

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

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 consumers’ 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.

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

1. 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 and 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 (Mayer, 1998 and Dotzour, et al., 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. (2008) and Goodman (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 (Knight et al, 1994; Horowitz, 1992). 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 and 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 (Zuehlke 1987, Haurin 1988, Yavas and Yang 1995, Pryce and Gibb 2006). 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 auctionsⁱ, with the bids usually being above the asking price. A theoretical framework is developed for analysing data generated from these auctions, including and distinguishing between the different incentives and signals for seller and buyer. This is accomplished by focusing on a specific price component, the difference between asking and final selling price, henceforth 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 examine 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.

2. 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 US (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.

2.1 Auctions in Game Theory

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 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 valuesⁱⁱ are assumed (Milgrom and Weber, 1982). This is not generally true in a common valuesⁱⁱⁱ setting, where less aggressive bids are induced, since the value of the object is affected by 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) finds that an outside substitute option significantly magnifies the revenue-premium of the first-price auction, since overbidding in first-price auctions is more prominent with outside options than without.

The analysis of Milgrom and Weber (1982) predicts 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, since 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 market circumstances. In times of price inflation we expect an exacerbation of higher value bids and the reverse when price levels fall.

2.2 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 respectively, whilst Dotzour et al. (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), 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 in 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 over-pricing 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.

2.3 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.” (p380). 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 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 to 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 and Gibb 2006, and 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 sends reduces buyer uncertainty. Secondly, 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) and Ooi et al. (2005).

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.

3. 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^{iv} characteristics of the locality being important, along with the structural characteristics of the property. This is a popular method in real-estate research (e.g. Zuehlke, 1987; Watkins, 2001; Pryce and Gibb, 2006).

The price P of the house i , in the m^{th} residential location is given by:

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

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

$$\ln(p_i) = \alpha_i + X_i\beta + T_i c + \varepsilon_i \quad (2)$$

Where β 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:

$$p_j = k_j + b_j \quad (3)$$

Where k_j is the asking price and b_j is the difference between selling and asking price or bid-premium in this research context. The seller sets an asking price k_j that maximises 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:

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

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, since by putting the house on sale the seller expects that given the perceived current market conditions she will receive at least her 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, 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 :

$$\{\max[E(b_j)] | X_j, t_j^*\} \Rightarrow \max(h_j) + \min(\xi_j) \quad (5)$$

There may be a perception of a strategic benefit to setting an asking price below the reservation price. However, this is 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 Haurin et al, 2008; Campbell et al, 2009).

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

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

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 to the conditions at asking price setting time t_j^* . This 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 of 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%. This is also consistent with the literature that finds a

premium in markets operating through auctions (Lusht, 1996; Newell et al., 1993; Dotzour et al., 1998; 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, since 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:

$$\ln(b_i) = a_i + gk_i + T_i c + \gamma h_i + \eta \xi_i + u_i \quad (7)$$

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

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, the asking price k_i . g , γ , 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 is not.

4. Data

4.1 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. GIS 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^v 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% (1320) of the houses were sold through private treaty. This was 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% 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% 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, since 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 opt for private treaty in our study period is 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.

4.2 *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 increases to approximately 10% by 1992 as demand rose relative to supply. At the same time, the percentage of private treaty sales fell from over 20% to less than 10%. Although the nation economy had gone into recession in 1990-91, 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 Maclellan, 1986 for a discussion of the Aberdeen economy and housing market). The bid-premium fell after 1992 and remained below 5% between 1995 and 2001. Private treaty sales accounted for between 20-25% of all sales during this period. After this period we see significant increases in the bid-premium. From 2003 onwards, the bid-premium is in excess of 10% and rises to almost 35% of the asking price by 2006, although the rate of increase in the bid-premium decreases between 2006 and 2007. Private treaty sales fall to a historical low during this later period. This signifies 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).

FIGURE 1 HERE

Looking at the 2004 – 2007 period in detail at quarterly intervals, Figure 2 shows that bid-premium does not fall below 15% of the asking price at any point while private treaty sales fluctuating just over 5% between 2004 and 2006 and remaining below 10% until 2007 quarter 3. From the beginning of 2005 we observe a strong positive trend until the peak in the first quarter of 2007 at around 35% of the asking price, which is remarkable in a historic context. Early signs of bad debt in the financial sector appear in quarter 3 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 2nd quarter of 2007 is no surprise. Nevertheless this, still, shows no return to the pre-2004 situation. The bid-premium percentage is still above 20% and private treaty sales proportion does not exceed 15%.

