Sealed-Bid Auctions and Fixed Price Sales: Seller Choice in Housing Markets

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Stephen Buschbom[a], Carolyn Dehring[b,†], Neil Dunse[c], Henry Munneke[d,*]

Abstract

The choice of marketing system used to allocate property rights is important across many industries. In Scotland, two systems of marketing real property co-exist: fixed price, where homes are listed for sale at a fixed price on "first-come-first-serve" basis, and offers over, which is a sealed-bid auction format where the seller indicates a floor for bids. Using 4,780 detached housing sales between 1984 and 2002, this paper explores potential price effects of the seller's choice of marketing system. Specifically, a log price model is estimated based on transactions under both marketing systems acknowledging endogeneity in the choice of marketing system. The empirical procedure reveals that sellers select the marketing system which results in the highest predicted price for their property.

Keywords: Housing Markets; Selection Bias; First-Price Sealed Bid Auctions
JEL classification: D83, R21, R31

*Contact author: Terry College of Business, Department of Insurance, Legal Studies, and Real Estate, University of Georgia, 341 Brooks Hall, Athens, GA 30602, Tel.: 706-542-8414, Fax: +1-706-542-4295, hmunneke@uga.edu.
[a] *Department of Insurance, Legal Studies, Real Estate, University of Georgia, Brooks Hall, Athens, GA 30602, United States, buschbom@uga.edu*
[b,†] *Department of Insurance, Legal Studies, Real Estate, University of Georgia, Brooks Hall, Athens, GA 30602, United States.* Deceased 11 March 2015.
[c] *School of the Built Environment, Heriot-Watt University, Edinburgh, EH14 4AS, UK, n.a.dunse@hw.ac.uk*
[d] *Department of Insurance, Legal Studies, Real Estate, University of Georgia, Brooks Hall, Athens, GA 30602, hmunneke@uga.edu.*

1 INTRODUCTION

The use of auctions within the United States is generally associated with areas outside the transfer of real property (e.g., antiques, art, collectibles, commodities, government securities, etc.). The expansion of online auction companies and the use for business transaction (e.g., telecommunications) has led to auctions becoming a more important instrument for transferring goods. Auctions are prominent in fixed income markets where securities trade over-the-counter and investors have the option to sell securities using a method called "bids wanted in competition" which is effectively a first-price, sealed bid auction.

The current study seeks to add to the literature on price effects between auctions and alternative marketing systems. Theoretical models support the presence of multiple marketing systems when there is sufficient variation in buyer search cost as well as in seller holding cost (Mayer, 1995; Quan, 2002) and also a seller's level of risk aversion (Gan, 2013). If there are cost efficiencies to market participants in marketing infrastructure, and two alternative mechanisms always produce the same expected revenue, then one should never observe two or more mechanisms operating in a given market. It follows that when two systems exist simultaneously, expected net sale proceeds should be higher with one system under a certain set of product attributes, market conditions, and market participant characteristics relative to the expected net sale proceeds for the alternative marketing system under the same set of conditions. For example, the auction literature has shown that in comparing between alternative auction systems, price effects between the formats arise with variations to the Vickrey (1961) basic framework along any number of dimensions, including the extent of risk aversion, information asymmetries, and the independence of bidder's values (McAfee and McMillan, 1987).[1]

In the United States, the predominant system of selling real property is through direct negotiation. In fact, real property auctions in US markets are often associated with distressed property or with

[1]The four basic types of auctions analyzed in this literature are English, Dutch, first-price sealed bid, and second-price sealed-bid.

new, multi-unit developments, in which sellers may realize economies of scale in marketing costs (Mayer, 1998). Thus, existing empirical contributions on real property auctions have either looked to foreign markets (Lusht, 1996; Ooi et al., 2006) or involve the sale of distressed property (Quan, 1994; Mayer, 1998; Chinloy et al., 2016).[2] Several of these empirical contributions explore whether auctions are associated with a price premium or price discount relative to the price achieved by similar properties under an alternative selling mechanism. These studies have produced mixed conclusions, some with evidence of auction premiums and some with discounts. Lusht (1996) and Mayer (1998) note that if the choice of selling mechanism is related to expected price, the endogeneity of the choice of selling mechanism must be considered for any price effect finding to be robust.

The current study, based on Scottish housing, adds to the literature on price effects between auctions and alternative marketing systems. The Scottish housing market is unique in that sellers select between a fixed price sale and a sealed-bid auction format. The fixed price system shares some similarities to the method of selling property by negotiating from an asking price, as used in the US. Based on the sample utilized in the study, over 95% of sellers received their listed fixed price or lower.

The empirical model utilized in this study allows the choice of marketing system to be treated endogenously, but also explores whether or not sellers are rational in the selection of selling mechanism. The results show that sellers select the marketing system which results in the highest predicted price for their property of the two systems. That is, their property would have sold for less had the alternative system been chosen. Overall, based on their rational choice of the appropriate system, the two systems are not found to result in a significantly different selling price. Thus, two systems exist simultaneously because the expected (conditional) sale proceeds are higher under one system relative to the expected (conditional) sale proceeds for the alternative marketing system under the same set of conditions.

The paper is organized as follows. The next section provides a review of the real estate auction literature, as well as some discussion of the broader auction literature. Section 3 includes a discussion of the mechanics of the Scottish housing system. Section 4 contains the empirical methodology. This

[2]Auctions are common in housing markets in Australia, Holland, and Scotland.

is followed by a discussion of the data and the empirical results. The paper concludes a summary of contributions.

2 REVIEW OF LITERATURE

The empirical studies of the price effect of real property auctions primarily focus upon the English auction system. Lusht (1996) uses a log price model which includes an auction indicator variable in his examination of 243 residential properties sales in Melbourne, 163 of which sold at English auction.[3] He finds an 8% premium associated with the auction mechanism relative to those properties which sold with direct negotiation. Acknowledging that the choice of marketing system is endogenous, he controlled for the possibility of selection bias, but his results provide no evidence of selection bias. Mayer (1998) uses a repeat sale methodology to examine real property auctions in Dallas, TX, and Los Angeles, CA, in which the auctioned properties include distressed properties. He finds discounts of 21% and 10%, respectively, on scattered site English auctions in the two markets relative to similar properties which sold through private negotiation. Mayer also finds a 9% discount associated with single site auctions in Dallas, but no discount associated with single site auctions in Los Angeles. Ooi et al. (2006) examine 202 residential land sites offered at sealed-bid auction by the Singapore Government's Sale of Sites program. They find prices increasing in the number of bidders and frequency of auction.

