509	0.0181	−13.85
DOM06Q3	−0.2709	0.0165	−16.43	CAR2D0_5	0.1787	0.0303	5.90
DOM06Q4	−0.2263	0.0179	−12.64	NOCARD	−0.1431	0.0169	−8.47
DOM07Q1	−0.0986	0.0174	−5.68	GLAZING	−0.0650	0.0105	−6.17
DOM07Q2	−0.0302	0.0162	−1.86	DENSDWEL	−0.0009	0.0001	−6.35
DOM07Q3	0.0085	0.0164	0.52	Constant	11.91054	0.0343845	346.39
DIST_AIR	0.0148	0.0022	6.63				
DIST_STA	−0.0265	0.0025	−10.39				
UNEMP	−0.0093	0.0033	−2.84				
DETACHED	0.1619	0.0200	8.10				
NODETACH	0.0520	0.0152	3.42				
BASEMENT	−0.2455	0.0437	−5.62				
FLOOR2	0.0235	0.0102	2.29				
FLOOR3	0.0969	0.0438	2.21				
FLOOR4PL	0.1039	0.1495	0.69				
FLOORUNK	−0.0204	0.0060	−3.41				
BEDR1	−0.5678	0.0131	−43.49				
BEDR2	−0.1762	0.0094	−18.66				
BEDR4	0.2147	0.0140	15.29				
BEDR5	0.4201	0.0226	18.57				
BEDR6PL	0.6287	0.0346	18.17				
BEDRUNK	−0.8575	0.0267	−32.08				
PUBROM3P	0.2513	0.0113	22.30				
BATH2	0.1578	0.0192	8.23				
Adj. R^2: 0.8168		N: 17 354		$F(48, 1663)$: 541.8217.61		Prob > F: 0	

[a] Cluster adjusted standard errors on COA, no. of clusters: 1664.

Appendix E: The HP model for private treaty sales and negative bid-premiums

Variable	Coef.	SE[a]	*t*	Variable	Coef.	SE[a]	*t*
Y04Q1	−0.9172	0.0430	−21.31	GARDEN	−0.0242	0.0280	−0.87
Y04Q2	−0.7866	0.0743	−10.59	DETACHDO	0.0562	0.0777	0.72
Y04Q3	−0.7049	0.0400	−17.61	NODETA_D	−0.0560	0.0374	−1.50
Y04Q4	−0.7308	0.0372	−19.66	NODOM	0.0532	0.0448	1.19
Y05Q1	−0.6383	0.0433	−14.74	SOCIAL_R	−0.0912	0.0588	−1.55
Y05Q2	−0.6193	0.0474	−13.05	PRIVRENT	−0.1054	0.0508	−2.08
Y05Q3	−0.5898	0.0366	−16.10	VACANT0	0.0319	0.0644	0.50
Y05Q4	−0.5155	0.0342	−15.06	OLD0_4	0.1380	0.0576	2.39
Y06Q1	−0.4219	0.0417	−10.12	ONEHH0_6	0.0178	0.0318	0.56
Y06Q2	−0.2967	0.0393	−7.56	No_quals	−0.2463	0.0445	−5.54
Y06Q3	−0.2590	0.0330	−7.85	CAR2D0_5	0.1643	0.0517	3.18
Y06Q4	−0.2052	0.0301	−6.82	NOCARD	−0.1501	0.0314	−4.78
Y07Q1	−0.0667	0.0473	−1.41	GLAZING	−0.0004	0.0324	−0.01
Y07Q2	0.0586	0.0295	1.99	DENSDWEL	−0.0017	0.0003	−5.45
Y07Q3	0.0129	0.0246	0.52	Constant	12.15545	0.065975	184.24
DIST_AIR	0.0211	0.0047	4.47				
DIST_STA	−0.0312	0.0055	−5.66				
UNEMP	−0.0045	0.0062	−0.72				
DETACHED	0.1240	0.0510	2.43				
NODETACH	0.0175	0.0351	0.50				
FLOOR2	−0.0356	0.0319	−1.12				
FLOOR3	0.2119	0.0704	3.01				
FLOOR4PL	0.2830	0.0945	3.00				
FLOORUNK	−0.0432	0.0213	−2.02				
BEDR1	−0.5807	0.0354	−16.41				
BEDR2	−0.1529	0.0299	−5.11				
BEDR4	0.1992	0.0340	5.85				
BEDR5	0.3422	0.0627	5.46				
BEDR6PL	0.5175	0.1161	4.46				
BEDRUNK	−0.9710	0.0490	−19.82				
PUBROM3P	0.2907	0.0417	6.98				
BATH2	0.1622	0.0426	3.81				
GARAGE	0.1184	0.0314	3.78				
HEATING	0.1398	0.0225	6.20				
Adj. R^2: 0.833		*N*: 1320			$F(47, 693)$: 140.062017.61		Prob > *F*: 0

[a] Cluster adjusted standard errors on COA, no. of clusters: 694.