FIGURE 2 HERE

It is clear that the distribution has shifted to the right from the 1st quarter of 2004 to the 1st quarter of 2007. The bid-premium to asking price ratio in the 1st quarter of 2007 is statistically significantly^{vi} higher than in 2004, with the mean of 2007 (42.7%) being almost two standard deviations to the right of the 2004 mean (18.6%).

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. 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.

5. Estimation and Results

This section presents results of the 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.

5.1 *HP models*

Except for the HP model in Eq. 2, we also estimate 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 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% of the data variation. Almost all coefficients have the expected signs a priori and most are statistically significant at the 95% 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^{vii} 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 do 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 longer marketing period on sale price and that houses with higher asking prices take longer to sell ceteris paribus.

5.2 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 4th 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 examine 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, where 30% people have 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 1. We employ a generalised method of moments (GMM) 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% level the hypothesis of the asking price not being endogenous to the bid-premium (Hausman, 1979; Hayashi, 2000). Under-identification is also rejected at this level (Kleibergen and 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 and Paap, 2006) when compared to the Stock-Yogo weak identification critical values (Stock and Yogo, 2005) allows us to reject weak

identification or that the instruments are only weakly correlated with the endogenous regressor.

5.3 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% of the data variation. Almost all coefficients are statistically significant at the 99% 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 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.

TABLE 1 HERE

5.4 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 2nd quarter of 2007
- 3) The beginning of the deflation in the final two quarters of 2007

In phase 1 we do not see any significant differences between the asking price, the sale price estimate. The bid-premium does not exhibit a positive trend, as all the other HP estimates do.

The sale prices inflate rapidly in phase 2, whereas asking price increases are not as steep. Only after the beginning of 2006 do the sale price estimates start to significantly diverge from the asking prices. The 1st quarter 2006 seems to be beginning the final and extreme phase of the bubble in the housing market in Aberdeen. The bid-premium has a positive trend during this phase. The sale price and bid-premium levels reach their maximum level in the 2nd quarter of 2007.

The first shock in the housing market comes in the 3rd quarter of 2007 when the “Northern Rock” bank is bailed out by the UK government. Immediately after this incident was a 32% fall in the bid-premium levels from the 2nd to the 4th quarter of 2007. The level of the bid-premium in the 4th quarter 2007 is adjusted downwards to the level of the 1st quarter 2006. Nevertheless, the sale prices suffer only a marginal reduction during the last two quarters of 2007. This deflation does not even adjust the price prices to the levels of 1st quarter 2007, let

alone 2006. Asking prices do not even register any reductions during the third phase, illustrating the significant lags in the housing market.

Figure 3 Here

In phases two and three, the asking price seems to lag by two to three quarters behind the sale price levels. These lags are due to the price setting behaviour of the sellers, who cannot 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 are retained even though the bid-premium levels fall significantly in the second half of 2007.

6. 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 from the literature and HP modelling, since we are 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 her reservation price. The significant effect of a high number of auction participants to the final sale price was also underlined in the literature. Time on the market 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, time on the market and higher bidding frequency. The model results were excellent, explaining nearly 56% 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 consumer'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 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 seller's 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 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.

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Figure 1: The Bid Premium (%) and Private Treaty Sales (% of total); Yearly 1985-2007