The theoretical and empirical auction literature suggests that seller choice may be a function of property attributes, market conditions, and market participant characteristics. Hansen (1986) conducted research on US Forest Service timber auctions. Previous research on timber auctions modeled the price effect using a simple auction indicator variable; the results revealed that sealed-bid auctions yielded higher revenues than English auctions. After estimating an endogenous selling mechanism choice model within a simultaneous equations framework, Hansen found that the revenue difference between the auction formats was no longer significant. This finding gave support to

[3]English auction is a standard means used to facilitate the transfer of real property in Australia.

the theoretical work of Vickrey (1961) which showed revenue equivalence between auction formats (McAfee and McMillan, 1987). Rather than explaining a seller's choice between auction formats, the theoretical model of Wang (1993) allows a seller to choose between selling at auction or selling at a fixed price. Wang (1993) shows auctions are preferred when buyers' valuations are widely distributed for a single object. Mayer (1995) generalizes the seller choice model for auction versus fixed price to the housing market in order to account for vacant stock as well as buyer preferences (mismatch cost) and shows auctions obtain a lower price than fixed price sales due to mismatch costs. Mayer (1995) also shows auction discounts are lower in favorable markets and for more homogeneous properties. The theoretical model of Quan (2002) expands upon prior models by incorporating search and holding costs. Quan (2002) shows auctions produce a higher price than fixed price sales due to high search cost buyers participation in the auction market. As an empirical test, Quan (2002) compares the price of 85 vacant residential lots sold at three multiple object auctions in Austin, TX with 117 similar lots sold though MLS. First ignoring endogenous choice in the estimation, the study finds auctioned properties sell at a discount of approximately 44% relative to negotiated sale prices. Using a method-of-moments technique described by Heckman and Robb (1985b,a), the study re-estimates the difference parameter and finds auction properties in their sample sold at a premium of approximately 30% relative to negotiated sales. Gan (2013) incorporates seller risk aversion into a model of seller choice and shows higher risk averse sellers choose to auction at a discount but are compensated by reduced risks since the auction occurs within a fixed time period. In addition, Gan (2013) shows more (fewer) sellers choose auctions when buyer demand is increasing (decreasing) and also that loss-averse sellers strictly prefer fixed price marketing.[4] Most recently, Chow et al. (2015) develop a model to evaluate auction and negotiated sales of residential property in Singapore, China. Using the standard Heckman approach to control for endogenous choice, the authors calculate the expected price difference between auction and negotiation for properties in their sample from the fitted conditional price equations. They find the auction-to-negotiation revenue difference increases with asset demand

[4]Other papers evaluating auction discounts include Adams et al. (1992), Tse et al. (2011), Han and Strange (2014), and Chinloy et al. (2016).

and is greater for more homogeneous assets such as the apartments in their sample.

3 SCOTTISH MARKETING SYSTEMS

In Scotland, the seller of residential property has considerable flexibility in the way that they can market their property. The dominant mechanism by which buyers and sellers agree on a transaction price for a residential property is through a legally binding sealed-bid auction. Potential purchasers submit a bid on the basis of both a professional valuation and an "offers-over" price set by the seller. Unlike a typical English auction, the date for bids is not pre-set and is only set when the seller's solicitor receives two or more "notes of interest".[5] The bids are revealed to the seller after the "closing date" for offers has elapsed. The seller is not required to set a closing date and may elect to postpone setting such a date until they obtain a sufficient number of potential bidders. It is normal for a seller to accept the highest bid but s/he is not legally obliged to do so. The decision to accept a lower bid may be due to other conditions set within the offer, for example the entry date may be unsuitable. In addition, the seller has the option of rejecting all bids and restarting the bidding process. This is rare and would typically be discouraged by the seller's agent.

The "offers-over" list price is not legally binding, and merely sets an indicative floor to the bidding price. Of course, as is the case with many other auction systems, the true or firm reservation price is not revealed by the seller. The "offers-over" price will be set by the seller in discussion with his/her real estate agent and will be set at a level that will attract potential buyers to view the property and generate a bidding process. Consideration will also be given to the seller's personal circumstance, for example, it is likely that the seller will at least want to cover the outstanding loan and transactions costs to avoid negative equity.

Note that while the "offers-over" marketing system seems unique to Scotland, the mechanics are very similar to negotiated sales in the US where a seller lists a property at a discount in order to induce a "bidding war" as studied by Han and Strange (2014). Viewed in this way, the current study

[5] All interested buyers are informed when the closing date is set if they have placed a "note of interest" with the selling solicitor.

is generalizable to housing markets outside of Scotland and allows for easier identification of the marketing strategy since sellers explicitly signal their marketing strategy via a system choice rather than implicitly signaling a strategy via a list price discount where the discount itself must first be identified relative to non-discount listings.

The alternative selling mechanism is known as the "fixed price" system.[6] It requires the seller to reveal his/her true reservation price and sell the property on a "first-come-first-serve" basis.[7] This system avoids the sealed-bid process and is very similar to the selling process found throughout the rest of the UK and the US.

The option to adopt the "fixed price" system is generally thought to be attributed to one of two circumstances. First, the seller may require a specific level of sales proceeds where one of the potential reasons for the requirement could be that the seller is loss-averse (Gan, 2013). Choosing a fixed price sends out a strong market signal about his/her intention to sell, thus reducing buyer uncertainty. This is common practice if the seller has committed to purchase another property and needs to release the equity tied up in their current property or payoff a loan from sale proceeds. Second, the seller, or the seller's estate agent, may believe that the list price necessary to garner bids which meet or exceed the true reservation price under the offers-over system is approaching the true reservation price so that it is optimal to use a fixed price marketing system. This may be due to a property's physical characteristics, location and/or general market conditions, for example over-supply of similar properties within the vicinity. This belief is consistent with the models of Mayer (1995), Ooi et al. (2006), Gan (2013), and Chow et al. (2015).

