Information transparency and pricing strategy in the Scottish housing market

Journal:	*International Journal of Housing Markets and Analysis*
Manuscript ID	IJHMA-11-2020-0140.R1
Manuscript Type:	Research Paper
Keywords:	Real Estate, Spatial residential, Housing market analysis, Housing prices, Housing policy, Pricing model

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Abstract

Purpose: Information transparency is crucially important in price setting in real estate, particularly when information asymmetry is concerned. This paper empirically examines how a change in government policy in relation to information disclosure and transparency impacts residential real estate price discovery. Specially, we investigate how real estate traders determined asking prices in the context of the Scottish housing market before and after the implementation of the Home Report, which aimed to prevent artificially low asking prices.

Methodology/approach: The paper employs spatial lag hedonic pricing models to empirically observe how residential asking prices are determined by property sellers in response to a change in government policy that is designed to enhance market transparency. It utilises over 79,000 transaction data of the Aberdeen residential market for the period of Q2 1998 to Q2 2013 to test the models.

Findings: The empirical findings provide some novel insights in relation to the price determination within the residential market in Scotland. Our spatial lag models suggest that spatial autocorrelation in property prices has increased since the Home Report came into effect, indicating that property sellers have become more prone to infer asking prices based on prior sales of dwellings in close vicinity. The once-common practice of setting artificially low asking prices seems to have dwindled to a certain extent statistically.

Originality: The importance of understanding the relationship between information transparency and property price determination has gathered momentum over the past decade. Although spatial hedonic techniques have been extensively used to study the impact of various property- and neighbourhood-specific attributes on residential real estate market in general, surprisingly little is known about the empirical relationship between spatial autocorrelation in real estate prices and information transparency.

1. Introduction

Pricing strategy has been an important concept in both theoretical and empirical modelling of housing transactions which is envisaged to impact upon the number of bids, final transaction price and the length of time to sell a home (Kang and Garnder, 1989; Yavas and Yang, 1995; Forgey et al., 1996; Arnold, 1999; Anglin et al., 2003; Pryce, 2011, Thanos and White, 2014). Equally, the evaluation of asking prices is also important in the valuation process, where estimated market value is derived from recently transacted comparable sale prices. As such, bias in the asking prices of comparable properties can distort the market

value estimate of the subject property, which in turn could lead to a divergence between the market value estimate and the sale price (Rabianski, 1992).

It is widely accepted that there is a degree of information asymmetry in most housing markets between sellers and buyers. This occurs when sellers and their agents have better knowledge of a property's qualities and location, whereas buyers are perceived to be less well informed (Lin and Vandell, 2007; Pope, 2008; Wong et al., 2012, Nanda and Ross, 2012). This effect of the improvement in information symmetry has been examined by a number of studies (for example, Pope, 2008; Nanda and Ross, 2012). Whilst numerous studies have investigated the impact of the introduction of property condition disclosure regulations on the selling prices, more limited analysis has been undertaken to examine the potential changes in the pricing strategy of the sellers.

In Scotland, the improvement in information transparency on housing transactions was also enforced by regulations. The Home Report scheme was introduced in December 2008, requiring the seller of a residential property to provide a Single Survey, an Energy Report, and a questionnaire when listing the property on the market. The Scottish government introduced the scheme with three main objectives: to improve information about a property's condition, to address the cost and efficiency issue associated with multiple valuations and surveys, and to address the problems created by the practice of setting artificially low asking prices (Black et al. 2015). Indeed, this artificial setting of low asking prices[1] has traditionally been common practice in Scotland, especially during periods of market upturns and sustained growth. This approach whilst benefitting sellers from the uncertainty and competition among potential buyers, has been heavily and publicly criticised for leading people, who cannot afford the property, paying for surveys to be undertaken. Consequently, to evaluate the extent to which the scheme met the initial objectives, the Scottish government carried out a five-year review in 2014. The findings emanating from the review illustrated that, on first showing, the scheme appeared to be successful, nonetheless, when specifically addressing the issue relating to the setting

[1] The "asking price" in the "price over" (which is explained in section 2) context is not the reservation price that sellers would expect to achieve, or it is a ceiling price in many housing markets where buyers normally negotiate downward from an asking price. It acts more like a "guide price", which sends a signal to potential buyers that the seller is expecting to achieve a certain amount above of this price (Pryce, 2011).

artificially low asking prices, the government's review was far less conclusive on how much this is due to poorer market conditions.

Accordingly, this paper attempts to complement the government review and provide some additional evidence as to the evaluation of potential changes in pricing strategy as a result of the implementation of the Home Report scheme. In this regard, we examine the potential changes in the relationship between asking and seller's perceived reservation price and further explore the explanations for such changes using auction theories relative to the Scottish sealed bid context. Using housing transaction data pre and post the introduction of the Home Report, we empirically test whether there has been a significant statistical difference in asking price relative to the "value" of the property since the introduction of the scheme. It is believed that a better empirical understanding and conceptualisation of the underpinning price determination process and dynamics of the real estate market, as well as the effect of government policy on market transparency is of crucial significance from the viewpoints of buyers, sellers and other stakeholders. It is further posited that the study should carry implications in relation to the effectiveness of government interventions to tackle problems arising from information asymmetry in real estate pricing and enhance the overall equitability of the real estate investment environment for market participants.

The remainder of the paper is structured as follows: Section 2 discusses the background of the Scottish housing market and the rationale for the enactment of the Home Report scheme. Section 3 explores the theories relative to pricing strategy in housing auctions with Section 4 offering descriptions of the data used within the empirical analysis. Sections 5 and 6 explain the empirical modelling and provide a discussion of the empirical findings, with Section 7 drawing conclusions.

2. Background of the Scottish housing market

The Scottish housing market has some unique characteristics. The dominant selling mechanism is the "price over" system, where properties on the market are listed as "offers over" or "price over" an amount set. When there is more than one potential buyer, the seller sets a "closing date" on which, offers from all the bidders are submitted in the form of first price sealed bid auction, and the highest offer tends to be accepted[2]. Gibb (1992) suggests that through uncertainties and opportunities created by this sealed bid system, sellers can capture economic rent. This is also supported by game theory which indicates that sealed bid auctions favour sellers in a strong market where the number of potential

[2] Sellers may also consider other conditions of the offer, such as proposed entry date.

bidders is relatively large, and bidders are likely to be "risk averse"[3]. However, this system could be viewed as an "unethical system" from a buyer's perspective mainly because it leaves estate agents open to accusations of setting artificially low asking prices to create fictitious competition, leading people who cannot afford the property paying for surveys.

In 2008, a new regulation - the Home Report was introduced to the Scottish housing market. By law, dwellings[4] listed on the market from the 1st December 2008 are required to have a Home Report undertaken. This report consists of a Single Survey, an energy report and a questionnaire. The Single Survey is a level 2 Homebuyers Survey and Valuation (HSV) equivalent survey[5], which includes a valuation. It should be highlighted that many mortgage lenders accept this valuation as the collateral value of the property. Sellers are responsible for the cost of the home Report, and any potential buyer can access the report via selling agents and property solicitor centres free of charge.

The scheme was introduced with three overarching objectives. The government believed that the scheme would improve housing market stability by providing the essential information about the properties to the buyers. However, this was met with concerns pertaining to the upfront cost of the scheme and also in relation to potential conflict of interests in the sense that "*the surveyor must produce a report that will be used by both the seller and buyer, two parties that have opposing interests in the property transaction – particularly in regards to the valuation and the repair categories*" (Black, et al. 2015:5).

The government's five-year review of the scheme included both a public consultation[6] and a research study[7] where all three objectives of Home Report were evaluated. Whilst the public consultation found that the majority of the respondents considered the scheme to be an improvement, it did still highlight concerns regarding the setting of unrealistic asking prices. Indeed, the findings indicated that while the valuation helped prevent the

[3] Bidders being risk averse refers to the fear of not being able to win the auction.
[4] This includes all private properties listed in the market, excluding "right to buy" properties, and some of the new developments.
[5]According to Royal Institute of Charter Surveyors (RICS), level 2 HSV shows the condition of the property, and includes a market valuation and insurance rebuild costs. It also provides guidance to legal advisors and advice on defects that may affect the value of the property such as repairs, and ongoing maintenance.
[6] Chartered surveyors, legal profession and estate agent respondents, local authorities, construction industry respondents, consumer, advice & campaign groups and property management, maintenance and conservation respondents were consulted.
[7] The research study surveyed 928 households in Scotland.

occurrence of artificially low asking price (to a certain degree), it is less useful in doing so in a rising market (Robertson & Blair, 2014). That said, the research study also suggested that relatively poorer market conditions could also have contributed in addressing the issue of artificially low asking prices (Black, et al. 2015). Further, the findings of the government's five-year review of the Home Report is based on both qualitative data and descriptive analysis. In this regard, it acknowledges but fails to control for the effect of changes in market conditions on pricing behaviours. With the use of a rich set of market transaction data for a specific case study area, North East Scotland, this paper complements the government review by providing further quantitative evidence on the effectiveness of the policy objective in relation to price setting in the housing market.

Previous research has theoretically and empirically corroborated that the choice of real estate marketing system in a given locality is indeed primarily dependent on the degree of variation in buyer search cost as well as seller holding cost (Quan 2002), information asymmetries between the contracting parties and their respective levels of risk aversion (McAfee and McMillan, 1987). Alternative forms of real estate pricing arrangements exist in other regions of the U.K. and elsewhere with the fixed-price system being the most commonly adopted in England, Wales and Northern Ireland. The fixed-price mechanism requires the seller to publicly disclose his reservation price whilst prospective buyers compete for the property on a first-come-first-serve basis. The fixed price essentially serves as a limit on the offers that the seller receives, which provides a greater degree of certainty for the willing buyers over the maximum price they will have to pay for the home (Buschbom et al., 2018). Gan (2013) attributes the adoption of the fixed price system to the loss-averse nature of the seller as choosing a fixed price virtually implies revealing a strong market signal to sell the property, particularly when the seller is under financial pressure to release capital tied up in the current property to, for example, buy another property. In the United States, residential property transactions are done mainly through direct negotiation whereby the seller and the prospective buyer have to bargain over the price in a series of offers and counter-offers. Usually, the process is conducted with the professional assistance of their property brokers or agents to reconciliate differences and reduce search cost and information asymmetries between the parties concerned.

3. Seller's pricing strategy in the Scottish housing market

In most housing markets, asking prices are typically set by agreement between the seller and the acting agent. This is determined according to knowledge of the acquisition price, the costs of improvements and maintenance, housing attributes, and the selling prices of similar properties nearby. Selling agents have insightful local market knowledge and more

comprehensive information and data on recent transactions, based on which they advise their clients on a pricing strategy. As highlighted by Thanos and White (2014), asking prices are therefore set according to the strategic behaviour of sellers with private values, as well as a perception of the "common value" element in the market advised by selling agents – the "expert advice".

Search model analysis as proffered by Yavas and Yang (1995:366) argues that asking price serves as a signalling function "*that maps the listing price to the seller's valuation of the property*". This implies that a lower asking price signals that the seller might accept a lower price, therefore increases the probability of sale and increases the expected selling price through this channel (Horowitz 1992; Yavas & Yang, 1995; Pryce, 2011). However, in a market where the asking price serves as a ceiling price, a lower asking price also reduces the upper end of the potential bids distribution, thus reduces the expected sale price (Horowitz 1992; Yavas & Yang, 1995). Consequently, sellers in such markets often face a trade-off between the time on the market (selling quickly) and achieving a higher sales price.

In the Scottish housing market, the "price over" asking price is not a ceiling price, the common "expert advice", certainly prior to the introduction of the Home Report, was to set an asking price below that of the expected selling price to achieve a high price (Levin and Pryce, 2007). In a sense, the "price over" amount is equivalent to a starting price in a conventional auction. There are two conflicting theories regarding the influence of starting price in auctions. The first suggests that a low starting price reduces the barrier to an auction, therefore increases the number of potential bidders (Ariely and Simonson, 2003; Kamins et al., 2004; Simonson and Ariely, 2005). This auction theory suggests that the optimal bid from each bidder in a sealed price auction rises as the number of bidders increases under both the "private value" and "common value" models[8], implying that a higher selling price is expected with greater number of bidders (Wilson, 1997; Laffont, 1996).

[8] It is worth noting that auction theories tend to distinguish between two models that make assumptions on the information possessed by participants concerning the valuation of the auction subject in question, namely the "independent private value" and "common value" models. With the independent private value model, each bidder is assumed to have his own valuation and different realisations of the value of the auction subject (Paarsch and Hong, 2006). Knowing other bidders' valuations will not change the bidder valuation. In a "common value" model, the actual value is the same for all bidders. Bulow and Klemperer (2002) suggest that a house's value has both elements, but due to complicity, housing auctions are normally modelled under either value.

Indeed, Ooi et al. (2006) illustrate such relationships in a theoretical model based on "private value", and also provide empirical evidence that supports the theoretical analysis using sealed price auction data on land transactions in Singapore. Equally, research undertaken by Levin and Pryce (2007) employed a simulation model based on a hypothetical database of 30,000 house valuations in the Scottish "price over" system. Their results found that the probability of extreme bids (high selling price) increased from over 5% to 18% when the number of bidders rises from 1 to 4. This confirms that the setting of low asking prices to attract bidders in the Scottish offers over system therefore seems to be a logical strategy.

Arguably, the winning bid is also influenced by bidders' risk aversion, in a sealed bid environment. Risk aversion does not alter bidder's behaviour in an open auction, because they, in theory, will stop bidding if the reservation price is reached[9]. However, in a sealed auction, a risk averse bidder (who has the fear of losing) may also be willing to pay a premium – in the form of a higher bid – for the insurance of winning (Maskin and Riley, 1985)[10]. As Pryce (2011) contends, this provides an explanation for the supposed popularity of the offers over system during market upswings, as buyers are more "desperate" to buy: dwellings are selling relatively fast, and buyers face higher opportunity costs to viewing as the probability of viewed dwellings being sold to other buyers increase. By setting low asking price, the seller increases the probability of viewings, thereby increases the probability of a viewer submitting a bid due to the risk of not finding a better alternative during his search period.