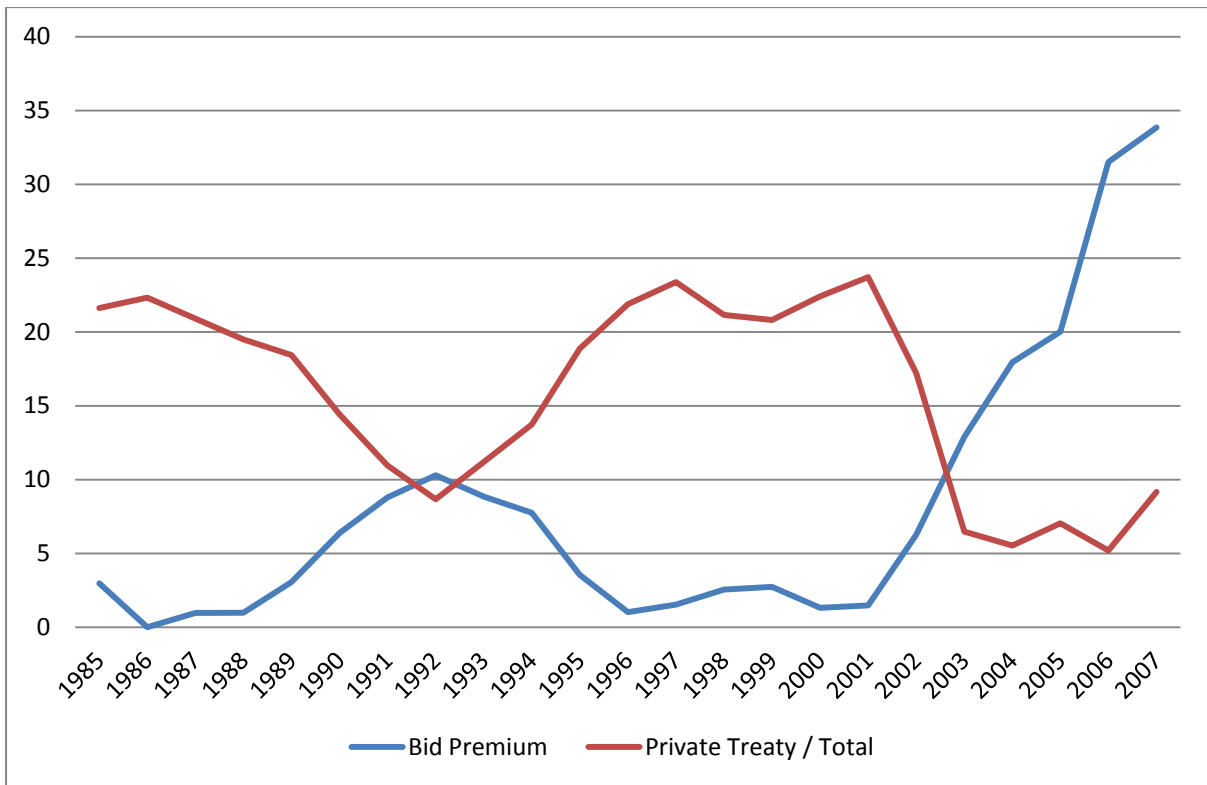


Figure 2: The Bid Premium (%) and Private Treaty Sales (% of total); Quarterly 2004-2007

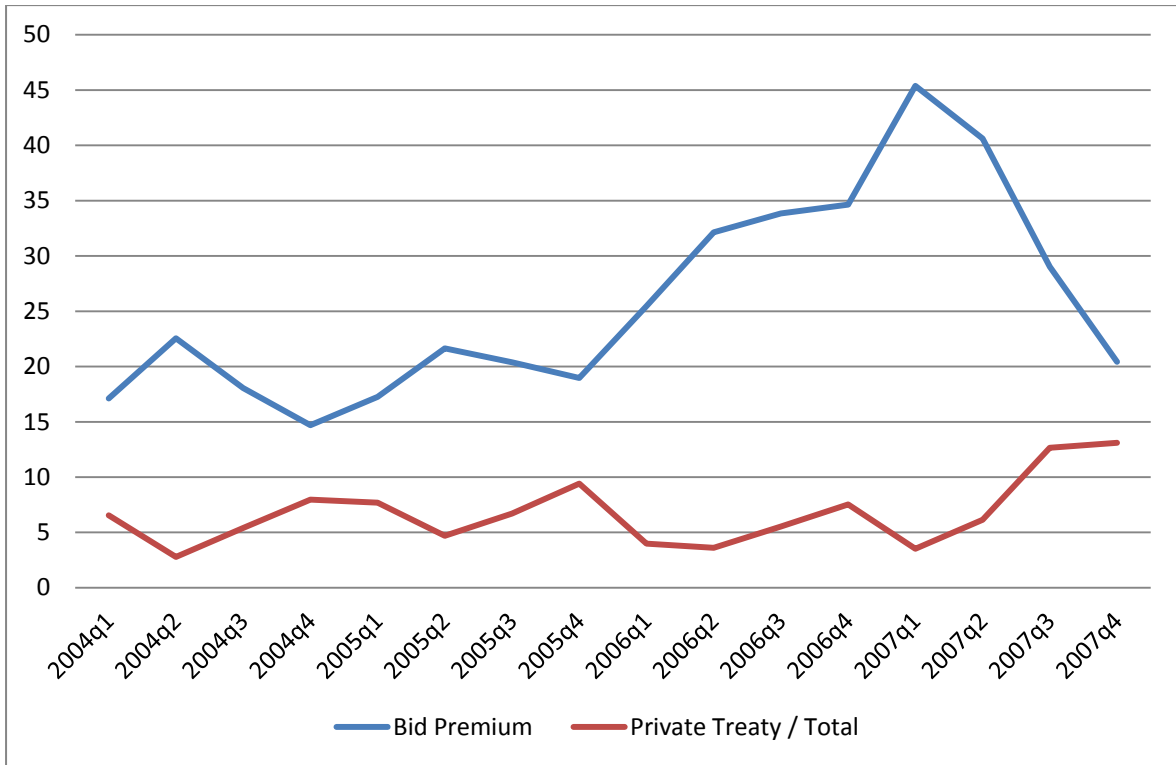


Table 1: GMM Two stage Bid-premium Model

Variable	Coefficient.	Std. Err.^	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