Under both systems, the seller seeks professional advice from real estate agents and solicitors/lawyers. The transaction costs faced by the seller are similar regardless of the selling choice. Estate agents typically charge 1% of the transaction price as their sale fee with other costs charged separately (for example, listing and newspaper advertisements). The comparability of costs under

[6] A seller may adopt to use the "fixed price" system at the start of the marketing process or switch to the "fixed price" system during the marketing process. While of interest, the data does not allow identification of sellers which switched between marketing systems during the selling process and only reveals the final marketing choice outcome.

[7] As with the offer over system, the seller is not legally bound to sell, even if the list price is met (e.g. if unacceptable conditions are attached to the offer).

each system is convenient, because observed gross sale proceeds will be equivalent to unobserved net sale proceeds.[8] Solicitors normally charge a fixed fee for the conveyance of the property. Again the price charged will independent of the selling method chosen.

Starting on December 1, 2008, home sellers in Scotland are required by law to provide prospective buyers with a home report which includes a surveyor assessment of value (i.e. an appraisal), an energy report, and a property questionnaire. Prior to the change, a prospective buyer of a home incurred the cost of a surveyor assessment of value. The 2008 regulation is the result of The Housing (Scotland) Act 2006 which aimed to increase transparency in the housing market. Around this same time, a third marketing system emerged called "offers around" and is a compromise between the lower bound list price of the offers over system and upper bound list price of the fixed price system. The current sample ends in 2002 prior to the new regulation and the introduction of a third system.

4 EMPIRICAL METHODOLOGY

The goal of the empirical analysis is to measure the impact of marketing system choice on house prices. If the expected house prices are used to determine the choice of marketing system, then selection bias should be considered as a factor in the estimation of the house price model.[9] While the traditional Heckman two-stage selection model is certainly viable, it does not provide direct evidence of the true price impact. Lee et al. (1979) provides the framework that this study will use to incorporate a direct test of the impact of auctions on house prices, recognizing the endogeneity of the choice of marketing system and the potential for selection bias.[10] The foundation of this framework is the estimation of the unconditional expectation of the house price of a property. The unconditional expected price of

[8]This is not the case in the Australian housing market where, as noted by Lusht (1996), commissions and advertising costs differ across the systems.

[9]This follows the argument of Wallace (1988) and McMillen and McDonald (1989, 1991) that if land values are a determinant of zoning, one should expect to find selection bias.

[10]The model of Lee et al. (1979) expanded upon switching regression work by Goldfeld and Quandt (1972, 1973) and Heckman (1976a,b).

the ith parcel may be written:

$$E(P_i) = E(P|I = 1)F_1 + E(P|I = 0)F_0 \tag{4.1}$$

where F_s is the probability a parcel sold under marketing system s and $E(P_i|I = s)$ is the conditional expected value of the price of a parcel given that it sold under marketing system s. Within this framework, the choice of the marketing system must be explicitly modelled.

Individual sellers select the system in which they wish to market their property. It seems reasonable to assert that this decision is, at least in part, based on the seller's belief of the net selling price that could be obtained under the different methods of marketing their property. In other words, one would expect to see an increase in the choice of a particular marketing system as the net expected price under that system increases relative to the net price under other systems. Such a choice model for a two choice system (fixed price and offers over) can be written as:

$$I_i^* = \delta\big[(P_{1i} - P_{0i}) + (C_{0i} - C_{1i})\big] + y_i\omega - \epsilon_i \tag{4.2}$$

where I_i^* is the underlying response variable ($I = 1$ if $I_i^* > 0$, otherwise $I = 0$), P_{si} is the house price under marketing system s, C_{si} is the cost of marketing under system s, and y_i represents other factors that may impact the choice of marketing system. The error term, ϵ_i, is assumed to be $N(0, \sigma_\epsilon^2)$. The house price equations for properties sold under the two marketing systems can be written as:

$$P_{1i} = \alpha_1 + \boldsymbol{X}_{1i}\boldsymbol{\beta}_1 + u_{1i}, \quad \text{iif } I = 1 \text{ (fixed price)} \tag{4.3}$$

and

$$P_{0i} = \alpha_0 + \boldsymbol{X}_{0i}\boldsymbol{\beta}_0 + u_{0i}, \quad \text{iif } I = 0 \text{ (offers over)} \tag{4.4}$$

where $\boldsymbol{X}_{si}$ is a vector of exogenous explanatory variables containing building, site, and location characteristics. The error terms, u_{si}, are assumed to be $N(0, \sigma_\epsilon^2)$. Substituting equations (4.3) and (4.4) into (4.2), a reduced-form of the choice model can be written as:

$$I_i = \boldsymbol{Z}_i\boldsymbol{\theta} - \eta_i \tag{4.5}$$

where $\boldsymbol{Z}_i$ is a vector of regressors that determine the choice of the marketing system, and $\eta_i = \epsilon_i - \delta(u_{1i} - u_{0i})$ is assumed to be $N(0, \sigma^2)$. Since equation (4.5) represents a reduced form model, the $\boldsymbol{Z}_i$ vector represents housing characteristics ($\boldsymbol{X}_{0i}$ and $\boldsymbol{X}_{1i}$), as well as other factors (y_i) that may determine the choice of marketing system.[11] Note that η_i contains the error terms from the price equations, therefore one would expect the error terms of the price equations to be correlated with the error term of the choice equation. If the error term in the choice equation and the error term in the price equation are correlated, then the estimates from the price equations are biased.