An alternative theory regarding starting price is that the initial price represents what Tversky and Kahenamn (1974) describe as an anchor. More specifically, a low starting price would indicate a low value and result in fewer bidders and a low(er) winning bid (Ariely and Simonson. 2003). Empirical studies examining this concept have tended to find mixed effects of starting price on the final winning bid in online English auctions (Ariely and Simonson, 2003; Lucking-Reiley et al., 2007). However, there has been limited analysis of starting price in sealed bid real estate auctions. It is important to note that the influence of starting price on the final selling price in an auction is likely to diminish if salient reference prices are available (Ariely and Simonson, 2003). For example, if consumers have a well-

[9] Ignoring irrational exuberance.
[10] see Maskin and Riley, 1985 for a full discussion of their theoretical model for this argument.

established reference price for an auctioned subject, the starting price may have relatively small effect on the final price. This may explain the rationale of using methods such as those adopted in the Home Report to address the problems associated with the setting of artificially low asking prices. The fundamental change with the scheme is that the Home Report Valuation acts as a "price marker" for buyers and is often used in negotiation over price (Black et al., 2015). Since the valuation serves as the reference price, it is more likely to serve the "signalling function" of seller's reservation price. Importantly, it also indicates the collateral value for mortgage purposes, therefore reduces the level of uncertainty for the buyers. With all these respects, the valuation is likely to determine the potential bids distribution, and there is less incentive for the sellers to set an asking price that derives hugely from the valuation. Arguably, the effect of the Home Report scheme is that the "price over" asking price has become more correlated to valuations, which are normally obtained through the comparable method using market transactions of recently sold nearby properties.

Based on the discussion above, we posit, firstly, that spatial autocorrelation in asking prices to selling price of properties in proximity should have increased since the implementation of the Home report as property prices are determined, to a large degree, on the basis of values of nearby properties. Empirically testing this proposition serves to establish whether the Home Report has achieved its objectives in relation to market transparency on one hand and inform future policy decisions on the other. Secondly, along the same line of logic, it is surmised that the Home Report should have reduced the difference between the asking price and the underlying value of the subject property given an increased level of transparency in the property price discovery process. The degree of such price deviation, we conjecture, should be dependent to the neighbourhood characteristic as well as property-level attributes. Therefore, this paper sets out to test the following three hypotheses in relation to the determination of asking prices of properties in Scotland:

Hypothesis 1 (H1): since the introduction of the Home Report, spatial autocorrelation in asking prices to selling price of nearby properties has become more pronounced; and

Hypothesis 2 (H2): the introduction of the Home Report has reduced the deviation of asking price from the underlying value of the property.

By testing the above hypotheses with market transactions data pre- and post- introduction of the Scheme, we should be able to empirically corroborate whether, and to what extent, the Home Report Scheme has achieved its stated objectives, and whether the property market has become more informationally efficient in terms of pricing.

4. Data

Transaction data on private residential properties from Aberdeen Solicitors Property Centre (ASPC)[11] was obtained on the basis of the non-disclosure agreement between University of Aberdeen and ASPC. The dataset covers the housing market in Aberdeen and Aberdeenshire (Figure 1)[12], and contains information on the physical attributes of the property, information on asking and selling prices, listing dates, transaction dates, and the method of sales.

[insert figure 1 here]

While the dataset commences in 1984, this study focuses on the time period between the second quarter of 1998 and the second quarter of 2013. This is due to the availability of geographical coordinates that are used in the analysis. In total, there are 79,648 observations in the data from (Q2 1998 to Q2 2013), 90% of which are successful transactions, with less than 10% of these properties withdrawn from ASPC without being sold. In total, 70,642 observations are used in the empirical modelling stage (Section 5), due to missing and incomplete variables. Table 1 provides a summary of the variables included in the empirical analysis and their descriptions.

[insert Table 1]

During the time period, over 82% of the properties in the dataset were marketed as “price over”, whereas “fixed price” dominates the remaining 18% of the sample. The proportion of properties marketed as “price over” varies according to market conditions, ranging from 60% in the late 1990s to over 90% in mid 2000s. Following the 2008 Global Financial Crisis, the

[11] ASPC was the first Solicitors Property Centre established in the UK, and serves as a central marketing place for residential properties and small commercial properties in the region. Approximately 90% of private residential properties in North East Scotland are marketed through ASPC.

[12] The map of Aberdeen Housing Market defined by local authorities is presented in Figure 1, it covers Aberdeen city local authority jurisdiction as well the commuting towns in Aberdeenshire.

market witnessed a reduction of properties marketed as "price over", however the popularity of this selling mechanism started to increase again in 2010, symbolic of the start of the market recovery phase. By 2013, 87% of properties in Aberdeen were marketed as "price over".

Since the valuations of the properties are not available in the dataset[13], a limitation of the research is that we cannot directly observe how asking price is set relative to the valuation of the market. The asking-selling price spread - "price premium", is calculated as a percentage difference between the transaction price and the asking price[14] for each quarter for both "price over" transactions and "fixed price" transactions. Figure 2 shows the average deflated house price with reference to the vertical axis, the average price premium for "price over" transactions and "fixed price" transactions with reference to the left hand side vertical axis during the time period. The average house price is affected by both national and local oil and gas dominated economic conditions.

[insert figure 2 here]

It is evident that fluctuations in "price over" premiums are much more pronounced in the time series, with an average of around 6% observed in the late 1990s and early 2000s, and over 40% in the second quarter of 2007. These changes undoubtedly reflect the market upturn witnessed across most, if not all, advanced economies caused by financialisation and macroeconomic conditions. Notably, the very large premiums between 2006 and early 2008 are not due to a few extreme values in the sample. This is in line with the explanations on market conditions' influence on pricing strategy discussed in the previous section.

The signs of subprime mortgage crisis started in the second quarter of 2007, during which time, both house prices and offers over premiums peaked. The decreases of average house price commenced from Q3 2007, which was accompanied by a decline in price premiums. Nevertheless, "price over" premiums were still relatively large throughout the first three quarters of 2008. Notably, the first quarter of 2009, shortly after the introduction of the Home Report with observed price premiums for "price over" transactions reducing

[13] Before the introduction of the Home Report, valuations are instructed by buyers, and often multiple valuations were carried for the same properties by different buyers, such information was not recorded by ASPC.

[14] Price premium = (sold price – asking price) / asking price

significantly to below 5% on average. Although the average house price also experienced a decrease simultaneously, the price decline was relatively insignificant. The average price premium for properties sold as "fixed price" on the other hand shows much less variation throughout the property cycle. Indeed, Figure 1 suggests that although market conditions play an important role in determining "price over" premiums, given the relatively high average price in Aberdeen post-GFC, there may be other forces that fundamentally changed the way in which the "price over" mechanism works.

5. Methodology and development of empirical models

Since the seminal work of Rosen (1974), there has been a broad consensus in the real estate literature that the hedonic valuation method provides a reliable and robust analytical environment to model property prices. The model is designed to predict or explain property market value using equations that accounts for variation in historical transaction prices as a function of different housing attributes. Nonetheless, the traditional hedonic approach does not explicitly take the locations and/or other spatial characteristics of the dwellings into consideration, which often results in inefficient estimation and biased inference due to the presence of spatially autocorrelated errors (Dubin et al., 1999). In light of this, the spatial lag hedonic valuation method (SLM) developed by Can (1992 and 1997) is utilised in this study to ascertain the degree of impact of the Home Report on property prices in Scotland. Generally speaking, a spatial lag model assumes that the transaction price of a dwelling at any given point in time can be expressed as a function of not only its structural attributes and the quality of the neighbourhood but also price effects from prior transactions within its close proximity. Hence, there should be a functional inter-relationship between the sales price of the subject dwelling and the prior transaction prices of other dwellings within its neighbourhood. In practice, these price effects are acknowledged and injected by the traders and valuers in the property market through "the comparable-sales" valuation method to estimate real estate prices (Can (1997) and Wong et al. (2013)). Indeed, spatial lag hedonic modelling techniques have been extensively employed in the literature to investigate real estate issues and problems. Examples include Kim et al. (2003) and McCord et al. (2018) who examine the relationship between residential property market and air pollution; McCord et al. (2019) who confirms an empirical linkage between energy performance certificate and property value; Haider and Miller (2000) who explores the effect of transportation infrastructure on residential property prices; Li and Joh (2016) who studies the synergistic economic benefit of enhancing bikeability and public transit accessibility with respect to real estate prices in an urban setting; and more recently, Barreca et al. (2020) who assesses how the real estate market is influenced by the level of

urban vibrancy. In the following sub-sections, we develop a number of spatial lag hedonic models to test the hypotheses formulated in Section 3.

Testing H1

To test H1, we start with the following hedonic equation:

$$lnP_{i,t} = c + \sum_{k=1}^{K} \beta_k S_k + \delta \sum_{k=1}^{n} W_{i,j} lnP_{j,t-h} + \varepsilon \quad \text{..... (Equation 1)}$$

$$with\ i \neq j$$

where $P_{i,t}$ is the asking price of property i at time t; c is a constant term; S_k is a bundle of structural characteristics of the subject property described in Table 1. β_k is the implicit price for the corresponding S_k. Since it is conjectured that sellers also use evidence of recently sold nearby properties when they set asking price, asking price is therefore expected to correlate with nearby properties transaction prices. To account for such pricing behaviour, a spatiotemporal term $\sum_{k=1}^{n} W_{i,j} lnP_{j,t-h}$ is included in the equation. $P_{j,t-h}$ is the actual transaction price of property j at time t-h, with $h = 2\ months$[15], $W_{i,j}$ is a spatial weight that reflects the degree as well as the structure of spatial proximity between properties i and j. Mathematically, $W_{i,j}$ can take one of the following forms:

$$W_{i,j} = \frac{1}{d_{i,j}} \quad \text{.....(Equation 1.1)}$$

$$W_{i,j} = \frac{1}{d_{i,j}^2} \quad \text{.....(Equation 1.2)}$$

$$W_{i,j} = \frac{1}{e_{i,j}^d} \quad \text{.....(Equation 1.3)}$$

where $d_{i,j}$ denotes the Euclidean distance measured in meter between property i and j; $W_{i,j}$ is so constructed since it is reasonable to assume that sellers would place heavier weight on more proximate properties in setting property price. The most typical measures (see Cliff and Ord, 1981, Basu, 1998 and Dublin, 1998) include inverse distances (Equation 1.1),

[15] We also used longer periods, and two months lag produced the highest spatial correlation coefficient.

inverse distances raised to some power (in Equation 1.2, we use distance-squared), and inverse exponential distance (Equation 1.3). Moreover, given that $\sum_{k=1}^{n} W_{i,j} = 1$, the spatial autoregressive term $W_{i,j} lnP_{j,t-h}$ suggests a weighted average of spatially lagged price information. The parameter δ therefore can indicate the degree to which sellers extract price information from prior sales to ascertain asking prices, and hence H1 can be tested. If past information is relevant and applicable, δ should be non-zero and statistically significant. In other words, housing prices are spatially auto-correlated. Finally, $\varepsilon_{i,t}$ is an error term that measures the effects stemming from missing variables, misspecification of the model, measurement errors and inadequate sampling. This specification essentially assumes a linear functional form and fixed parameters.

It must also be highlighted that while neighbourhood attributes are commonly employed and explicitly measured in a typical hedonic model, they are intentionally left out in our analysis. We surmise that the inclusion of $\mathrm{W_{i,j}} ln\mathrm{P_{j,t-h}}$ can indeed capture a set of neighborhood features pertaining to the socioeconomic and physical make-up of the neighbourhood and accessibility to various urban services and amenities. In addition, variables that are normally used to control for market conditions are not included in Equation (1) for the same reason. The omission of such variables should thus avoid potential statistical nuisances associated with over-specification of our models.

In addition to the spatial autoregressive variable, a dummy variable, $Withdrawn$, is included in the hedonic equation to explicitly discern properties that are withdrawn from the market after listing. Modifications of the equation yields Equation (2) below:

$$ln\mathrm{P_{i,t}} = \mathrm{c} + \delta \sum_{k=1}^{n} \mathrm{W_{i,j}} ln\mathrm{P_{j,t-h}} + \sum_{k=1}^{K} \beta_k \mathrm{S_k} + \lambda Withdrawn + \varepsilon$$

.....(Equation 2)

where $Withdrawn$ takes the value 1 if the property is withdrawn from the market, and 0 otherwise; and λ is coefficients to be estimated. It is expected that overpriced properties are more likely to experience difficulties to sell, some of which may even be withdrawn from the market.

To test H1, which is deduced from the proposition that sellers have become more prone to infer asking prices based on actual prices of nearby recently transacted properties since the introduction of the Home Report Scheme, thereby increasing the spatial autocorrelation in the property prices, Equation (2) is thus modified by including a dummy variable, Dec_{2008}. The variable is designed to interact with $\mathrm{W_{i,j}} ln \mathrm{P_{j,t-h}}$. Dec_{2008} has a value of 1 if the observation occurs on or after 1st December 2008, and 0 otherwise. Accordingly, we develop Equation (3) as follows:

$$ln\mathrm{P_{i,t}} = \mathrm{c} + \rho\, Dec_{2008} \times \sum_{\mathrm{k}=1}^{\mathrm{n}} \mathrm{W_{i,j}} ln \mathrm{P_{j,t-h}} + \delta \sum_{\mathrm{k}=1}^{\mathrm{n}} \mathrm{W_{i,j}} ln \mathrm{P_{j,t-h}} + \sum_{\mathrm{k}=1}^{\mathrm{K}} \beta_{\mathrm{k}} \mathrm{S_k} + \lambda Withdrawn + \varepsilon$$

$$with\ i \neq j \ldots\ldots \text{(Equation 3)}$$

The coefficient of ρ is expected to be positive and statistically significant, if sellers have indeed given more weight to nearby transactions when they set asking prices for the subject properties since the introduction of the Home Report. In other words, we should observe a stronger spatial autocorrelation between asking prices and nearby transaction prices after the scheme came into effect.

Testing H2

The second hypothesis formulated in this paper tests whether there is a reduction in deviation between asking price and the "value" of the property after the implementation of the scheme. More specifically, it tests whether potential house sellers are less inclined to market their properties by setting an unrealistically low asking price relative to the properties' potential market value after December 2008. To measure the degree of such pricing deviation, $Dev_{i,t}$[16] is used:

$$Dev_i = \frac{P_i^A}{P_i^E} \quad \ldots\ldots \text{(Equation 4)}$$

where P_i^A is the actual asking price of property i, and P_i^E is the estimated value of the property obtained from the following equation:

$$ln P'_{i,t} = \mathrm{c} + \delta \sum_{\mathrm{k}=1}^{\mathrm{n}} \mathrm{W_{i,j}} ln \mathrm{P_{j,t-h}} + \sum_{\mathrm{k}=1}^{\mathrm{K}} \beta_{\mathrm{k}} \mathrm{S_k} + \varepsilon$$

[16] This follows the concept of degree of overpricing in Kang and Garder (1989); Yavas and Yang (1995); Donald et al (1996); Anglin et al (2003); and Pryce (2011). Seller's pricing strategy is presented by an asking price relative to the value of the property.

$$with\ i \neq j \ldots\ldots \text{(Equation 5)}$$

Where $\mathrm{P}'_{\mathrm{i,t}}$ is the sale price of property i at time t. P_i^E is the fitted value of $\mathrm{P}'_{\mathrm{i,t}}$ for each dwelling obtained by estimating Equation (5).