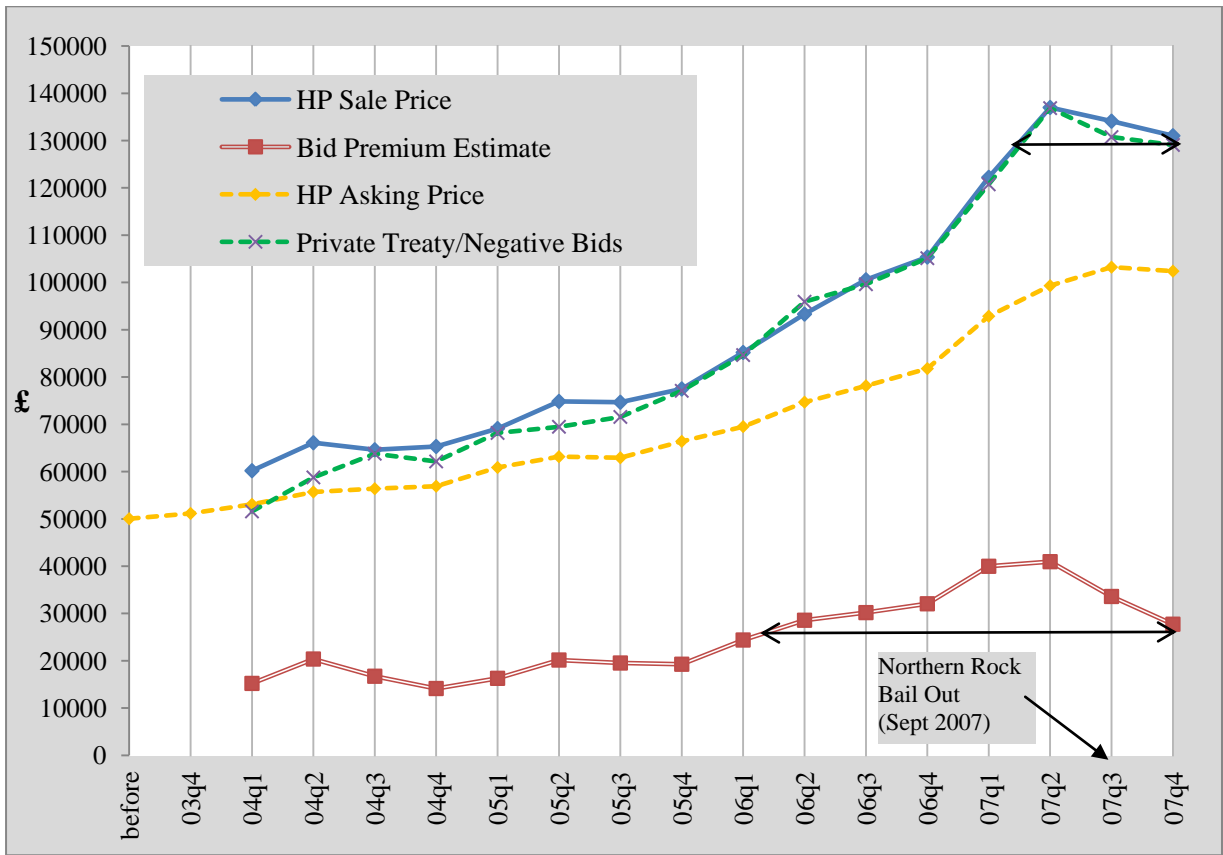
Adjusted R²: 0.5646 N: 17354 F(18, 1663): 645.38 Prob > F: 0.0

Instrumented variable: Asking price
 Instruments: DIST_AIR UNEMP GARDEN SOCIAL_R PRIVRENT VACANT0
 No_qual5 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