The conditional expectations of the house price equations can be written as:

$$E(P_{1i} \mid I = 1) = \alpha_1 + \boldsymbol{X}_{1i}\boldsymbol{\beta}_1 - \sigma_{1\eta}\left[\frac{\boldsymbol{\phi}(\boldsymbol{Z}_i\boldsymbol{\theta})}{\boldsymbol{\Phi}(\boldsymbol{Z}_i\boldsymbol{\theta})}\right] \tag{4.6}$$

and

$$E(P_{0i} \mid I = 0) = \alpha_0 + \boldsymbol{X}_{0i}\boldsymbol{\beta}_0 - \sigma_{0\eta}\left[\frac{\boldsymbol{\phi}(\boldsymbol{Z}_i\boldsymbol{\theta})}{1 - \boldsymbol{\Phi}(\boldsymbol{Z}_i\boldsymbol{\theta})}\right] \tag{4.7}$$

where $\sigma_{1\eta}$ and $\sigma_{0\eta}$ represent the covariance between u_{si} and η while $\boldsymbol{\phi}$ is the standard normal probability density function, and $\boldsymbol{\Phi}$ is the standard normal cumulative distribution function. To estimate the conditional price equations, the final bracketed terms in (4.6) and (4.7) would be constructed from

[11] In the current study, a variable measuring the prevalence of the fixed price marketing system (CON) within a fixed distance of any given house is used to identify the selection equation and is excluded from the price equation given we would not expect the choice of marketing system to impose a price externality on other nearby homes after controlling for house characteristics and market conditions.

the maximum likelihood estimation of (4.5). The presence of selection bias would be revealed by the significance of σ_{si}. However, a direct test of the impact of marketing system would not exist. The estimation of the unconditional price equation allows for such a test.

The unconditional price equation can be obtained by substituting (4.6) and (4.7) into (4.1). Letting $\boldsymbol{X}_{1i} = \boldsymbol{X}_{0i} = \boldsymbol{X}_i$ and imposing the additional constraint of equality across parameters ($\boldsymbol{\beta}_1 = \boldsymbol{\beta}_0$), with the expectation of the covariance parameters and the constants, the resulting unconditional price equation can be expressed as:

$$E(P_i) = \alpha_0 + \boldsymbol{X}_i\boldsymbol{\beta}_0 + (\alpha_1 - \alpha_0)\boldsymbol{\Phi}(\boldsymbol{Z}_i\boldsymbol{\theta}) + (\sigma_{0\eta} - \sigma_{1\eta})\boldsymbol{\phi}(\boldsymbol{Z}_i\boldsymbol{\theta}) + \nu_i. \tag{4.8}$$

To estimate (4.8), the unknown parameter $\boldsymbol{\theta}$ is first obtained via maximum likelihood estimation of the choice equation (4.5) in order to obtain $\hat{\boldsymbol{\Phi}}_i = \boldsymbol{\Phi}(\boldsymbol{Z}_i\hat{\boldsymbol{\theta}})$ and $\hat{\boldsymbol{\phi}}_i = \boldsymbol{\phi}(\boldsymbol{Z}_i\hat{\boldsymbol{\theta}})$. Next, ordinary least squares can then be used to estimate (4.8) and obtain consistent estimates of the parameters. The parameter on $\hat{\boldsymbol{\Phi}}_i$ reflects the difference in the intercepts across properties in each marketing system, while the parameter on $\hat{\boldsymbol{\phi}}_i$ provides insight into the selection process. The presence of estimated variables, as well as heteroskedasticity in the error term, requires a variation of the procedure implemented by Lee (1982) and reiterated by Maddala (1983) be used to obtain a corrected asymptotic covariance matrix.[12] Alternatively, consistent estimates of (4.8) and asymptotic standard errors can be obtained according to Procedure 21.3 in Wooldridge (2010) where (4.5) is estimated via probit to obtain $\hat{\boldsymbol{\Phi}}_i$ and $\hat{\boldsymbol{\phi}}_i$ which are then used as instruments in a typical 2SLS with a linear probability first-stage and OLS estimate of (4.8) in the second-stage. The procedure still requires an adjustment be made to the standard errors given $\hat{\boldsymbol{\phi}}_i$ is a generated regressor under the assumption $(\sigma_{0\eta} - \sigma_{1\eta}) \neq 0$. Wooldridge (2010) notes bootstrapping or the delta may be used in this case.[13]

The empirical methodology employed allows for estimation of a direct price effect of sealed-bid

[12] Accuracy of the estimated variables depend upon the variance of δ contained in the error term of equation (4.5).

[13] Equation (4.8) is estimated using the methods of Maddala (1983) and Wooldridge (2010). Coefficient estimates are virtually identical between the two methods and standard errors obtained using 1,000 bootstrap for each method are equally similar (i.e. the collection of variables which are significant at 5% level are identical for the two methods).

auctions. In addition, it allows exploration of a more basic question as to whether or not sellers are rational in the selection of the optimal selling mechanism.

5 DATA AND ESTIMATION RESULTS

5.1 Data

The data for the study are from the city of Aberdeen, located in the North East of Scotland. It is Scotland's third largest city with a population of approximately 250,000, and serves as a major service center to a wide catchment area. The data have been obtained from the Aberdeen Solicitors Property Center (ASPC)[14] and pertain to residential sales from the City of Aberdeen between 1984 and 2002.[15] The information contained within the dataset includes property address, postal/zip code, geocode, sale price, date of sale, and various structural property attributes.[16]

The working dataset includes 4,780 detached housing sales for the entire City of Aberdeen, 4,199 of which sold through a sealed-bid auction.[17] Descriptive Statistics are presented in Table 1. The average sale price during the sample period is £115,000. On average properties sold during the sample period have three bedrooms and two additional rooms. Seventy percent of properties had a dining room separate from the kitchen. The majority of properties sold during the sample period feature central heating and a garage. The prevalence of the fixed price marketing system is measured for three distance thresholds of 0.50mi, 0.75mi and 1mi (*CON_050*, *CON_075* and *CON_100*). On average, there were between forty and sixty-three detached dwellings within the sample that sold using the fixed price method within ½ to 1 mile of a given observation during the sample period. The

[14]The ASPC is operated by a group of local solicitors and estate agents within the City of Aberdeen and Aberdeenshire.

[15]While it would be of interest to extend the study period, sellers are required, starting in 2008, to provide prospective buyers with a home report which includes a surveyor assessment of value which may mitigate the potential for a price difference between the two marketing systems but remains a question to be answered by future research.

[16]A property's geo-coordinates are defined by the centroid of the postal code to which it belongs. According to 2012 National Records of Scotland GIS postcode extract data, each postal code area is physically no larger than 1 square mile.

[17]The sample has been reduced as not to include observation where the price per bedroom is less than £7,500 or greater than £125,000. In both cases, these appear to be outliers.