We further posit that $\mathrm{Dev}_{\mathrm{i,t}}$ is a function of the structural variable $\mathrm{S_k}$, since sellers are expected to have better knowledge of the quality of the property, and their pricing strategy should reflect this accordingly. Pryce (2011) argues that the asking-selling price spread is likely to contain a locational convention γ_k^* (i.e. neighbourhoods may have implicit conventions on asking-selling price spread). However, γ_k^* is not directly observable in the dataset, we therefore use the standard deviation of the actual asking-selling price spread $\sigma_{i,k}$ within the neighbourhood k as a proxy for the locational convention:

$$\sigma_{i,\,k} = SD(Dev_k) \ldots\ldots \text{(Equation 6)}$$

Neighbourhood k is defined as a 3-kilometre radius circle[17] centred at property i. In addition, we only consider transactions that occur within the past two months prior to the sale of property i when computing $\sigma_{i,k}$. One would expect that within a neighbourhood k, if the standard deviation of asking-selling price spread $\sigma_{\gamma ik}$ is small, there is likely to be a "locational convention". On the other hand, if the variation in the asking-selling price spread is large, the evidence of locational convention γ_k^* should be less apparent. To test this, Equation (7) is constructed. $\sigma_{i,\,k}$ is expected to have a significant effect on $Dev_{i,t}$ and ω should be negative and statistically significant. Furthermore, it has been established that market conditions also play an important role in price setting (Pryce, 2011), hence, we posit that T, a time dummy variable (with a coefficient φ to be estimated) measured on a monthly basis, should affect $Dev_{i,t}$:

$$lnDev_{i,t} = \mathrm{c} + \sum_{\mathrm{k}=1}^{\mathrm{K}} \beta_{\mathrm{k}} \mathrm{S_k} + \omega\sigma_{i,\,k} + \varphi \mathrm{T} + \varepsilon \ldots\ldots \text{(Equation 7)}$$

Lastly, Dec_{2008} is added to Equation (8) to test H2. We believe that the Home Report should have a market-wide impact on how sellers set their initial prices. In particular, the practice of setting artificially low asking prices to draw more potential house buyers to bid will cease to a large extent. Accordingly, we re-write Equation (7) as follows:

$$lnDev_{i,t} = \mathrm{c} + \Omega Dec_{2008} + \sum_{\mathrm{k}=1}^{\mathrm{K}} \beta_{\mathrm{k}} \mathrm{S_k} + \omega\sigma_{i,\,k} + \varphi \mathrm{T} + \varepsilon \ldots\ldots \text{(Equation 8)}$$

Ω is expected to be positive and statistically significant.

We estimate the equations using Ordinary Least Squares (OLS) methods. Our models are designed in such a way that only past events can exert influence on current events but not vice versa. This can largely avoid statistical inference problems such as endogeneitiy in the

[17] The choice of the size of neighbourhood k is not arbitrarily determined. Indeed, the size of Aberdeen city (including Old Aberdeen) is roughly equal to that of a 3-km radius circle.

spatial lag terms. Provided that the error terms of the equations are independent and identically distributed, the OLS estimator will be asymptotically efficient and consistent. The summary statistics of the variables are shown in Table 2.

[Insert Table 2 here]

6. Regression results and discussions

Results for H1

Table 3 presents the regression results for Equation (1) to (3) using the three specifications of spatial weight respectively. The p-value for each variable is given in brackets. The last three rows of the table display the R-squared, adjusted R-squared and F-statistics of the models.

[Insert Tables 3 here]

Most coefficients estimated using Equation (1) in all three measures of spatial weight show the expected signs and are statistically significant at the 1% level. For example, sellers are prone to demand a higher price for qualities such as extra bedrooms, public rooms, bathrooms, central heating, garage(s), double glazing, and cloak room (WC). New properties also tend to fetch ~~have~~ a higher asking price. Dummy variable $Garden$ yields negative coefficients with all three spatial weighting specifications, which seems to be counter-intuitive. However, these coefficients became statistically insignificant once the variables on selling mechanisms and withdrawn properties are specified. Overall, the results on the property-specific variables are in agreement with those in the hedonic literature (e.g. Can (1992) and McCord et al. (2018))

In regard to testing H1, which states that asking prices are assumed to be spatially linked to prices of nearby properties sold within the previous two months. We observe that the coefficients of the spatial lag term, δ, are 0.0339, 0.1599, and 0.1131 respectively under that three different spatial specifications, and is statistically significant at the 1% level. This confirms our view that the housing prices are spatially auto-correlated. Of significance is the positive sign of the coefficient, which implies that house prices seem to move in tandem with one another: a higher (*lower*) price of a neighbouring property will generally result in a higher (*lower*) asking price of the subject property. Indeed, the findings echo Can (1997), which reveals spatial spillover/adjacency effect of absolute property prices arising from prior sales within an immediate neighbourhood via a practice of “comparable-sales”. Interestingly, the effect of $\mathrm{W_{i,j}}ln\mathrm{P_{j,t-h}}$ are very different across the three specifications with the size the magnitude of the variable appearing to be larger when non-liner measures (as in Equation 1.2 and Equation 1.3) are employed. In sum, the models achieve an explanatory power of around 50%.

As a modification of Equation (1), Equation (2) is designed to examine how properties that are withdrawn from the market are priced differently by the sellers. The coefficients on Withdrawn, significant at the 1% level, range from 0.1390 to 0.1769 across the three spatial weight specifications, suggesting that this category of properties tend to be priced 15%-19% higher than the others, *ceteris paribus*. We surmise the fact that the properties are overpriced relative to other properties on the market could be a reason why they are withdrawn.

Equation (3) incorporates an interaction term, $Dec_{2008} \times \mathrm{W_{i,j}} ln \mathrm{P_{j,t-h}}$, to the model, which is designed to examine whether property sellers rely more on prior sales from the neighbourhood in ascertaining asking prices after the inception of the Home Report scheme. We find that the coefficients on the interaction term with all three specifications are around 0.05 and significant at the 1% level. This confirms our belief that after December 2008, asking prices are more spatially dependent on nearby sale prices by virtue of the price discovery process of the sellers given a more informationally efficient housing market. Hence, the Home Report might have increased the overall transparency of the market.

Results for H2

Equation (7) is formulated to investigate the determinants of pricing strategy, which is measured as the asking price relative to the estimated value derived from our hedonic model. Equation (8) further incorporates a dummy variable that ~~indicates~~ represents the introduction of the Home Report to test H2. Table 4 depicts the regressions results for H2 under the three spatial weighting specifications.

[insert Table 4]

Examining the results for Equation (7), locational convention measure $\sigma_{i,k}$ yields negative and significant coefficients with Equation (1.2) and (1.3) specifications. This is in line with our expectation that in a neighbourhood where there is a higher variation in the asking-selling price spread, the effect of locational convention should be less apparent with sellers being more likely to set asking prices that diverge more from the underlying values. The results also reveal that some housing attributes exhibit statistically significant effect on the dependent variable, suggesting that sellers do consider certain housing attributes such as number of bedrooms and heating systems when pricing their properties.

Lastly, Dec_{2008} is incorporated to Equation (8) to test H2. Its coefficient is 0.0523, 0.0274, 0.0397 under the three spatial weight specifications (1.1), (1.2), ~~,~~ and (1.3) respectively. In all three cases, the coefficients are significant at the 1% level. Mathematically, it can be interpreted that there is a reduction in asking price valuation deviation. More precisely ~~specifically~~, the ratio between asking price and the value of the property is 3%-5% closer to 1. This suggests that the marketing strategies employed to set unrealistically low asking

prices by the sellers have become less evidenced since the introduction of the Home Report scheme, however, the magnitude of such effect is relatively small.

In terms of R-squared and adjusted R-squared, our models achieve an explanatory power of around 40% for all the three spatial weight specifications. The estimation is marginally improved when location convention measure is taken into consideration. One might argue that the relatively low R-square could undermine the validity of the findings of the study. However, the main emphasis of this paper is on whether the Scheme affects the way sellers determine asking prices, *not* on the discovery of various determinants of valuation deviation of real estate price formation. Therefore, it should be highlighted that only the improvement of R-square, as well as the signs and statistical significance of the variables of interest in the models that are of crucial relevance to our research.

As a robustness test, we generate Equation (9) by discarding all statistically insignificant structural variables with p-value below 1% in Equation (8). It is shown that the results are highly consistent with those of the other models. For instance, the model using $1/d_{i,j}$as spatial weight (with *Floor* and the property type variables removed) suggests a reduced level of asking price deviation *post-2008*, given that the coefficient on Dec_{2008} is positive and statistically significant at the 1% level. The model produces an adjusted R-squared of 0.4431, which is comparable to that of the original model. Similar findings are observed in the model using the spatial specification of inverse exponential distances (with *Garden, Floor* and the property type variables discarded) in terms of the signs and statistical significance of Dec_{2008} and other hedonic attributes.

7. Concluding Remarks

This paper investigates how property sellers determine asking prices in response to a change in government policy with the use of a large number of real estate transactions in the North East of Scotland. By subjecting the analysis in an information search context and in a hedonic setting that explicitly incorporates a spatial process of price discovery using spatial lag modelling techniques and controls for a large number of housing attributes (i.e. to test H1), we find strong *prima facie* evidence that property sellers have become more prone to rely on prior sales to establish asking prices since the introduction of a new government policy, namely the Home Report , as indicated by an elevated level of spatial autocorrelation in the sample house prices across all statistical models examined. The once-common practice of setting artificially low asking price ~~with the aim~~ to attract buyers seems to have dwindled to a certain extent. In other words, after the Scheme came into effect, real estate sellers seem to have set prices on a basis that is more closely in line with the general market conditions and the underlying value of property. The results of testing H2 in our analysis, which compares price divergence pre- and post- 2008 ~~2018~~, further confirms this conjecture. More specifically, our statistical models reveal that the accuracy of property pricing has, on average, improved by a factor of 3 - 5% after the implementation of the Scheme.

A major learning outcome of this study is to provide robust evidence-based justifications for necessary government interventions to help address issues associated with market failures stemming from information asymmetry between buyers and sellers within a property market. Prior to the introduction of the Home Report, problems concerning the propensity of property sellers in Scotland artificially lowering initial asking prices were rife, placing potential buyers in a relatively weaker bargaining position. Indeed, an early investigation by Akerlof (1970) suggests that information asymmetry, which deters market participants from making mutually advantageous trade in a free enterprise economy, is particularly more widespread in markets dominated by second-hand assets such as direct real estate. This is due to the fact that sellers of second-hand homes are better informed about the quality of the dwellings than the buyers, and consequently creating an unlevel playing field when it comes to pricing. Our empirical results support the view that government should play a more active role in facilitating transactions in the real estate market by putting forward measures that counteract such information asymmetry in property pricing, ensuring a higher degree of market transparency which could result in enhanced market information efficiency and equitability that benefit not only the market players but also the society at large.

From a methodological stance, this study demonstrates how housing policies can be empirically evaluated and scrutinised in the framework of spatial hedonic price modelling, which is one of the greatest departures from the mainstream real estate literature. Existing approaches to examining institutional arrangements of housing market have been predominately normative or descriptive in nature, often producing elusive and subjective explanations, conclusions and implications that cannot be hypothesised and/or validated with empirical data. We believe that the findings and the methodology of the study yield both theoretical and practical insights into real estate price formation and modelling, which are of great use and interest to various categories of property stakeholders. For instance, the hedonic models developed in the paper demonstrate that a parsimonious model with a high degree of explanatory power could be achieved by accounting for spatially lagged pricing information through incorporating a spatial autoregressive process that reduces the number of housing attributes to be considered in the analysis, providing a justification for adopting a simple yet reliable valuation approach to conducting mass property appraisals for valuers, policy makers and other property professionals. From the perspective of property investors and property developers, the results in relation to property price deviation in Scotland presented in the study provides evidence-based explanations on how real estate prices could respond to government interference dynamically vis-a-vis the changing levels of the overall market transparency and information asymmetry resulting from the implementation of a new housing policy, which should bear implications for formulating arbitrage and trading strategies in real estate investment, as well as conducting policy evaluation in the arena of public services delivery.

Last but not least, we acknowledge that the scope of the current study is somewhat limited in terms of the amount of data explored, which only covers a cross section of the entire Scottish residential property market. We therefore contend that the current study could be further extended to incorporate comparison with other cities in the U.K. and elsewhere where different institutional arrangements in property pricing and marketing are in place.

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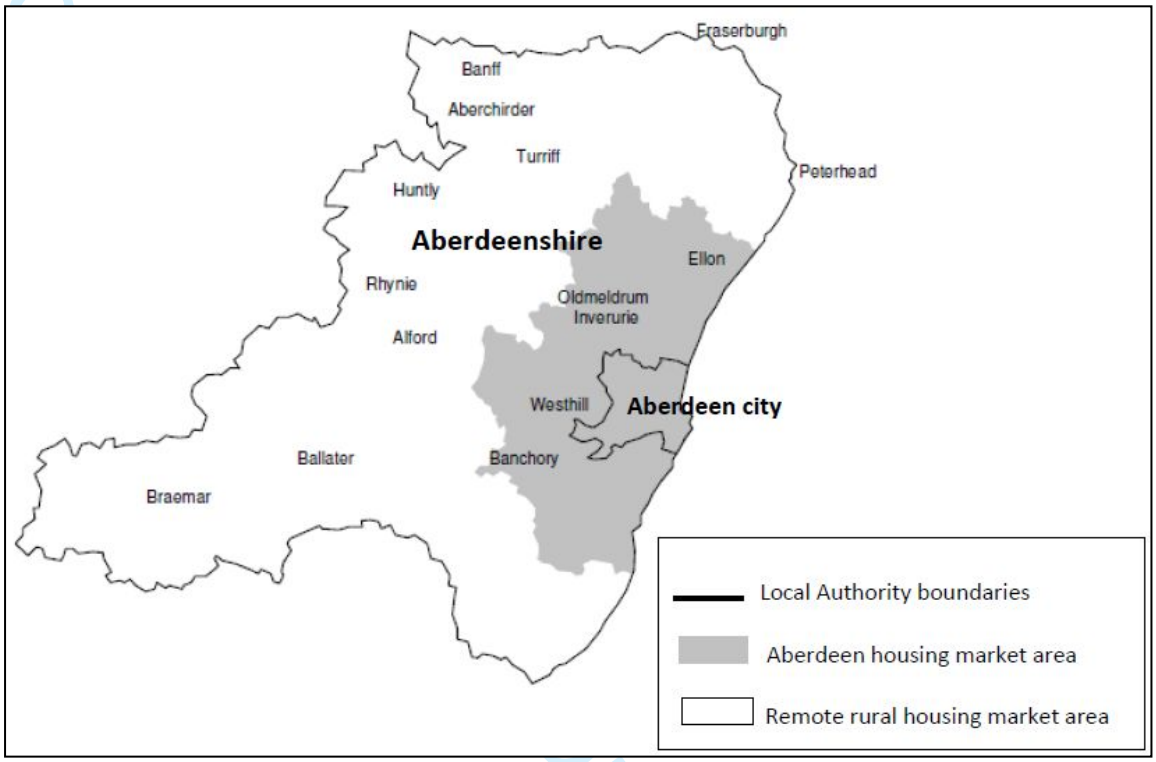
Figures and tables

Figure 1. Housing market areas of Aberdeen city and Aberdeenshire.