^Cluster adjusted standard errors on COA, No. of clusters: 1664

Figure 3: Hedonic Prices and Bid-premium levels



Appendix A: Description of the Variables used in the HP Models

Variable Name	Variable Description
Sprice [^]	Selling price [^]
askpri [^]	Asking price [^]
Bid_Pemium [^]	The difference between the asking and selling price [^]
LNPRICED	Natural logarithm of Sprice
LNASKPRI	Natural logarithm of askpri
LNBID	Natural logarithm of Bid_Pemium
DIST_AIR	Distance to airport in kilometres
DIST_STA	Distance to central train station in kilometres
DENSCHIL	Children density - children aged 0 - 15 per hectare
UNEMP	The percentage of all 16-74 who are ea and unemployed in 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 2nd floor flat, 0 otherwise
FLOOR3	1 for 3rd floor flat, 0 otherwise
FLOOR4PL	1 for 4th 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_qual	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)

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 4 th quarter of 2003 to 2007, 1 for the house going in the market in the specific quarter, 0
DOMBEFOR	1 for the house going in the market before the 4 th quarter of 2003, 0 otherwise

^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	134145	100149	22607	1856789
askpri	105223	79737	15373	1088193
Bid_Pemium	28555	26649	303	881789
LNPRICED	28555	26649	303	881789
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_qual	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

Variable	Coef.	SE^	t	Variable	Coef.	SE^	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_qual	-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:17354		F(48, 1663): 612.96		Prob > F: 0	

^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 [^]	t	Variable	Coef.	SE [^]	t
DOMBEFO	-0.7206	0.0345	-	GARAGE	0.1508	0.0108	13.97
DOM03Q4	-0.6977	0.0222	-	HEATING	0.1303	0.0080	16.30
DOM04Q1	-0.6591	0.0174	-	GARDEN	0.0364	0.0121	3.01
DOM04Q2	-0.6119	0.0165	-	DETACHD	0.0076	0.0406	0.19
DOM04Q3	-0.5996	0.0168	-	NODETA_D	-0.0253	0.0205	-1.23
DOM04Q4	-0.5897	0.0169	-	NODOM	0.0639	0.0255	2.50
DOM05Q1	-0.5220	0.0171	-	SOCIAL_R	-0.0439	0.0285	-1.54
DOM05Q2	-0.4845	0.0169	-	PRIVRENT	-0.1044	0.0258	-4.05
DOM05Q3	-0.4880	0.0165	-	VACANT0	-0.0220	0.0353	-0.62
DOM05Q4	-0.4328	0.0177	-	OLD0_4	0.1361	0.0249	5.47
DOM06Q1	-0.3872	0.0173	-	ONEHH0_6	-0.0185	0.0174	-1.06
DOM06Q2	-0.3151	0.0155	-	No_noquals	-0.2509	0.0181	-13.85
DOM06Q3	-0.2709	0.0165	-	CAR2D0_5	0.1787	0.0303	5.90
DOM06Q4	-0.2263	0.0179	-	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	DENSWE	-0.0009	0.0001	-6.35
DOM07Q3	0.0085	0.0164	0.52	Constant	11.9105	0.034384	346.3
DIST_AIR	0.0148	0.0022	6.63				
DIST_STA	-0.0265	0.0025	-				
UNEMP	-0.0093	0.0033	-2.84				
DETACHED	0.1619	0.0200	8.10				
NODETAC	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	-				
BEDR2	-0.1762	0.0094	-				
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	-				
PUBROM3P	0.2513	0.0113	22.30				
BATH2	0.1578	0.0192	8.23				
Adj R ² : 0.8168		N:17354		F(48, 1663): 541.82		Prob > F: 0	

[^]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^	t	Variable	Coef.	SE^	t
Y04Q1	-0.9172	0.0430	-21.31	GARDEN	-0.0242	0.0280	-0.87
Y04Q2	-0.7866	0.0743	-10.59	DETACHD	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_qual	-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	DENSDWE	-0.0017	0.0003	-5.45
Y07Q3	0.0129	0.0246	0.52	constant	12.1554	0.06597	184.2
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				
NODETAC	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): 140.06		Prob > F: 0	

^Cluster adjusted standard errors on COA, No. of clusters: 694

ⁱ 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 and Weber, 1982).

ⁱⁱ 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.

ⁱⁱⁱ “The common value theory allows for statistical dependence among bidders' value estimates, but offers no role for differences in individual tastes” (Milgrom and Weber 1982, pp:1095)

^{iv} that includes accessibility, socioeconomic and environmental attributes

^v After dropping by 1258 transactions due to incomplete data or errors.

^{vi} The t-stat of 22.43 rejects, at the 99% level, the null hypothesis of the difference between the means of the two distributions being zero.

^{vii} Noise insulation is expected in areas with noise pollution problems, unfortunately we could not obtain noise data to confirm this.