COMPETE variable measures the concentration of housing substitutes (competition) within 0.50mi, 0.75mi and 1mi. Specifically, it represents the number of properties within ½, ¾ and 1 mile of the ith property, within ±1 bedroom, whose sale price is within ±5% of the ith property, and whose listing period overlapped with the ith property. On average, sellers in the sample faced competition from one or more similar properties with the competition measure increasing with the distance threshold.

The marketing systems sub-samples suggests a difference in the underlying properties found in each of the marketing systems. The fixed price system is associated with, on average, lower priced properties. The mean sale price of fixed price properties during the sample period is £95,138, while it is £118,507 for offers over properties. On average, the properties which sell at fixed price are appear to be smaller and located farther out from the city center. Fixed price properties have, on average, between fifteen and nineteen more properties within ½ to 1 mile which sold using the fixed price method relative to offers over properties in the sample. In addition, fixed price properties face, on average, competition from approximately one more property in close proximity relative to their offers over counterpart. While not reported in Table 1, the number of fixed price sales ranged between 2% and 23% of the total number of sales within a given year.[18]

The dataset has three limitations which should be mentioned. The first is that only sales which are successful are observed so that properties which are marketed and withdrawn are censored in the data. The second limitation is that the sample likely includes properties which were initially listed under one system and were switched to the other system. The third limitation is that while properties which sold at offer over likely went to sealed-bid auction, it remains possible that the seller simply privately negotiated with the first interested bidder. By the same token, it is possible a fixed price sale resulted in a "bidding war" between more than one interested buyers.[19]

[18] Propensity score matching is used to ensure the main results are robust to concerns regarding imbalance (see Robustness Check section).

[19] In unreported results, the sample is trimmed to remove offers over sales which occurred at discount relative to list price and fixed price sales which occurred at a premium relative to list price. The results are robust to these sample restrictions.

5.2 Estimation Results

Table 2 presents the results from the estimation of the selling choice model. The models presented only differ in specification by the distance thresholds (½, ¾ and 1 mile) used to construct the *CON* variable. As coefficient size and significance for all property characteristic variables is similar across the three models, the discussion hereafter will focus on Model (1). Many of the property characteristic parameters are significant, and the results are generally of the expected sign. The results indicate that properties further from the city center are more likely to be sold fixed price. The more additional rooms the property features (*OTHRRMS*), the less likely the property sells at fixed price. Properties with central heating are more likely to sell fixed price, while the odds of fixed price are lower for properties with a garage. The former result is somewhat puzzling, since one would think the presence of central heating would be positively associated with buyer demand and, as noted earlier, assets in high demand typically obtain a higher price under the sealed bid marketing system. In addition, the majority of properties in the sample (88%) have central heating so that the absence of this feature would make a property more heterogeneous which favors the fixed price marketing system. The odds of a property being marketed using the fixed price system increase as the number of properties in the vicinity which sell using the fixed price system increase (*CON*). This is intuitive since similar properties are likely to be in close proximity.[20,21] Submarket and year fixed effect estimates are omitted from the tables for brevity sake, but select results are discussed. Relative to 2002, which was a strong year for the Aberdeen housing market in terms of buyer demand, the odds of fixed price were higher in the years 1984–1987, and in the years 1992–2001.

Table 3 reports the unconditional log price equation estimates where models (1), (2) and (3) rely

[20] The variable ceases to be significant at the 5% level when a search radius of 1.25 miles is used which seems logical as this technique is akin to an appraiser's attempt to minimize search distance when finding sale comps when estimating a subject property's value.

[21] While the study has framed marketing choice as being selected by the seller, it may also be the case that the seller is merely acting in accordance with the market standard in that a property's location and neighborhood characteristics determine the choice of system. In any case, the current study is ambivalent as to the origin of the selection choice and is primarily concerned with controlling for the selection choice bias in the price equation. In unreported results, a 3SLS model is used to account for cross-equation correlation in the error terms and the results are unchanged.

upon estimates from their counterparts in Table 2.[22] The results unrelated to choice of marketing system are generally consistent with expectations with negligible differences between the three models in terms of coefficient size and significance. The distance gradient is insignificant. Price is increasing in the number of rooms and bedrooms. Properties with central heating and a garage sell for more, other things being equal. Consistent with expectations regarding supply effects, price is decreasing as the concentration of housing substitutes (*COMPETE*) increases. Similar to Table 2, submarket and year fixed effects are not reported, but key results are discussed. A majority of the year variables are negative and significant ('84–'93); a finding consistent with the UK and local market's performance.[23] During the mid-late eighties, the oil industry suffered a major economic downturn, which resulted in a major shock to the housing market. The years 1992–2001 marked a period of slow recovery, not unlike every city in the UK. From 2002 onward, there was rapid growth in house prices equivalent to that experienced in the rest of Scotland, and the UK as a whole.

The results provide some interesting evidence related to the impact of the fixed price marketing system and presence of sample selection bias. In contrast to prior studies which find a positive or negative difference between marketing systems, the coefficient on the endogenous fixed price variable CDF ($\hat{\mathbf{\Phi}}_i$) is found to be statistically insignificant. The estimated parameter on the selection hazard variable PDF ($\hat{\boldsymbol{\phi}}_i$) is found to be positive and statistically significant, indicating that the covariance between u_{0i} and η is greater than the covariance between u_{1i} and η; selection bias is present in the estimation. The combined interpretation of these two results provides insight into the individuals' selection of marketing schemes.

If individuals are acting rationally, then they would be expected to select the marketing system which would yield the highest expected price for their particular type of property. Within the context of the current study, one would expect that a *fixed price type* property would sell for more under the fixed price system than it would have if the *fixed price type* property had sold under the offers over

[22]Procedure 21.3 in Wooldridge (2010) is used where standard errors are derived from 1,000 bootstrap replications using uniform sampling with replacement. As noted earlier, estimates and significance are equivalent for the two estimation methods considered for estimating (4.8).

[23]Fixed effects for 1994–2001 are insignificant relative to the omitted year of 2002.

system. Table 4 contains the conditional price expectation under the two marketing systems. To be consistent with the empirical modelling, the difference in the expected prices across the marketing systems is evaluated, with all parameters except the intercept and selection terms constrained to be equal.