Source: Aberdeen City Council

Figure 2, Asking-selling price premiums and average real house price in Aberdeen housing market 1998 Q2 to 2013Q2.

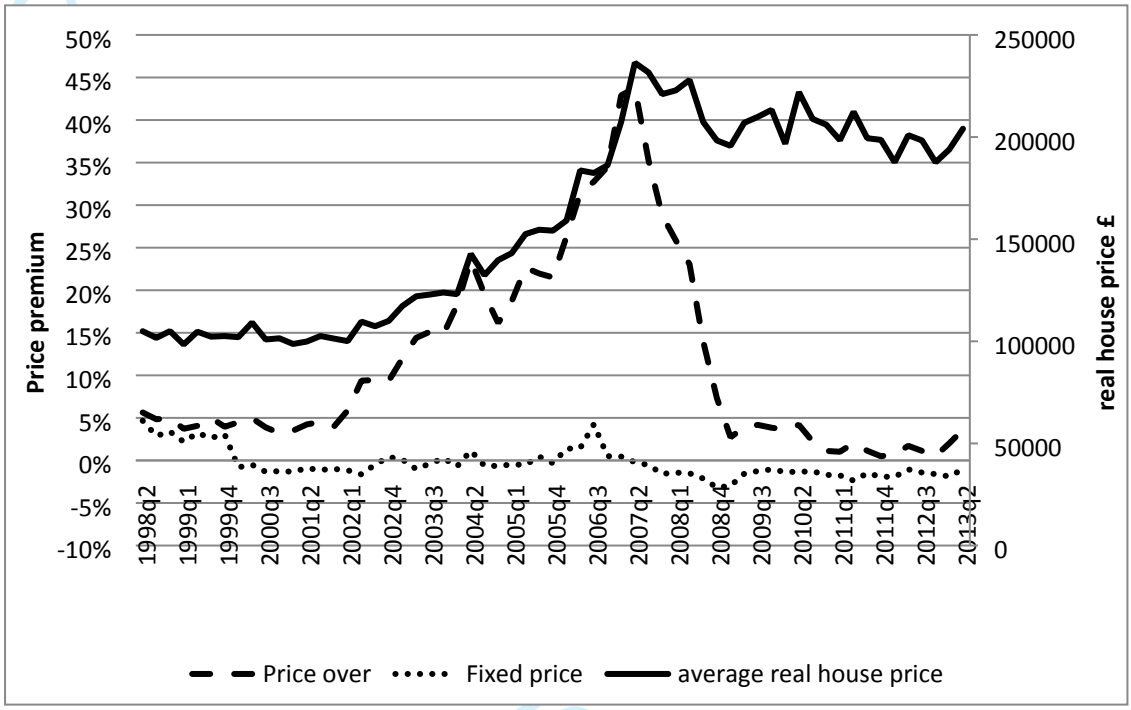


Table 1: descriptions of variables:

Variable	Description/Type
Heating type (Heating)	1 if property has central heating, =0 if property has no heating or any other form of heating
Double Glazed	1 if property has double glazing, otherwise =0
Garden	1 if property has garden(s), otherwise =0
Floor	Number of floor stories within the dwelling: 1 for flat and bungalows, 2 or more for multi-storey houses
Bathroom	Number of bathrooms.
Bedroom	Number of bedrooms
WC	Number of separate toilets/cloak rooms
Public	Number of public rooms, including kitchen, lounge, conservatory, play room, etc.
Dec_{2008}	1 if property was listed on and after December 1st 2008, otherwise =0
Garage	If a property has a garage(s)
New	1 if property is a new build, otherwise =0
Withdrawn	1 if property was withdrawn from the market, otherwise=0
Type D	1 if dwelling is detached property, otherwise=0
Type F	1 if dwelling is a flat, otherwise=0
Type N	1 if dwelling is non-detached property, otherwise=0
Dev	Ratio: the deviation between asking price and the "value" of the property after the implementation of the scheme.

Table 2: Descriptive statistics of the main variables

	Unit	Mean	Std. Dev.	Min	Max
$P_{i,t}$	GBP£	131 239	107 836	9000	3500000
$V_{i,t}$	GBP£	134 097	106 729	24077	6002596
$Dev_{i,t}$	Ratio	0.9999	0.0244	0.8320	1.3730
$SD(Dev_k)$	---	0.2761	0.0022	0.2017	0.3183
Heating	Dummy Var.	0.8128	0.3900	0	1
DoubleGlazed	Dummy Var.	0.8778	0.3274	0	1
Garden	Dummy Var.	0.5971	0.4904	0	1
Floor	Number	1.4585	0.5596	1	6
Bathroom	Number	0.9165	0.3599	0	4
Bedroom	Number	2.3297	1.1398	0	9
Garage	Number	0.3637	0.6038	0	8
WC	Number	0.1630	0.3784	0	3
Public	Number	1.4747	0.8033	0	14
Dec_{2008}	Dummy Var.	0.2450	0.4301	0	1
New	Dummy Var.	0.0058	0.0763	0	1
Withdrawn	Dummy Var.	0.0997	0.2970	0	1
Type D	Dummy Var.	0.1674	0.3733	0	1
Type F	Dummy Var.	0.5331	0.4989	0	1
Type N	Dummy Var.	0.2994	0.4580	0	1

Table 3: Regression results for Equations 1 to 3

Dependent Variable	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$
Spatial Weight	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$
Independent Variables	**Eqn 1**	**Eqn 2**	**Eqn 3**	**Eqn 1**	**Eqn 2**	**Eqn 3**	**Eqn 1**	**Eqn 2**	**Eqn 3**
$W_{i,j}P_{j,t-h}$	0.0339	0.0390	0.0220	0.1599	0.1818	0.1255	0.1131	0.1294	0.0883
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$Dec_{2008} \times W_{i,j}P_{j,t-}$	----	----	0.0534	----	----	0.0518	----	----	0.0524
			(0.0000)			(0.0000)			(0.0000)
C	10.1342	10.2254	10.2355	8.8068	8.7396	9.1640	9.2912	9.2794	9.5441
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Heating	0.1994	0.2020	0.1888	0.2013	0.2047	0.1911	0.2001	0.2033	0.1904
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DoubleGlazed	0.0247	-0.0202	-0.0245	0.0116	0.0049	-0.0349	0.0128	0.0063	-0.0341
	(0.0000)	(0.0004)	(0.0000)	(0.0419)	(0.3833)	(0.0000)	(0.0259)	(0.2687)	(0.0000)
Garden	-0.0134	-0.0059	-0.0019	-0.0053	0.0049	0.0059	-0.0154	-0.0070	-0.0031
	(0.0140)	(0.2719)	(0.6778)	(0.3172)	(0.3470)	(0.1859)	(0.0441)	(0.1861)	(0.4889)
Bedroom	0.2661	0.2648	0.2470	0.2650	0.2632	0.2460	0.2655	0.2639	0.2464
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Floor	0.0339	0.0282	0.0241	0.0308	0.0237	0.0206	0.0382	0.0323	0.0271
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bathroom	0.0215	0.0188	0.0381	0.0137	0.0096	0.0432	0.0189	0.0155	0.0394
	(0.0000)	(0.0002)	(0.0000)	(0.0063)	(0.0521)	(0.0000)	(0.0002)	(0.0018)	(0.0000)
Garage	0.0992	0.1045	0.1100	0.1038	0.1107	0.1140	0.0961	0.1017	0.1077
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
WC	0.0388	0.0350	0.0261	0.0363	0.0318	0.0240	0.0350	0.0304	0.0228
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Public	0.1406	0.1420	0.1512	0.1422	0.1439	0.1527	0.1420	0.1437	0.1527
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Type D	0.0764	0.0636	0.0837	0.0751	030596	0.0802	0.0695	0.0539	0.0764
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Type F	0.0302	0.0208	0.0368	0.0237	0.0113	0.0289	0.0475	0.0389	0.0505
	(0.0000)	(0.0035)	(0.0000)	(0.0008)	(0.1041)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
New	0.6005	0.4858	0.5309	0.5811	0.4443	0.4999	0.5825	0.4502	0.5038
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Withdrawn	----	0.1390	0.1267	----	0.1769	0.1539	----	0.1663	0.1466
		(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)
Included Obs.	70642	70642	70642	70642	70642	70642	70642	70642	70642
R^2	0.5085	0.5218	0.6600	0.5293	0.5476	0.6759	0.5229	0.5399	0.6720
$Adjusted\ R^2$	0.5084	0.5217	0.6599	0.5292	0.5475	0.6759	0.5228	0.5398	0.6719
Prob (F Stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p-values are in brackets

Table 4: Regression results for Equations 7 to 9

Dependent Variable	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$
Spatial Weight	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$
Independent Variables	**Eqn 7**	**Eqn 8**	**Eqn 9**	**Eqn 7**	**Eqn 8**	**Eqn 9**	**Eqn 7**	**Eqn 8**	**Eqn 9**
Dec_{2008}	----	0.0523	0.0522	----	0.0274	0.0272	----	0.0397	0.0395
		(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)
Locational	-0.9392	-1.2298	-1.4340	-2.1019	-2.1149	-2.1096	-1.5328	-1.5881	-1.6217
Convention	(0.1450)	(0.0562)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
C	-0.1070	-0.0504	----	0.1649	0.1530	0.1546	0.0056	-0.0036	----
	(0.5698)	(0.7888)		(0.0000)	(0.0000)	(0.0000)	(0.8679)	(0.9150)	
Heating	-0.0131	-0.0131	-0.0136	-0.0133	-0.0133	-0.0134	-0.0134	-0.0134	-0.0133
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DoubleGlazed	-0.0475	-0.0481	-0.0468	-0.0291	-0.0294	-0.0297	-0.0362	-0.0367	-0.0358
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Garden	0.0111	0.0108	0.0117	0.0018	0.0016	----	0.0053	0.0051	----
	(0.0017)	(0.0022)	(0.0000)	(0.6249)	(0.6522)		(0.1418)	(0.1581)	
Bedroom	-0.0073	-0.0075	-0.0063	-0.0064	-0.0065	-0.0036	-0.0069	-0.0070	-0.0050
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0002)	(0.0072)	(0.0001)	(0.0000)	(0.0009)
Floor	-0.0018	-0.0021	----	0.0006	0.0005	----	-0.0004	-0.0005	----
	(0.6347)	(0.5959)		(0.8862)	(0.9070)		(0.9258)	(0.8959)	
Bathroom	0.0494	0.0501	0.0505	0.0405	0.0409	0.0418	0.0440	0.0445	0.0445
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Garage	0.0169	0.0169	0.0228	0.0105	0.0105	0.0186	0.0130	0.0131	0.0198
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
WC	-0.0139	-0.0140	-0.0106	-0.0088	-0.0088	----	-0.0108	-0.0109	-0.0070
	(0.0002)	(0.0002)	(0.0037)	(0.0236)	(0.0227)		(0.0053)	(0.0050)	(0.0632)
Public	0.0065	0.0067	0.0079	0.0049	0.0049	----	0.0056	0.0057	0.0074
	(0.0010)	(0.0008)	(0.0000)	(0.0163)	(0.0148)		(0.0060)	(0.0051)	(0.0002)
Type D	0.0235	0.0237	----	0.0259	0.0261	----	0.0251	0.0253	----
	(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)	
Type F	-0.0028	-0.0034	----	0.0008	0.0005	----	-0.0003	-0.0007	----
	(0.5502)	(0.4698)		(0.8615)	(0.9099)		(0.9487)	(0.8794)	
New	-0.3389	-0.3408	-0.3390	-0.2912	-0.2923	-0.2913	-0.3094	-0.3108	-0.3105
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Included Obs.	64070	64070	64070	64070	64070	64070	64070	64070	64070
R^2	0.4435	0.4449	0.4446	0.3946	0.3950	0.3945	0.4005	0.4013	0.4009
$Adjusted\ R^2$	0.4420	0.4434	0.4431	0.3930	0.3934	0.3930	0.3988	0.3997	0.3994
Prob (F Stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p-values are in brackets

Information transparency and pricing strategy in the Scottish housing market

Abstract

Purpose: Information transparency is crucially important in price setting in real estate, particularly when information asymmetry is concerned. This paper empirically examines how a change in government policy in relation to information disclosure and transparency impacts residential real estate price discovery. Specially, we investigate how real estate traders determined asking prices in the context of the Scottish housing market before and after the implementation of the Home Report, which aimed to prevent artificially low asking prices.

Methodology/approach: The paper employs spatial lag hedonic pricing models to empirically observe how residential asking prices are determined by property sellers in response to a change in government policy that is designed to enhance market transparency. It utilises over 79,000 transaction data of the Aberdeen residential market for the period of Q2 1998 to Q2 2013 to test the models.

Findings: The empirical findings provide some novel insights in relation to the price determination within the residential market in Scotland. Our spatial lag models suggest that spatial autocorrelation in property prices has increased since the Home Report came into effect, indicating that property sellers have become more prone to infer asking prices based on prior sales of dwellings in close vicinity. The once-common practice of setting artificially low asking prices seems to have dwindled to a certain extent statistically.

Originality: The importance of understanding the relationship between information transparency and property price determination has gathered momentum over the past decade. Although spatial hedonic techniques have been extensively used to study the impact of various property- and neighbourhood-specific attributes on residential real estate market in general, surprisingly little is known about the empirical relationship between spatial autocorrelation in real estate prices and information transparency.