Examining the difference in the conditional expectation within the choice of a particular marketing system provides insight into the selection of marketing system selected by individuals. The difference in the expected price equations for the fixed price properties is:

$$E(P_{1i} \mid I = 1) - E(P_{0i} \mid I = 1) = (\alpha_1 - \alpha_0) + (\sigma_{0\eta} - \sigma_{1\eta})\frac{\boldsymbol{\phi}}{\boldsymbol{\Phi}} \tag{5.1}$$

For properties sold offers over, the difference of the expected price equations across marketing systems is:

$$E(P_{0i} \mid I = 0) - E(P_{1i} \mid I = 0) = -(\alpha_1 - \alpha_0) + (\sigma_{0\eta} - \sigma_{1\eta})\frac{\boldsymbol{\phi}}{1 - \boldsymbol{\Phi}}. \tag{5.2}$$

The estimated parameter on the endogenous dummy variable ($\hat{\boldsymbol{\Phi}}_i$) provides an estimate of $(\alpha_1 - \alpha_0)$, while the estimated parameter on the selection variable ($\hat{\boldsymbol{\phi}}_i$) provides an estimate of $(\sigma_{0\eta} - \sigma_{1\eta})$. Interpreting the constants as being equivalent due to the insignificance of $(\alpha_1 - \alpha_0)$ in the estimation of the house price equation, the differences in the expected price equations across marketing schemes, (5.1) and (5.2), are both positive based on the estimated parameter $(\sigma_{0\eta} - \sigma_{1\eta})$ being positive. This result indicates that even though an insignificant price impact of offers over is found, individuals are selecting the marketing system which leads to the highest expected price for their property type.

5.3 Robustness Check

As a robustness check, propensity score matching is used to test if estimation of the endogenous fixed price effect $(\alpha_1 - \alpha_0)\hat{\boldsymbol{\Phi}}_i$ and selection hazard $(\sigma_{0\eta} - \sigma_{1\eta})\hat{\boldsymbol{\phi}}_i$ hold. The matching process is a first-best, 1-to-1 match, with replacement, using the fitted propensity score of the marketing choice models in Table 2. To ensure covariate balance for the matched sample, possible matches for the ith property are constrained based uniform caliper radius of 0.80 for all variables used in the estimation of the

three models in Table 2 with the exception of the submarket and year fixed effects.[24] A caliper radius (ζ) is a ratio of the pooled standard deviation for variable X_k, whose standard deviation for the two groups in the study is σ_{1k} for fixed price sales and σ_{0k} for offers over sales, which produces a caliper width to limit variable differences between a given matched pair of properties i and j. The caliper constraint for the study can be written as:

$$|\Delta X_{k;i,j}| = |X_{ik} - X_{jk}| \leq \zeta \sqrt{\frac{\sigma_{1k}^2 + \sigma_{0k}^2}{2}} \tag{5.3}$$

so that property j which results in the minimum absolute propensity score difference relative to property i must also satisfy the K requirements of (5.3). The competition variable ($COMPETE$) and the natural log of a property's time on the market (ln_TOM) are included in the K variable constraints in attempt to minimize imbalance which might affect estimation of the price equation but are not included in estimation of the probit choice model(s).

Table 5 reports the matching procedure results for three specifications corresponding to the three model in Table 2. The number of matched pairs increases as the search radius increases. Model 1 uses a maximum search radius of 0.50mi which produces 186 matched pairs, Model 2 uses 0.75mi resulting in 220 matched pairs, and Model 3 uses 1mi resulting in 234 matched pairs.[25] The bottom section of Table 5 reports the caliper width for each variable according to (5.3). In all three models, the price difference between fixed price sales and offers over properties, both in natural log and linear form, is insignificant. The endogenous fixed price variable ($\hat{\mathbf{\Phi}}_i$) and the selection hazard ($\hat{\boldsymbol{\phi}}_i$) are balanced as both the group difference in means and variances are insignificant. While not reported, balance across all other K variables is checked and both the difference in means and variances are insignificant.[26]

Table 6 reports estimates for the unconditional log price equation similar to Table 3 for each

[24] A distance threshold (0.50mi, 0.75mi and 1mi for models 1, 2 and 3 in Table 2) is used to control for property location and the sale date difference for the matched properties is required to be less than 68 days to control for time.

[25] As studies of propensity score matching have shown Cochran and Rubin (1973); Rosenbaum and Rubin (1983); Austin (2011), a smaller caliper radius may reduce bias may also reduce the sample size so that the researcher must find a radius which minimizes bias and imbalance but also does not produce a prohibitively small matched sample.

[26] In addition to standard difference in means tests, the standardized mean difference for all variables and variance ratios are checked to confirm all covariates are balanced.

of the three matched samples given the difference in means test in Table 5 will not reveal if the endogenous fixed price effect $(\alpha_1 - \alpha_0)\hat{\mathbf{\Phi}}_i$ and selection hazard $(\sigma_{0\eta} - \sigma_{1\eta})\hat{\boldsymbol{\phi}}_i$ are statistically significant in explaining price. The endogenous fixed price effect remains insignificant in all three models and, for Model 1 and 2 whose search radii are 0.50mi and 0.75mi respectively, the selection hazard remains positive and significant. Interestingly, the selection hazard becomes insignificant for Model 3 where the search radius is 1mi. The result is likely due to the fact that the probit choice model becomes more inaccurate as distance increases such that properties farther away from subject property i are less predictive of its outcome relative to properties in close proximity.

6 CONCLUSION

This paper analyzed how the choice of selling system affects residential values. The simultaneous existence of two alternative selling systems in Scotland, the offers over and fixed price system, offers a unique opportunity to compare residential transactions under each system.

The real estate auction literature is growing in the number of empirical examinations of real property auctions but these studies have produced mixed conclusions with regard to price effects. There is both evidence of auction premiums and auction discounts. However, as noted by both Lusht (1996) and Mayer (1998), if the choice of selling mechanism is related to expected price, sample selection correction is essential for any price effect finding to be robust. Acknowledging that the choice of marketing system should be treated endogenously within the empirical estimation, this paper explores whether or not sellers are rational in the selection of the optimal selling mechanism.

This paper compares the sealed-bid auction format against fixed price sales and significantly adds to the literature on price effects between auctions and alternative marketing systems. Evidence of sample selection is found, but this study does not find a price effect associated with the sealed-bid auction format relative to the fixed price sale. However, the analysis does reveal that sellers are rational in that they select the system which results in the highest predicted price for their property. That is, their property would have sold for less had the alternative system been chosen and is consistent with Vickrey (1961) as these two marketing systems would not coexist if the conditional expected net

proceeds under the two systems are the same.

Opportunities exist for further research which includes extending the analysis to incorporate different property types in which the use of fixed price could be more prevalent. Also, comparison with other Scottish cities would provide an interesting contrast since the Aberdeen housing market is dominated by the Aberdeen Solicitors Property Centre. Ideally an improved dataset would enable a better understanding of the marketing choice. Specifically, more detailed tracking of the history of the property throughout the sale period, for example, knowing if and when the property was switched from "offers over" to "fixed price", the number of bids submitted and whether the "offers over" property actually went to sealed-bid auction. This information would allow for a more insightful model of marketing choice and provide greater information regarding buyer demand.

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Table 1: Descriptive statistics of detached dwellings in Aberdeen, Scotland (1984–2002)

	Full Sample (N = 4,780)		Offers Over (N = 581)		Fixed Price (N = 4,199)	
Variable	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Selling Price in thousands (P)	115.667	65.440	118.507	66.864	95.138	49.458
Distance to CBD in miles ($UCBD$)	3.056	1.302	3.020	1.314	3.316	1.180
Number of bedrooms ($BEDRMS$)	3.359	1.093	3.403	1.091	3.041	1.053
Number of rooms other than bedrooms ($OTHRRMS$)	2.072	0.937	2.111	0.943	1.788	0.844
Presence of a dining room ($DINE\_RM = 1$)	0.706	0.456	0.724	0.447	0.573	0.495
Presence of a heating system ($HEAT = 1$)	0.885	0.319	0.885	0.319	0.886	0.318
Presence of a garage ($GARAGE = 1$)	0.813	0.390	0.825	0.380	0.728	0.445
Prevalence of fixed price system w/i 0.50mi (CON_050)	40.223	32.909	37.887	31.734	57.103	36.193
Prevalence of fixed price system w/i 0.75mi (CON_075)	53.511	34.000	51.253	32.807	69.833	37.830
Prevalence of fixed price system w/i 1.00mi (CON_100)	63.435	30.753	61.649	29.784	76.336	34.381
Num. of housing substitutes w/i 0.50mi ($COMPETE\_050$)	1.223	1.780	1.113	1.663	2.019	2.316
Num. of housing substitutes w/i 0.75mi ($COMPETE\_075$)	1.627	2.127	1.513	2.028	2.458	2.593
Num. of housing substitutes w/i 1.00mi ($COMPETE\_100$)	1.905	2.299	1.800	2.225	2.661	2.658

Table 2: Marketing Choice Equation (Reduced-Form Probit)

	(1)		(2)		(3)	
Variable	Parameter Estimate	|t-value|	Parameter Estimate	|t-value|	Parameter Estimate	|t-value|
Intercept	−2.1844	10.16	−2.2821	10.54	−2.3084	10.49
UCBD	0.2232	3.59	0.2491	4.08	0.2870	4.91
OTHRRMS	−0.1818	3.68	−0.1827	3.70	−0.1848	3.75
BEDRMS	−0.0026	0.09	−0.0062	0.21	−0.0086	0.30
DINE_RM	0.1107	1.25	0.1058	1.19	0.1006	1.14
HEAT	0.2005	2.32	0.2085	2.41	0.2013	2.34
GARAGE	−0.1921	2.74	−0.1928	2.75	−0.1974	2.83
CON_050	0.0059	4.71				
CON_075			0.0054	4.30		
CON_100					0.0035	2.75
SMKT FE	yes		yes		yes	
Year FE	yes		yes		yes	
N	4,780		4,780		4,780	
AIC	3,177.94		3,181.28		3,192.82	
SC	3,404.46		3,407.80		3,419.34	

The dependent variable for all 3 models is a binary variable coded as 1 if the property is sold using a fixed price marketing scheme and 0 if the property is sold using offers over. The only difference in specification between the three models is how the variable which measures the prevalence of the fixed price marketing system, *CON*, is measured. Models (1), (2) and (3) use distance thresholds of ½, ¾ and 1 mile respectively.

Table 3: Unconditional Price Equation (Second-Stage OLS)

	(1)		(2)		(3)	
Variable	Parameter Estimate	|t-value|	Parameter Estimate	|t-value|	Parameter Estimate	|t-value|
Intercept	11.0602	234.60	11.0605	231.50	11.0600	260.97
UCBD	−0.0153	0.88	−0.0134	0.74	−0.0253	1.14
OTHRRMS	0.0975	7.72	0.0952	7.29	0.0997	7.23
BEDRMS	0.1665	22.04	0.1656	21.32	0.1652	23.00
DINE_RM	0.0286	1.51	0.0307	1.56	0.0293	1.63
HEAT	0.1499	7.68	0.1524	7.52	0.1477	7.45
GARAGE	0.1157	6.37	0.1133	5.94	0.1174	5.93
COMPETE_050	−0.0143	8.23				
COMPETE_075			−0.0122	7.92		
COMPETE_100					−0.0108	7.37
CDF ($\hat{\mathbf{\Phi}}_i$)	0.2934	1.02	0.0753	0.33	−0.1387	0.63
PDF ($\hat{\boldsymbol{\phi}}_i$)	1.4277	3.54	1.2842	3.64	0.9610	2.27
SMKT FE	yes		yes		yes	
Year FE	yes		yes		yes	
N	4,780		4,780		4,780	
Adj. R^2	0.8092		0.8355		0.8336	

The dependent variable for all 3 models is the natural log of sales price. The CDF and PDF variables in each model are generated from the corresponding model in Table 2. Models (1), (2) and (3) use distance thresholds of ½, ¾ and 1 mile respectively for the variable measuring the concentration of housing substitutes (*COMPETE*) defined in Section 5.1. Each model is estimated using Procedure 21.3 in Wooldridge (2010) where (4.5) is estimated via probit to obtain $\hat{\mathbf{\Phi}}_i$ and $\hat{\boldsymbol{\phi}}_i$ which are then used as instruments in a typical 2SLS with a linear probability first-stage and OLS estimate of (4.8) in the second-stage. Bootstrap standard errors are used to calculate t-values based on 1,000 replications using uniform sampling with replacement.