1. Introduction

Pricing strategy has been an important concept in both theoretical and empirical modelling of housing transactions which is envisaged to impact upon the number of bids, final transaction price and the length of time to sell a home (Kang and Garnder, 1989; Yavas and Yang, 1995; Forgey et al., 1996; Arnold, 1999; Anglin et al., 2003; Pryce, 2011, Thanos and White, 2014). Equally, the evaluation of asking prices is also important in the valuation process, where estimated market value is derived from recently transacted comparable sale prices. As such, bias in the asking prices of comparable properties can distort the market value

estimate of the subject property, which in turn could lead to a divergence between the market value estimate and the sale price (Rabianski, 1992).

It is widely accepted that there is a degree of information asymmetry in most housing markets between sellers and buyers. This occurs when sellers and their agents have better knowledge of a property's qualities and location, whereas buyers are perceived to be less well informed (Lin and Vandell, 2007; Pope, 2008; Wong et al., 2012, Nanda and Ross, 2012). This effect of the improvement in information symmetry has been examined by a number of studies (for example, Pope, 2008; Nanda and Ross, 2012). Whilst numerous studies have investigated the impact of the introduction of property condition disclosure regulations on the selling prices, more limited analysis has been undertaken to examine the potential changes in the pricing strategy of the sellers.

In Scotland, the improvement in information transparency on housing transactions was also enforced by regulations. The Home Report scheme was introduced in December 2008, requiring the seller of a residential property to provide a Single Survey, an Energy Report, and a questionnaire when listing the property on the market. The Scottish government introduced the scheme with three main objectives: to improve information about a property's condition, to address the cost and efficiency issue associated with multiple valuations and surveys, and to address the problems created by the practice of setting artificially low asking prices (Black et al. 2015). Indeed, this artificial setting of low asking prices[1] has traditionally been common practice in Scotland, especially during periods of market upturns and sustained growth. This approach whilst benefitting sellers from the uncertainty and competition among potential buyers, has been heavily and publicly criticised for leading people, who cannot afford the property, paying for surveys to be undertaken. Consequently, to evaluate the extent to which the scheme met the initial objectives, the Scottish government carried out a five-year review in 2014. The findings emanating from the review illustrated that, on first showing, the scheme appeared to be successful, nonetheless, when specifically addressing the issue relating to the

[1] The "asking price" in the "price over" (which is explained in section 2) context is not the reservation price that sellers would expect to achieve, or it is a ceiling price in many housing markets where buyers normally negotiate downward from an asking price. It acts more like a "guide price", which sends a signal to potential buyers that the seller is expecting to achieve a certain amount above of this price (Pryce, 2011).

setting artificially low asking prices, the government's review was far less conclusive on how much this is due to poorer market conditions.

Accordingly, this paper attempts to complement the government review and provide some additional evidence as to the evaluation of potential changes in pricing strategy as a result of the implementation of the Home Report scheme. In this regard, we examine the potential changes in the relationship between asking and seller's perceived reservation price and further explore the explanations for such changes using auction theories relative to the Scottish sealed bid context. Using housing transaction data pre and post the introduction of the Home Report, we empirically test whether there has been a significant statistical difference in asking price relative to the "value" of the property since the introduction of the scheme. It is believed that a better empirical understanding and conceptualisation of the underpinning price determination process and dynamics of the real estate market, as well as the effect of government policy on market transparency is of crucial significance from the viewpoints of buyers, sellers and other stakeholders. It is further posited that the study should carry implications in relation to the effectiveness of government interventions to tackle problems arising from information asymmetry in real estate pricing and enhance the overall equitability of the real estate investment environment for market participants.

The remainder of the paper is structured as follows: Section 2 discusses the background of the Scottish housing market and the rationale for the enactment of the Home Report scheme. Section 3 explores the theories relative to pricing strategy in housing auctions with Section 4 offering descriptions of the data used within the empirical analysis. Sections 5 and 6 explain the empirical modelling and provide a discussion of the empirical findings, with Section 7 drawing conclusions.

2. Background of the Scottish housing market

The Scottish housing market has some unique characteristics. The dominant selling mechanism is the "price over" system, where properties on the market are listed as "offers over" or "price over" an amount set. When there is more than one potential buyer, the seller sets a "closing date" on which, offers from all the bidders are submitted in the form of first price sealed bid auction, and the highest offer tends to be accepted[2]. Gibb (1992) suggests that through uncertainties and opportunities created by this sealed bid system, sellers can capture economic rent. This is also supported by game theory which indicates that sealed bid auctions favour sellers in a strong market where the number of potential bidders is relatively

[2] Sellers may also consider other conditions of the offer, such as proposed entry date.

large, and bidders are likely to be "risk averse"[3]. However, this system could be viewed as an "unethical system" from a buyer's perspective mainly because it leaves estate agents open to accusations of setting artificially low asking prices to create fictitious competition, leading people who cannot afford the property paying for surveys.

In 2008, a new regulation - the Home Report was introduced to the Scottish housing market. By law, dwellings[4] listed on the market from the 1st December 2008 are required to have a Home Report undertaken. This report consists of a Single Survey, an energy report and a questionnaire. The Single Survey is a level 2 Homebuyers Survey and Valuation (HSV) equivalent survey[5], which includes a valuation. It should be highlighted that many mortgage lenders accept this valuation as the collateral value of the property. Sellers are responsible for the cost of the home Report, and any potential buyer can access the report via selling agents and property solicitor centres free of charge.

The scheme was introduced with three overarching objectives. The government believed that the scheme would improve housing market stability by providing the essential information about the properties to the buyers. However, this was met with concerns pertaining to the upfront cost of the scheme and also in relation to potential conflict of interests in the sense that "*the surveyor must produce a report that will be used by both the seller and buyer, two parties that have opposing interests in the property transaction – particularly in regards to the valuation and the repair categories*" (Black, et al. 2015:5).

The government's five-year review of the scheme included both a public consultation[6] and a research study[7] where all three objectives of Home Report were evaluated. Whilst the public consultation found that the majority of the respondents considered the scheme to be an improvement, it did still highlight concerns regarding the setting of unrealistic asking prices. Indeed, the findings indicated that while the valuation helped prevent the occurrence of

[3] Bidders being risk averse refers to the fear of not being able to win the auction.
[4] This includes all private properties listed in the market, excluding "right to buy" properties, and some of the new developments.
[5] According to Royal Institute of Charter Surveyors (RICS), level 2 HSV shows the condition of the property, and includes a market valuation and insurance rebuild costs. It also provides guidance to legal advisors and advice on defects that may affect the value of the property such as repairs, and ongoing maintenance.
[6] Chartered surveyors, legal profession and estate agent respondents, local authorities, construction industry respondents, consumer, advice & campaign groups and property management, maintenance and conservation respondents were consulted.
[7] The research study surveyed 928 households in Scotland.

artificially low asking price (to a certain degree), it is less useful in doing so in a rising market (Robertson & Blair, 2014). That said, the research study also suggested that relatively poorer market conditions could also have contributed in addressing the issue of artificially low asking prices (Black, et al. 2015). Further, the findings of the government's five-year review of the Home Report is based on both qualitative data and descriptive analysis. In this regard, it acknowledges but fails to control for the effect of changes in market conditions on pricing behaviours. With the use of a rich set of market transaction data for a specific case study area, North East Scotland, this paper complements the government review by providing further quantitative evidence on the effectiveness of the policy objective in relation to price setting in the housing market.

Previous research has theoretically and empirically corroborated that the choice of real estate marketing system in a given locality is indeed primarily dependent on the degree of variation in buyer search cost as well as seller holding cost (Quan 2002), information asymmetries between the contracting parties and their respective levels of risk aversion (McAfee and McMillan, 1987). Alternative forms of real estate pricing arrangements exist in other regions of the U.K. and elsewhere with the fixed-price system being the most commonly adopted in England, Wales and Northern Ireland. The fixed-price mechanism requires the seller to publicly disclose his reservation price whilst prospective buyers compete for the property on a first-come-first-serve basis. The fixed price essentially serves as a limit on the offers that the seller receives, which provides a greater degree of certainty for the willing buyers over the maximum price they will have to pay for the home (Buschbom et al., 2018). Gan (2013) attributes the adoption of the fixed price system to the loss-averse nature of the seller as choosing a fixed price virtually implies revealing a strong market signal to sell the property, particularly when the seller is under financial pressure to release capital tied up in the current property to, for example, buy another property. In the United States, residential property transactions are done mainly through direct negotiation whereby the seller and the prospective buyer have to bargain over the price in a series of offers and counter-offers. Usually, the process is conducted with the professional assistance of their property brokers or agents to reconciliate differences and reduce search cost and information asymmetries between the parties concerned.

3. Seller's pricing strategy in the Scottish housing market

In most housing markets, asking prices are typically set by agreement between the seller and the acting agent. This is determined according to knowledge of the acquisition price, the costs of improvements and maintenance, housing attributes, and the selling prices of similar properties nearby. Selling agents have insightful local market knowledge and more

comprehensive information and data on recent transactions, based on which they advise their clients on a pricing strategy. As highlighted by Thanos and White (2014), asking prices are therefore set according to the strategic behaviour of sellers with private values, as well as a perception of the "common value" element in the market advised by selling agents – the "expert advice".

Search model analysis as proffered by Yavas and Yang (1995:366) argues that asking price serves as a signalling function "*that maps the listing price to the seller's valuation of the property*". This implies that a lower asking price signals that the seller might accept a lower price, therefore increases the probability of sale and increases the expected selling price through this channel (Horowitz 1992; Yavas & Yang, 1995; Pryce, 2011). However, in a market where the asking price serves as a ceiling price, a lower asking price also reduces the upper end of the potential bids distribution, thus reduces the expected sale price (Horowitz 1992; Yavas & Yang, 1995). Consequently, sellers in such markets often face a trade-off between the time on the market (selling quickly) and achieving a higher sales price.

In the Scottish housing market, the "price over" asking price is not a ceiling price, the common "expert advice", certainly prior to the introduction of the Home Report, was to set an asking price below that of the expected selling price to achieve a high price (Levin and Pryce, 2007). In a sense, the "price over" amount is equivalent to a starting price in a conventional auction. There are two conflicting theories regarding the influence of starting price in auctions. The first suggests that a low starting price reduces the barrier to an auction, therefore increases the number of potential bidders (Ariely and Simonson, 2003; Kamins et al., 2004; Simonson and Ariely, 2005). This auction theory suggests that the optimal bid from each bidder in a sealed price auction rises as the number of bidders increases under both the "private value" and "common value" models[8], implying that a higher selling price is expected with greater number of bidders (Wilson, 1997; Laffont, 1996). Indeed, Ooi et al. (2006) illustrate such

[8] It is worth noting that auction theories tend to distinguish between two models that make assumptions on the information possessed by participants concerning the valuation of the auction subject in question, namely the "independent private value" and "common value" models. With the independent private value model, each bidder is assumed to have his own valuation and different realisations of the value of the auction subject (Paarsch and Hong, 2006). Knowing other bidders' valuations will not change the bidder valuation. In a "common value" model, the actual value is the same for all bidders. Bulow and Klemperer (2002) suggest that a house's value has both elements, but due to complicity, housing auctions are normally modelled under either value.

relationships in a theoretical model based on "private value", and also provide empirical evidence that supports the theoretical analysis using sealed price auction data on land transactions in Singapore. Equally, research undertaken by Levin and Pryce (2007) employed a simulation model based on a hypothetical database of 30,000 house valuations in the Scottish "price over" system. Their results found that the probability of extreme bids (high selling price) increased from over 5% to 18% when the number of bidders rises from 1 to 4. This confirms that the setting of low asking prices to attract bidders in the Scottish offers over system therefore seems to be a logical strategy.

Arguably, the winning bid is also influenced by bidders' risk aversion, in a sealed bid environment. Risk aversion does not alter bidder's behaviour in an open auction, because they, in theory, will stop bidding if the reservation price is reached[9]. However, in a sealed auction, a risk averse bidder (who has the fear of losing) may also be willing to pay a premium – in the form of a higher bid – for the insurance of winning (Maskin and Riley, 1985)[10]. As Pryce (2011) contends, this provides an explanation for the supposed popularity of the offers over system during market upswings, as buyers are more "desperate" to buy: dwellings are selling relatively fast, and buyers face higher opportunity costs to viewing as the probability of viewed dwellings being sold to other buyers increase. By setting low asking price, the seller increases the probability of viewings, thereby increases the probability of a viewer submitting a bid due to the risk of not finding a better alternative during his search period.

An alternative theory regarding starting price is that the initial price represents what Tversky and Kahenamn (1974) describe as an anchor. More specifically, a low starting price would indicate a low value and result in fewer bidders and a low(er) winning bid (Ariely and Simonson. 2003). Empirical studies examining this concept have tended to find mixed effects of starting price on the final winning bid in online English auctions (Ariely and Simonson, 2003; Lucking-Reiley et al., 2007). However, there has been limited analysis of starting price in sealed bid real estate auctions. It is important to note that the influence of starting price on the final selling price in an auction is likely to diminish if salient reference prices are available (Ariely and Simonson, 2003). For example, if consumers have a well-established reference price for an auctioned subject, the starting price may have relatively small effect on the final

[9] Ignoring irrational exuberance.
[10] see Maskin and Riley, 1985 for a full discussion of their theoretical model for this argument.

price. This may explain the rationale of using methods such as those adopted in the Home Report to address the problems associated with the setting of artificially low asking prices. The fundamental change with the scheme is that the Home Report Valuation acts as a "price marker" for buyers and is often used in negotiation over price (Black et al., 2015). Since the valuation serves as the reference price, it is more likely to serve the "signalling function" of seller's reservation price. Importantly, it also indicates the collateral value for mortgage purposes, therefore reduces the level of uncertainty for the buyers. With all these respects, the valuation is likely to determine the potential bids distribution, and there is less incentive for the sellers to set an asking price that derives hugely from the valuation. Arguably, the effect of the Home Report scheme is that the "price over" asking price has become more correlated to valuations, which are normally obtained through the comparable method using market transactions of recently sold nearby properties.

Based on the discussion above, we posit, firstly, that spatial autocorrelation in asking prices to selling price of properties in proximity should have increased since the implementation of the Home report as property prices are determined, to a large degree, on the basis of values of nearby properties. Empirically testing this proposition serves to establish whether the Home Report has achieved its objectives in relation to market transparency on one hand and inform future policy decisions on the other. Secondly, along the same line of logic, it is surmised that the Home Report should have reduced the difference between the asking price and the underlying value of the subject property given an increased level of transparency in the property price discovery process. The degree of such price deviation, we conjecture, should be dependent to the neighbourhood characteristic as well as property-level attributes. Therefore, this paper sets out to test the following three hypotheses in relation to the determination of asking prices of properties in Scotland:

Hypothesis 1 (H1): since the introduction of the Home Report, spatial autocorrelation in asking prices to selling price of nearby properties has become more pronounced; and

Hypothesis 2 (H2): the introduction of the Home Report has reduced the deviation of asking price from the underlying value of the property.

~~Hypothesis 3 (H3): the degree of deviation of asking price from the value of the property is determined by neighbourhood and property attributes.~~

By testing the above three hypotheses with market transactions data pre- and post-introduction of the Scheme, we should be able to empirically corroborate whether, and to what extent, the Home Report Scheme has achieved its stated objectives, and whether the property market has become more informationally efficient in terms of pricing.

4. Data

Transaction data on private residential properties from Aberdeen Solicitors Property Centre (ASPC)[11] was obtained on the basis of the non-disclosure agreement between University of Aberdeen and ASPC. The dataset covers the housing market in Aberdeen and Aberdeenshire (Figure 1)[12], and contains information on the physical attributes of the property, information on asking and selling prices, listing dates, transaction dates, and the method of sales.

[insert figure 1 here]

While the dataset commences in 1984, this study focuses on the time period between the second quarter of 1998 and the second quarter of 2013. This is due to the availability of geographical coordinates that are used in the analysis. In total, there are 79,648 observations in the data from (Q2 1998 to Q2 2013), 90% of which are successful transactions, with less than 10% of these properties withdrawn from ASPC without being sold. In total, 70,642 observations are used in the empirical modelling stage (Section 5), due to missing and incomplete variables. Table 1 provides a summary of the variables included in the empirical analysis and their descriptions.

[insert Table 1]

During the time period, over 82% of the properties in the dataset were marketed as “price over”, whereas “fixed price” dominates the remaining 18% of the sample. The proportion of properties marketed as “price over” varies according to market conditions, ranging from 60% in the late 1990s to over 90% in mid 2000s. Following the 2008 Global Financial Crisis, the market witnessed a reduction of properties marketed as “price over”, however the popularity

[11] ASPC was the first Solicitors Property Centre established in the UK, and serves as a central marketing place for residential properties and small commercial properties in the region. Approximately 90% of private residential properties in North East Scotland are marketed through ASPC.

[12] The map of Aberdeen Housing Market defined by local authorities is presented in Figure 1, it covers Aberdeen city local authority jurisdiction as well the commuting towns in Aberdeenshire.

of this selling mechanism started to increase again in 2010, symbolic of the start of the market recovery phase. By 2013, 87% of properties in Aberdeen were marketed as "price over".

Since the valuations of the properties are not available in the dataset[13], a limitation of the research is that we cannot directly observe how asking price is set relative to the valuation of the market. The asking-selling price spread - "price premium", is calculated as a percentage difference between the transaction price and the asking price[14] for each quarter for both "price over" transactions and "fixed price" transactions. Figure 2 shows the average deflated house price with reference to the ~~right hand side~~ vertical axis, the average price premium for "price over" transactions and "fixed price" transactions with reference to the left hand side vertical axis during the time period. The average house price is affected by both national and local oil and gas dominated economic conditions.

[insert figure 2 here]

It is evident that fluctuations in "price over" premiums are much more pronounced in the time series, with an average of around 6% observed in the late 1990s and early 2000s, and over 40% in the second quarter of 2007. These changes undoubtedly reflect the market upturn witnessed across most, if not all, advanced economies caused by financialisation and macroeconomic conditions. Notably, the very large premiums between 2006 and early 2008 are not due to a few extreme values in the sample. This is in line with the explanations on market conditions' influence on pricing strategy discussed in the previous section.

The signs of subprime mortgage crisis started in the second quarter of 2007, during which time, both house prices and offers over premiums peaked. The decreases of average house price commenced from Q3 2007, which was accompanied by a decline in price premiums. Nevertheless, "price over" premiums were still relatively large throughout the first three quarters of 2008. Notably, the first quarter of 2009, shortly after the introduction of the Home Report with observed price premiums for "price over" transactions reducing significantly to below 5% on average. Although the average house price also experienced a decrease simultaneously, the price decline was relatively insignificant. The average price premium for

[13] Before the introduction of the Home Report, valuations are instructed by buyers, and often multiple valuations were carried for the same properties by different buyers, such information was not recorded by ASPC.

[14] Price premium = (sold price – asking price) / asking price

properties sold as "fixed price" on the other hand shows much less variation throughout the property cycle. Indeed, Figure 1 suggests that although market conditions play an important role in determining "price over" premiums, given the relatively high average price in Aberdeen post-GFC, there may be other forces that fundamentally changed the way in which the "price over" mechanism works.

5. Methodology and development of empirical models

Since the seminal work of Rosen (1974), there has been a broad consensus in the real estate literature that the hedonic valuation method provides a reliable and robust analytical environment to model property prices. The model is designed to predict or explain property market value using equations that accounts for variation in historical transaction prices as a function of different housing attributes. Nonetheless, the traditional hedonic approach does not explicitly take the locations and/or other spatial characteristics of the dwellings into consideration, which often results in inefficient estimation and biased inference due to the presence of spatially autocorrelated errors (Dubin et al., 1999). In light of this, the spatial lag hedonic valuation method (SLM) developed by Can (1992 and 1997) is utilised in this study to ascertain the degree of impact of the Home Report on property prices in Scotland. Generally speaking, a spatial lag model assumes that the transaction price of a dwelling at any given point in time can be expressed as a function of not only its structural attributes and the quality of the neighbourhood but also price effects from prior transactions within its close proximity. Hence, there should be a functional inter-relationship between the sales price of the subject dwelling and the prior transaction prices of other dwellings within its neighbourhood. In practice, these price effects are acknowledged and injected by the traders and valuers in the property market through "the comparable-sales" valuation method to estimate real estate prices (Can (1997) and Wong et al. (2013)). Indeed, spatial lag hedonic modelling techniques have been extensively employed in the literature to investigate real estate issues and problems. Examples include Kim et al. (2003) and McCord et al. (2018) who examine the relationship between residential property market and air pollution; McCord et al. (2019) who confirms an empirical linkage between energy performance certificate and property value; Haider and Miller (2000) who explores the effect of transportation infrastructure on residential property prices; Li and Joh (2016) who studies the synergistic economic benefit of enhancing bikeability and public transit accessibility with respect to real estate prices in an urban setting; and more recently, Barreca et al. (2020) who assesses how the real estate market is influenced by the level of urban vibrancy. In the following sub-sections, we develop a number of spatial lag hedonic models to test the hypotheses formulated in Section 3.

Testing H1

To test H1, we start with the following hedonic equation:

$$lnP_{i,t} = c + \sum_{k=1}^{K} \beta_k S_k + \delta \sum_{k=1}^{n} W_{i,j} lnP_{j,t-h} + \varepsilon \quad \text{..... (Equation 1)}$$

$$with\ i \neq j$$

where $P_{i,t}$ is the asking price of property i at time t; c is a constant term; S_k is a bundle of structural characteristics of the subject property described in Table 1. β_k is the implicit price for the corresponding S_k. Since it is conjectured that sellers also use evidence of recently sold nearby properties when they set asking price, asking price is therefore expected to correlate with nearby properties transaction prices. To account for such pricing behaviour, a spatiotemporal term $\sum_{k=1}^{n} W_{i,j} lnP_{j,t-h}$ is included in the equation. $P_{j,t-h}$ is the actual transaction price of property j at time *t-h,* with $h = 2\ months$[15], $W_{i,j}$ is a spatial weight that reflects the degree as well as the structure of spatial proximity between properties i and j. Mathematically, $W_{i,j}$ can take one of the following forms:

$$W_{i,j} = \frac{1}{d_{i,j}} \quad \text{.....(Equation 1.1)}$$

$$W_{i,j} = \frac{1}{d_{i,j}^2} \quad \text{.....(Equation 1.2)}$$

$$W_{i,j} = \frac{1}{e^{d}_{i,j}} \quad \text{.....(Equation 1.3)}$$

where $d_{i,j}$ denotes the Euclidean distance measured in meter between property i and j; $W_{i,j}$ is so constructed since it is reasonable to assume that sellers would place heavier weight on more proximate properties in setting property price. The most typical measures (see Cliff and Ord, 1981, Basu, 1998 and Dublin, 1998) include inverse distances (Equation 1.1), inverse distances raised to some power (in Equation 1.2, we use distance-squared), and inverse exponential distance (Equation 1.3). Moreover, given that $\sum_{k=1}^{n} W_{i,j} = 1$, the spatial autoregressive term $W_{i,j} lnP_{j,t-h}$ suggests a weighted average of spatially lagged price information. The parameter δ therefore can indicate the degree to which sellers extract price

[15] We also used longer periods, and two months lag produced the highest spatial correlation coefficient.

information from prior sales to ascertain asking prices, and hence H1 can be tested. If past information is relevant and applicable, δ should be non-zero and statistically significant. In other words, housing prices are spatially auto-correlated. Finally, $\varepsilon_{i,t}$ is an error term that measures the effects stemming from missing variables, misspecification of the model, measurement errors and inadequate sampling. This specification essentially assumes a linear functional form and fixed parameters.

It must also be highlighted that while neighbourhood attributes are commonly employed and explicitly measured in a typical hedonic model, they are intentionally left out in our analysis. We surmise that the inclusion of $W_{i,j} ln P_{j,t-h}$ can indeed capture a set of neighborhood features pertaining to the socioeconomic and physical make-up of the neighbourhood and accessibility to various urban services and amenities. In addition, variables that are normally used to control for market conditions are not included in Equation (1) for the same reason. The omission of such variables should thus avoid potential statistical nuisances associated with over-specification of our models.

In addition to the spatial autoregressive variable, a dummy variable, $Withdrawn$, is included in the hedonic equation to explicitly discern properties that are withdrawn from the market after listing. Modifications of the equation yields Equation (2) below:

$$ln P_{i,t} = c + \delta \sum_{k=1}^{n} W_{i,j} ln P_{j,t-h} + \sum_{k=1}^{K} \beta_k S_k + \lambda Withdrawn + \varepsilon$$

.....(Equation 2)

where $Withdrawn$ takes the value 1 if the property is withdrawn from the market, and 0 otherwise; and λ is coefficients to be estimated. It is expected that overpriced properties are more likely to experience difficulties to sell, some of which may even be withdrawn from the market.

To test H1, which is deduced from the proposition that sellers have become more prone to infer asking prices based on actual prices of nearby recently transacted properties since the introduction of the Home Report Scheme, thereby increasing the spatial autocorrelation in the property prices, Equation (2) is thus modified by including a dummy variable, Dec_{2008}.

The variable is designed to interact with $\mathrm{W_{i,j}}ln\mathrm{P_{j,t-h}}$. Dec_{2008} has a value of 1 if the observation occurs on or after 1st December 2008, and 0 otherwise. Accordingly, we develop Equation (3) as follows:

$$ln\mathrm{P_{i,t}} = \mathrm{c} + \rho\, Dec_{2008} \times \sum_{\mathrm{k}=1}^{\mathrm{n}} \mathrm{W_{i,j}}ln\mathrm{P_{j,t-h}} + \delta \sum_{\mathrm{k}=1}^{\mathrm{n}} \mathrm{W_{i,j}}ln\mathrm{P_{j,t-h}} + \sum_{\mathrm{k}=1}^{\mathrm{K}} \beta_{\mathrm{k}}\mathrm{S_k} + \lambda Withdrawn + \varepsilon$$

$$with\ i \neq j \ldots\ldots \text{(Equation 3)}$$

The coefficient of ρ is expected to be positive and statistically significant, if sellers have indeed given more weight to nearby transactions when they set asking prices for the subject properties since the introduction of the Home Report. In other words, we should observe a stronger spatial autocorrelation between asking prices and nearby transaction prices after the scheme came into effect.

Testing H2

The second hypothesis formulated in this paper tests whether there is a reduction in deviation between asking price and the "value" of the property after the implementation of the scheme. More specifically, it tests whether potential house sellers are less inclined to market their properties by setting an unrealistically low asking price relative to the properties' potential market value after December 2008. To measure the degree of such pricing deviation, $Dev_{i,t}$[16] is used:

$$Dev_i = \frac{P_i^A}{P_i^E} \quad \ldots\ldots \text{(Equation 4)}$$

where P_i^A is the actual asking price of property i, and P_i^E is the estimated value of the property obtained from the following equation:

$$ln\mathrm{P'_{i,\,t}} = \mathrm{c} + \delta \sum_{\mathrm{k}=1}^{\mathrm{n}} \mathrm{W_{i,j}}ln\mathrm{P_{j,t-h}} + \sum_{\mathrm{k}=1}^{\mathrm{K}} \beta_{\mathrm{k}}\mathrm{S_k} + \varepsilon$$

$$with\ i \neq j \ldots\ldots \text{(Equation 5)}$$

Where $\mathrm{P'_{i,\,t}}$ is the sale price of property i at time t. P_i^E is the fitted value of $\mathrm{P'_{i,\,t}}$ for each dwelling obtained by estimating Equation (5).

[16] This follows the concept of degree of overpricing in Kang and Garder (1989); Yavas and Yang (1995); Donald et al (1996); Anglin et al (2003); and Pryce (2011). Seller's pricing strategy is presented by an asking price relative to the value of the property.

We further posit that $\mathrm{Dev_{i,t}}$ is a function of the structural variable $\mathrm{S_k}$, since sellers are expected to have better knowledge of the quality of the property, and their pricing strategy should reflect this accordingly. Pryce (2011) argues that the asking-selling price spread is likely to contain a locational convention γ_k^* (i.e. neighbourhoods may have implicit conventions on asking-selling price spread). However, γ_k^* is not directly observable in the dataset, we therefore use the standard deviation of the actual asking-selling price spread $\sigma_{i,k}$ within the neighbourhood k as a proxy for the locational convention:

$$\sigma_{i,\,k} = SD(Dev_k) \ldots\ldots \text{(Equation 6)}$$

Neighbourhood k is defined as a 3-kilometre radius circle[17] centred at property i. In addition, we only consider transactions that occur within the past two months prior to the sale of property i when computing $\sigma_{i,k}$. One would expect that within a neighbourhood k, if the standard deviation of asking-selling price spread $\sigma_{\gamma ik}$ is small, there is likely to be a "locational convention". On the other hand, if the variation in the asking-selling price spread is large, the evidence of locational convention γ_k^* should be less apparent. To test this, Equation (7) is constructed. $\sigma_{i,\,k}$ is expected to have a significant effect on $Dev_{i,t}$ and ω should be negative and statistically significant. Furthermore, it has been established that market conditions also play an important role in price setting (Pryce, 2011), hence, we posit that T, a time dummy variable (with a coefficient φ to be estimated) measured on a monthly basis, should affect $Dev_{i,t}$:

$$lnDev_{i,t}=\mathrm{c} + \sum_{\mathrm{k}\,=\,1}^{\mathrm{K}} \beta_{\mathrm{k}} \mathrm{S_k} + \omega\sigma_{i,\,k} + \varphi \mathrm{T} + \varepsilon \ldots\ldots \text{(Equation 7)}$$

Lastly, Dec_{2008} is added to Equation (8) to test H2. We believe that the Home Report should have a market-wide impact on how sellers set their initial prices. In particular, the practice of setting artificially low asking prices to draw more potential house buyers to bid will cease to a large extent. Accordingly, we re-write Equation (7) as follows:

$$lnDev_{i,t}=\mathrm{c} + \Omega Dec_{2008} + \sum_{\mathrm{k}\,=\,1}^{\mathrm{K}} \beta_{\mathrm{k}} \mathrm{S_k} + \omega\sigma_{i,\,k} + \varphi \mathrm{T} + \varepsilon \ldots\ldots \text{(Equation 8)}$$

Ω is expected to be positive and statistically significant.