Table 4: Expected Prices under Fixed Price and Offers Over Marketing Systems

	Expected Price under Fixed Price	Expected Price under Offers Over
Fixed Price Properties ($I = 1$)	$E(P_1 \mid I = 1) = \alpha_1 + \boldsymbol{X}_1\boldsymbol{\beta}_1 - \sigma_{1\eta}\frac{\boldsymbol{\phi}}{\boldsymbol{\Phi}}$	$E(P_0 \mid I = 1) = \alpha_0 + \boldsymbol{X}_0\boldsymbol{\beta}_0 - \sigma_{0\eta}\frac{\boldsymbol{\phi}}{\boldsymbol{\Phi}}$
Offers Over Properties ($I = 0$)	$E(P_1 \mid I = 0) = \alpha_1 + \boldsymbol{X}_1\boldsymbol{\beta}_1 + \sigma_{1\eta}\frac{\boldsymbol{\phi}}{1-\boldsymbol{\Phi}}$	$E(P_0 \mid I = 0) = \alpha_0 + \boldsymbol{X}_0\boldsymbol{\beta}_0 + \sigma_{0\eta}\frac{\boldsymbol{\phi}}{1-\boldsymbol{\Phi}}$

Table 5: Propensity Score Matching

	(1)				(2)				(3)			
	Mean				Mean				Mean			
	Fixed Price	Offers Over	$\lvert\Delta\rvert$	|t-value| (p-value)	Fixed Price	Offers Over	$\lvert\Delta\rvert$	|t-value| (p-value)	Fixed Price	Offers Over	$\lvert\Delta\rvert$	|t-value| (p-value)
ln(Price)	11.495	11.541	0.046	0.973 (0.331)	11.506	11.529	0.023	0.550 (0.583)	11.506	11.535	0.030	0.737 (0.462)
Price(£1,000)	108.636	113.316	4.679	0.920 (0.358)	109.672	110.726	1.053	0.233 (0.816)	109.358	111.446	2.088	0.476 (0.634)
CDF $(\hat{\mathbf{\Phi}}_i)$	0.193	0.193	0.000	0.035 (0.972)	0.188	0.188	0.000	0.041 (0.968)	0.182	0.182	0.000	0.004 (0.997)
PDF $(\hat{\boldsymbol{\phi}}_i)$	0.253	0.251	0.001	0.114 (0.909)	0.247	0.247	0.000	0.007 (0.995)	0.243	0.244	0.001	0.086 (0.931)
N	186				220				234			
$\lvert\text{Distance}_{i,j}\rvert$	≤ 0.50				≤ 0.75				≤ 1.00			
$\lvert\Delta\text{SaleDate}_{i,j}\rvert$	≤ 68				≤ 68				≤ 68			
$\lvert\Delta\text{UCBD}_{i,j}\rvert$	≤ 0.9992				≤ 0.9992				≤ 0.9992			
$\lvert\Delta\text{OTHRRMS}_{i,j}\rvert$	≤ 1				≤ 1				≤ 1			
$\lvert\Delta\text{BEDRMS}_{i,j}\rvert$	≤ 1				≤ 1				≤ 1			
$\lvert\Delta\text{CON}_{i,j}\rvert$	≤ 27				≤ 28				≤ 26			
$\lvert\Delta\text{COMPETE}_{i,j}\rvert$	≤ 2				≤ 2				≤ 2			
$\lvert\Delta\text{CDF}_{i,j}\rvert$	≤ 0.0807				≤ 0.0801				≤ 0.0788			
$\lvert\Delta\text{ln\_TOM}_{i,j}\rvert$	≤ 0.6697				≤ 0.6697				≤ 0.6697			

Summary of matched samples where (1), (2) and (3) utilize the corresponding model in Table 2 to generate the *CDF* $(\hat{\mathbf{\Phi}}_i)$ and *PDF* $(\hat{\boldsymbol{\phi}}_i)$. The top section reports group means, difference in group means and significance for primary variables of interest. The middle section reports the match sample sizes for the three models as well as match criterion not based on the caliper radius. The bottom section reports matching criterion based on a uniform caliper radius of 0.80. The definition of the fixed price concentration (*CON*) and housing substitute (*COMPETE*) variables remains unchanged from Tables 2 and 3. While not shown in the list of caliper constraints, matched pairs are also required to be identical with respect to the presence or absence of a dining room (*DINE_RM*), central heating (*HEAT*) and garage (*GARAGE*).

Table 6: Unconditional Price Equation for Propensity Score Matched Sample

	(1)		(2)		(3)	
Variable	Parameter Estimate	|t-value|	Parameter Estimate	|t-value|	Parameter Estimate	|t-value|
Intercept	11.2752	86.11	11.2870	98.13	11.2076	78.88
UCBD	−0.0147	0.41	0.0306	0.99	0.0024	0.06
OTHRRMS	0.0703	2.39	0.0495	1.69	0.0732	1.92
BEDRMS	0.1966	12.99	0.1969	13.65	0.1969	14.03
DINE_RM	−0.0407	1.06	−0.0066	0.19	−0.0255	0.68
HEAT	0.1633	3.67	0.1706	4.63	0.1519	3.14
GARAGE	0.1669	4.19	0.1398	3.71	0.1316	3.02
COMPETE_050	−0.0086	1.77				
COMPETE_075			−0.0073	1.73		
COMPETE_100					−0.0120	2.77
CDF ($\hat{\mathbf{\Phi}}_i$)	0.0674	0.11	0.0608	0.12	−0.7563	1.31
PDF ($\hat{\boldsymbol{\phi}}_i$)	1.9185	2.28	2.1416	3.23	0.5463	0.61
SMKT FE	yes		yes		yes	
Year FE	yes		yes		yes	
N	372		440		468	
Adj. R^2	0.8610		0.8602		0.8481	

The dependent variable for all 3 models is the natural log of sales price. Models (1), (2) and (3) are estimated from the corresponding matched sample reported in Table 5. Variable definitions and modeling procedure remain unchanged from Table 3.