We estimate the equations using Ordinary Least Squares (OLS) methods. Our models are designed in such a way that only past events can exert influence on current events but not vice versa. This can largely avoid statistical inference problems such as endogeneitiy in the spatial lag terms. Provided that the error terms of the equations are independent and identically distributed, the OLS estimator will be asymptotically efficient and consistent. The summary statistics of the variables are shown in Table 2.

[17] The choice of the size of neighbourhood k is not arbitrarily determined. Indeed, the size of Aberdeen city (including Old Aberdeen) is roughly equal to that of a 3-km radius circle.

[Insert Table 2 here]

6. Regression results and discussions

Results for H1

Table 3 presents the regression results for Equation (1) to (3) using the three specifications of spatial weight respectively. The p-value for each variable is given in brackets. The last three rows of the table display the R-squared, adjusted R-squared and F-statistics of the models.

[Insert Tables 3 here]

Most coefficients estimated using Equation (1) in all three measures of spatial weight show the expected signs and are statistically significant at the 1% level. For example, sellers are prone to demand a higher price for qualities such as extra bedrooms, public rooms, bathrooms, central heating, garage(s), double glazing, and cloak room (WC). New properties also tend to fetch ~~have~~ a higher asking price. Dummy variable $Garden$ yields negative coefficients with all three spatial weighting specifications, which seems to be counter-intuitive. However, these coefficients became statistically insignificant once the variables on selling mechanisms and withdrawn properties are specified. Overall, the results on the property-specific variables are in agreement with those in the hedonic literature (e.g. Can (1992) and McCord et al. (2018))

In regard to testing H1, which states that asking prices are assumed to be spatially linked to prices of nearby properties sold within the previous two months. We observe that the coefficients of the spatial lag term, δ, are 0.0339, 0.1599, and 0.1131 respectively under that three different spatial specifications, and is statistically significant at the 1% level. This confirms our view that the housing prices are spatially auto-correlated. Of significance is the positive sign of the coefficient, which implies that house prices seem to move in tandem with one another: a higher (*lower*) price of a neighbouring property will generally result in a higher (*lower*) asking price of the subject property. Indeed, the findings echo Can (1997), which reveals spatial spillover/adjacency effect of absolute property prices arising from prior sales within an immediate neighbourhood via a practice of "comparable-sales". Interestingly, the effect of $\mathrm{W_{i,j}}ln\mathrm{P_{j,t-h}}$ are very different across the three specifications with the size the magnitude of the variable appearing to be larger when non-liner measures (as in Equation 1.2 and Equation 1.3) are employed. In sum, the models achieve an explanatory power of around 50%.

As a modification of Equation (1), Equation (2) is designed to examine how properties that are withdrawn from the market are priced differently by the sellers. The coefficients on Withdrawn, significant at the 1% level, range from 0.1390 to 0.1769 across the three spatial weight specifications, suggesting that this category of properties tend to be priced 15%-19% higher than the others, *ceteris paribus*. We surmise the fact that the properties are overpriced relative to other properties on the market could be a reason why they are withdrawn.

Equation (3) incorporates an interaction term, $Dec_{2008} \times \mathrm{W_{i,j}} ln \mathrm{P_{j,t-h}}$, to the model, which is designed to examine whether property sellers rely more on prior sales from the neighbourhood in ascertaining asking prices after the inception of the Home Report scheme. We find that the coefficients on the interaction term with all three specifications are around 0.05 and significant at the 1% level. This confirms our belief that after December 2008, asking prices are more spatially dependent on nearby sale prices by virtue of the price discovery process of the sellers given a more informationally efficient housing market. Hence, the Home Report might have increased the overall transparency of the market.

Results for H2

Equation (7) is formulated to investigate the determinants of pricing strategy, which is measured as the asking price relative to the estimated value derived from our hedonic model. Equation (8) further incorporates a dummy variable that ~~indicates~~ represents the introduction of the Home Report to test H2. Table 4 depicts the regressions results for H2 under the three spatial weighting specifications.

[insert Table 4]

Examining the results for Equation (7), locational convention measure $\sigma_{i,\,k}$ yields negative and significant coefficients with Equation (1.2) and (1.3) specifications. This is in line with our expectation that in a neighbourhood where there is a higher variation in the asking-selling price spread, the effect of locational convention should be less apparent with sellers being more likely to set asking prices that diverge more from the underlying values. The results also reveal that some housing attributes exhibit statistically significant effect on the dependent variable, suggesting that sellers do consider certain housing attributes such as number of bedrooms and heating systems when pricing their properties.

Lastly, Dec_{2008} is incorporated to Equation (8) to test H2. Its coefficient is 0.0523, 0.0274, 0.0397 under the three spatial weight specifications (1.1), (1.2)~~,~~ and (1.3) respectively. In all three cases, the coefficients are significant at the 1% level. Mathematically, it can be interpreted that there is a reduction in asking price valuation deviation. More precisely ~~specifically~~, the ratio between asking price and the value of the property is 3%-5% closer to 1. This suggests that the marketing strategies employed to set unrealistically low asking prices by the sellers have become less evidenced since the introduction of the Home Report scheme, however, the magnitude of such effect is relatively small.

In terms of R-squared and adjusted R-squared, our models achieve an explanatory power of around 40% for all the three spatial weight specifications. The estimation is marginally improved when location convention measure is taken into consideration. One might argue that the relatively low R-square could undermine the validity of the findings of the study. However, the main emphasis of this paper is on whether the Scheme affects the way sellers determine asking prices, *not* on the discovery of various determinants of valuation deviation

of real estate price formation. Therefore, it should be highlighted that only the improvement of R-square, as well as the signs and statistical significance of the variables of interest in the models that are of crucial relevance to our research.

As a robustness test, we generate Equation (9) by discarding all statistically insignificant structural variables with p-value below 1% in Equation (8). It is shown that the results are highly consistent with those of the other models. For instance, the model using $1/d_{i,j}$as spatial weight (with *Floor* and the property type variables removed) suggests a reduced level of asking price deviation *post-2008*, given that the coefficient on Dec_{2008} is positive and statistically significant at the 1% level. The model produces an adjusted R-squared of 0.4431, which is comparable to that of the original model. Similar findings are observed in the model using the spatial specification of inverse exponential distances (with *Garden, Floor* and the property type variables discarded) in terms of the signs and statistical significance of Dec_{2008} and other hedonic attributes.

7. Concluding Remarks

~~Understanding the underlying price determination process and dynamics of real estate is important from the viewpoints of buyers, sellers and other stakeholders, especially in a market that is characterised by information inefficiency, a diverse composition of market players as well as heterogeneity of quality of housing. This study aims to empirically evaluate the effectiveness of the Home Report Scheme introduced and implemented in Scotland in 2008, which was designed to improve information efficiency about property condition as well as address the often-criticized malpractice of setting artificially low list prices by property sellers. To achieve this,~~ This paper investigates how property sellers determine asking prices in response to a change in government policy ~~in an information search context~~ with the use of a large number of real estate transactions in the North East of Scotland. By subjecting the analysis in an information search context and in a hedonic setting that explicitly incorporates a spatial process of price discovery using spatial lag modelling techniques and controls for a large number of housing attributes (i.e. to test H1), we find strong *prima facie* evidence that property sellers have become more prone to rely on prior sales to establish asking prices since the introduction of a new government policy, namely the Home Report , as indicated by an elevated level of spatial autocorrelation in the sample house prices across all statistical models examined. The once-common practice of setting artificially low asking price ~~with the aim~~ to attract buyers seems to have dwindled to a certain extent. In other words, after the Scheme came into effect ~~introduction of the Scheme~~, real estate sellers seem to have set prices on a basis that is more closely in line with the general market conditions and the underlying value of property. The results of testing H2 in our analysis, which compares price divergence pre- and post- 2008 ~~2018~~, further confirms this conjecture. More specifically, our statistical models reveal that the accuracy of property pricing has, on average, improved by a factor of 3 - 5% after the implementation of the Scheme.

A major learning outcome of this study is to provide robust evidence-based justifications for necessary government interventions to help address issues associated with market failures stemming from information asymmetry between buyers and sellers within a property market. Prior to the introduction of the Home Report, problems concerning the propensity of property sellers in Scotland artificially lowering initial asking prices were rife, placing potential buyers in a relatively weaker bargaining position. Indeed, an early investigation by Akerlof (1970) suggests that information asymmetry, which deters market participants from making mutually advantageous trade in a free enterprise economy, is particularly more widespread in markets dominated by second-hand assets such as direct real estate. This is due to the fact that sellers of second-hand homes are better informed about the quality of the dwellings than the buyers, and consequently creating an unlevel playing field when it comes to pricing. Our empirical results support the view that government should play a more active role in facilitating transactions in the real estate market by putting forward measures that counteract such information asymmetry in property pricing, ensuring a higher degree of market transparency which could result in enhanced market information efficiency and equitability that benefit not only the market players but also the society at large.

From a methodological stance, this study demonstrates how housing policies can be empirically evaluated and scrutinised in the framework of spatial hedonic price modelling, which is one of the greatest departures from the mainstream real estate literature. Existing approaches to examining institutional arrangements of housing market have been predominately normative or descriptive in nature, often producing elusive and subjective explanations, conclusions and implications that cannot be hypothesised and/or validated with empirical data. We believe that the findings and the methodology of the study yield both theoretical and practical insights into real estate price formation and modelling, which are of great use and interest to various categories of property stakeholders. For instance, the hedonic models developed in the paper demonstrate that a parsimonious model with a high degree of explanatory power could be achieved by accounting for spatially lagged pricing information through incorporating a spatial autoregressive process that reduces the number of housing attributes to be considered in the analysis, providing a justification for adopting a simple yet reliable valuation approach to conducting mass property appraisals for valuers, policy makers and other property professionals. From the perspective of property investors and property developers, the results in relation to property price deviation in Scotland presented in the study provides evidence-based explanations on how real estate prices could respond to government interference dynamically vis-a-vis the changing levels of the overall market transparency and information asymmetry resulting from the implementation of a new housing policy, which should bear implications for formulating arbitrage and trading strategies in real estate investment, as well as conducting policy evaluation in the arena of public services delivery.

Last but not least, we acknowledge that the scope of the current study is somewhat limited in terms of the amount of data explored, which only covers a cross section of the entire

Scottish residential property market. We therefore contend that the current study could be further extended to incorporate comparison with other cities in the U.K. and elsewhere where different institutional arrangements in property pricing and marketing are in place.

~~Last but not least, we believe that the findings of the study yield both theoretical and practical insights into real estate price formation, which are of great use and interest to policymakers, real estate developers, individual homebuyers, financial institutions and property professionals.~~

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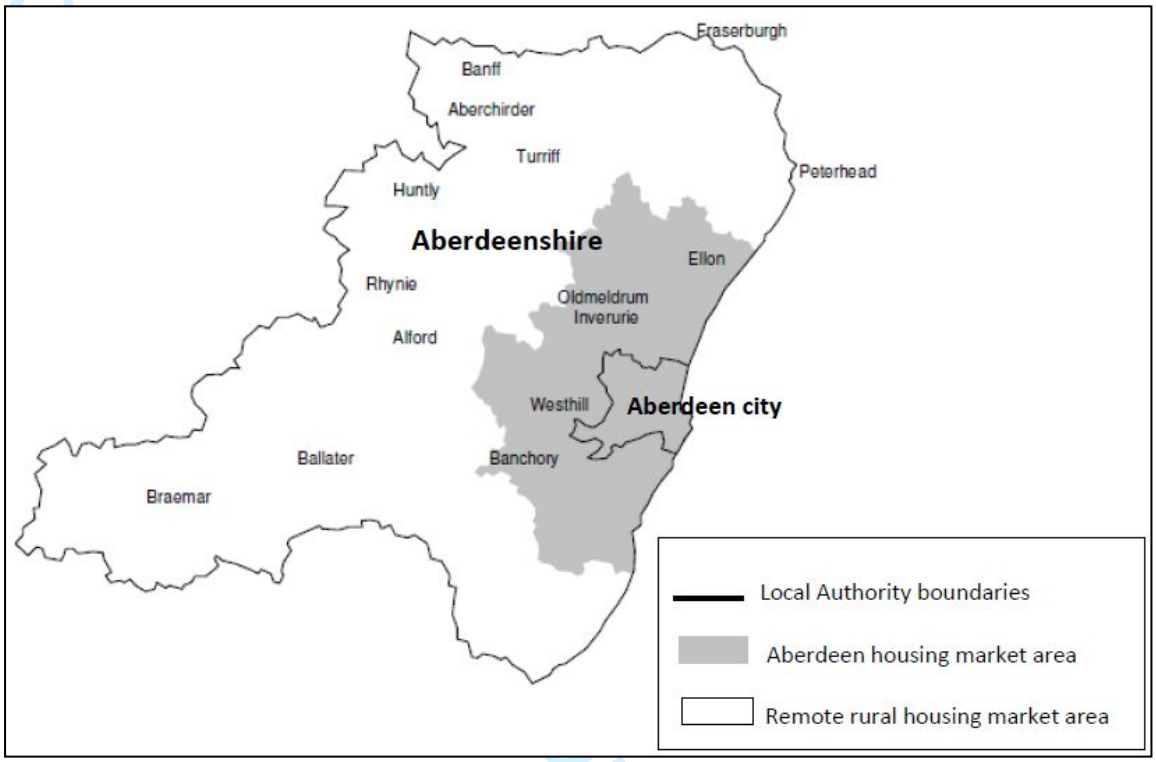
Figures and tables

Figure 1. Housing market areas of Aberdeen city and Aberdeenshire.



Source: Aberdeen City Council

Figure 2, Asking-selling price premiums and average real house price in Aberdeen housing market 1998 Q2 to 2013Q2.

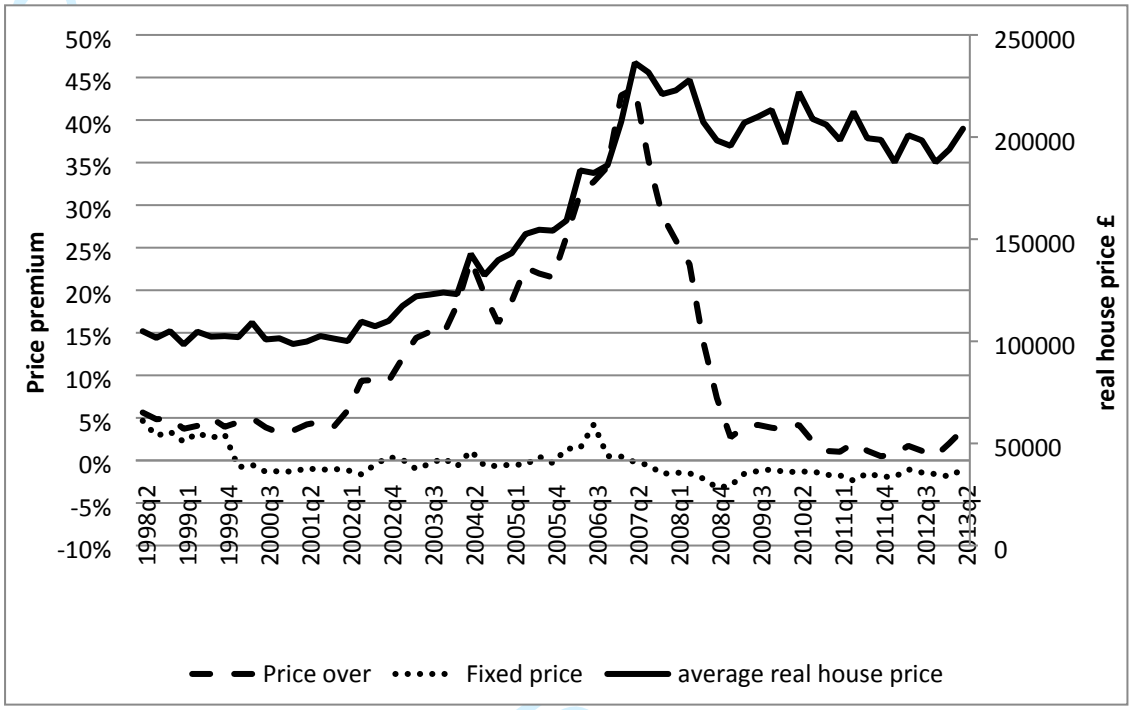


Table 1: descriptions of variables:

Variable	Description/Type
Heating type (Heating)	1 if property has central heating, =0 if property has no heating or any other form of heating
Double Glazed	1 if property has double glazing, otherwise =0
Garden	1 if property has garden(s), otherwise =0
Floor	Number of floor stories within the dwelling: 1 for flat and bungalows, 2 or more for multi-storey houses
Bathroom	Number of bathrooms.
Bedroom	Number of bedrooms
WC	Number of separate toilets/cloak rooms
Public	Number of public rooms, including kitchen, lounge, conservatory, play room, etc.
Dec_{2008}	1 if property was listed on and after December 1st 2008, otherwise =0
Garage	If a property has a garage(s)
New	1 if property is a new build, otherwise =0
Withdrawn	1 if property was withdrawn from the market, otherwise=0
Type D	1 if dwelling is detached property, otherwise=0
Type F	1 if dwelling is a flat, otherwise=0
Type N	1 if dwelling is non-detached property, otherwise=0
Dev	Ratio: the deviation between asking price and the "value" of the property after the implementation of the scheme.

Table 2: Descriptive statistics of the main variables

	Unit	Mean	Std. Dev.	Min	Max
$P_{i,t}$	GBP£	131 239	107 836	9000	3500000
$V_{i,t}$	GBP£	134 097	106 729	24077	6002596
$Dev_{i,t}$	Ratio	0.9999	0.0244	0.8320	1.3730
$SD(Dev_k)$	---	0.2761	0.0022	0.2017	0.3183
Heating	Dummy Var.	0.8128	0.3900	0	1
DoubleGlazed	Dummy Var.	0.8778	0.3274	0	1
Garden	Dummy Var.	0.5971	0.4904	0	1
Floor	Number	1.4585	0.5596	1	6
Bathroom	Number	0.9165	0.3599	0	4
Bedroom	Number	2.3297	1.1398	0	9
Garage	Number	0.3637	0.6038	0	8
WC	Number	0.1630	0.3784	0	3
Public	Number	1.4747	0.8033	0	14
Dec_{2008}	Dummy Var.	0.2450	0.4301	0	1
New	Dummy Var.	0.0058	0.0763	0	1
Withdrawn	Dummy Var.	0.0997	0.2970	0	1
Type D	Dummy Var.	0.1674	0.3733	0	1
Type F	Dummy Var.	0.5331	0.4989	0	1
Type N	Dummy Var.	0.2994	0.4580	0	1

Table 3: Regression results for Equations 1 to 3

Dependent Variable	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$
Spatial Weight	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$
Independent Variables	**Eqn 1**	**Eqn 2**	**Eqn 3**	**Eqn 1**	**Eqn 2**	**Eqn 3**	**Eqn 1**	**Eqn 2**	**Eqn 3**
$W_{i,j}P_{j,t-h}$	0.0339	0.0390	0.0220	0.1599	0.1818	0.1255	0.1131	0.1294	0.0883
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$Dec_{2008} \times W_{i,j}P_{j,t-}$	----	----	0.0534	----	----	0.0518	----	----	0.0524
			(0.0000)			(0.0000)			(0.0000)
C	10.1342	10.2254	10.2355	8.8068	8.7396	9.1640	9.2912	9.2794	9.5441
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Heating	0.1994	0.2020	0.1888	0.2013	0.2047	0.1911	0.2001	0.2033	0.1904
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DoubleGlazed	0.0247	-0.0202	-0.0245	0.0116	0.0049	-0.0349	0.0128	0.0063	-0.0341
	(0.0000)	(0.0004)	(0.0000)	(0.0419)	(0.3833)	(0.0000)	(0.0259)	(0.2687)	(0.0000)
Garden	-0.0134	-0.0059	-0.0019	-0.0053	0.0049	0.0059	-0.0154	-0.0070	-0.0031
	(0.0140)	(0.2719)	(0.6778)	(0.3172)	(0.3470)	(0.1859)	(0.0441)	(0.1861)	(0.4889)
Bedroom	0.2661	0.2648	0.2470	0.2650	0.2632	0.2460	0.2655	0.2639	0.2464
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Floor	0.0339	0.0282	0.0241	0.0308	0.0237	0.0206	0.0382	0.0323	0.0271
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bathroom	0.0215	0.0188	0.0381	0.0137	0.0096	0.0432	0.0189	0.0155	0.0394
	(0.0000)	(0.0002)	(0.0000)	(0.0063)	(0.0521)	(0.0000)	(0.0002)	(0.0018)	(0.0000)
Garage	0.0992	0.1045	0.1100	0.1038	0.1107	0.1140	0.0961	0.1017	0.1077
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
WC	0.0388	0.0350	0.0261	0.0363	0.0318	0.0240	0.0350	0.0304	0.0228
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Public	0.1406	0.1420	0.1512	0.1422	0.1439	0.1527	0.1420	0.1437	0.1527
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Type D	0.0764	0.0636	0.0837	0.0751	030596	0.0802	0.0695	0.0539	0.0764
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Type F	0.0302	0.0208	0.0368	0.0237	0.0113	0.0289	0.0475	0.0389	0.0505
	(0.0000)	(0.0035)	(0.0000)	(0.0008)	(0.1041)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
New	0.6005	0.4858	0.5309	0.5811	0.4443	0.4999	0.5825	0.4502	0.5038
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Withdrawn	----	0.1390	0.1267	----	0.1769	0.1539	----	0.1663	0.1466
		(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)
Included Obs.	70642	70642	70642	70642	70642	70642	70642	70642	70642
R^2	0.5085	0.5218	0.6600	0.5293	0.5476	0.6759	0.5229	0.5399	0.6720
$Adjusted\ R^2$	0.5084	0.5217	0.6599	0.5292	0.5475	0.6759	0.5228	0.5398	0.6719
Prob (F Stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p-values are in brackets

Table 4: Regression results for Equations 7 to 9

Dependent Variable	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$
Spatial Weight	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$
Independent Variables	**Eqn 7**	**Eqn 8**	**Eqn 9**	**Eqn 7**	**Eqn 8**	**Eqn 9**	**Eqn 7**	**Eqn 8**	**Eqn 9**
Dec_{2008}	----	0.0523	0.0522	----	0.0274	0.0272	----	0.0397	0.0395
		(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)
Locational	-0.9392	-1.2298	-1.4340	-2.1019	-2.1149	-2.1096	-1.5328	-1.5881	-1.6217
Convention	(0.1450)	(0.0562)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
C	-0.1070	-0.0504	----	0.1649	0.1530	0.1546	0.0056	-0.0036	----
	(0.5698)	(0.7888)		(0.0000)	(0.0000)	(0.0000)	(0.8679)	(0.9150)	
Heating	-0.0131	-0.0131	-0.0136	-0.0133	-0.0133	-0.0134	-0.0134	-0.0134	-0.0133
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DoubleGlazed	-0.0475	-0.0481	-0.0468	-0.0291	-0.0294	-0.0297	-0.0362	-0.0367	-0.0358
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Garden	0.0111	0.0108	0.0117	0.0018	0.0016	----	0.0053	0.0051	----
	(0.0017)	(0.0022)	(0.0000)	(0.6249)	(0.6522)		(0.1418)	(0.1581)	
Bedroom	-0.0073	-0.0075	-0.0063	-0.0064	-0.0065	-0.0036	-0.0069	-0.0070	-0.0050
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0002)	(0.0072)	(0.0001)	(0.0000)	(0.0009)
Floor	-0.0018	-0.0021	----	0.0006	0.0005	----	-0.0004	-0.0005	----
	(0.6347)	(0.5959)		(0.8862)	(0.9070)		(0.9258)	(0.8959)	
Bathroom	0.0494	0.0501	0.0505	0.0405	0.0409	0.0418	0.0440	0.0445	0.0445
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Garage	0.0169	0.0169	0.0228	0.0105	0.0105	0.0186	0.0130	0.0131	0.0198
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
WC	-0.0139	-0.0140	-0.0106	-0.0088	-0.0088	----	-0.0108	-0.0109	-0.0070
	(0.0002)	(0.0002)	(0.0037)	(0.0236)	(0.0227)		(0.0053)	(0.0050)	(0.0632)
Public	0.0065	0.0067	0.0079	0.0049	0.0049	----	0.0056	0.0057	0.0074
	(0.0010)	(0.0008)	(0.0000)	(0.0163)	(0.0148)		(0.0060)	(0.0051)	(0.0002)
Type D	0.0235	0.0237	----	0.0259	0.0261	----	0.0251	0.0253	----
	(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)	
Type F	-0.0028	-0.0034	----	0.0008	0.0005	----	-0.0003	-0.0007	----
	(0.5502)	(0.4698)		(0.8615)	(0.9099)		(0.9487)	(0.8794)	
New	-0.3389	-0.3408	-0.3390	-0.2912	-0.2923	-0.2913	-0.3094	-0.3108	-0.3105
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Included Obs.	64070	64070	64070	64070	64070	64070	64070	64070	64070
R^2	0.4435	0.4449	0.4446	0.3946	0.3950	0.3945	0.4005	0.4013	0.4009
$Adjusted\ R^2$	0.4420	0.4434	0.4431	0.3930	0.3934	0.3930	0.3988	0.3997	0.3994
Prob (F Stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p-values are in brackets

Responses to Reviewer(s)' Comments to Author:

Referee: 1

Recommendation: Major Revision

Comments:

Comment 1: To make the manuscript more appealing to readers 'outside' the Scottish housing market, I think the authors should add some text to compare the Scottish system with the systems implemented in other countries. Then the reader can have a better understanding of the issue investigated from a broader perspective. This comparison could be added to close Section 2.

We totally agree with the reviewer's *Comment* 1. We have therefore included one long paragraph in Section 2 to describe and explain various pricing systems adopted elsewhere (e.g. England, Wales, Northern Ireland and the U.S.)

Comment 2: The authors should better emphasise in the introduction the importance of the topic that they are investigating. What is the value added/which are the lessons learnt from this piece of research that other researchers analysing housing markets in other countries could apply? For the manuscript to have a high impact it is important not to present the issue as something important at 'local' scale, it is much better to place it in a more broader context so that the advantages of the system or the lesson learnt from the research can be inspiring for others. I think it is important to firstly tackle this in the introduction (in a brief manner); and then pick up the issue again in the concluding part (focusing on the value added for policy-makers, for other agents operating in the housing market, etc?

We thank you for the reviewer's comments. We have amended the text in the manner suggested by the reviewer (please see the second last paragraph of Section 1 and the second last paragraph of Section 7) to elucidate the importance of the topic.

Comment 3: The second paragraph of Section 3 is interesting although I am missing examples of housing markets (at country/regional level) to illustrate the different types of housing markets that are described here.

We have added a footnote (footnote 8) to provide some geographic examples showing the empirical relationship between asking price and market signals in the literature.

Comment 4: On page 6 line 56, please, add a reference to support the statement on the collateral value.

We have added one reference (Wyman et al., 2011) to address the reviewer's question in relation to "collateral value" .

Comment 5: On page 11 line 19, please, add a reference to direct the reader to some literature on hedonic prices.

We have included Can's papers (on hedonic spatial lag modelling).

Comment 6: The discussion of the results should be expanded for a better linkage with the existing body of work on the topic.

We thank you for the review's comment which we think is extremely useful. The discussion has been substantially expanded in a manner that provides a better connection with the existing literature. For example, the results are compared to the works of Can (1992), Can and Megbolugbe (1997), McCord et al. (2018) who also observed spatial adjacency/ autocorrelation effects in the housing markets they investigated.

Comment 7: The statement 'Last but not least, we believe that the findings of the study yield both theoretical and practical insights into real estate price formation, which are of great use and interest to policymakers, real estate developers, individual homebuyers, financial institutions and property professionals' is very important. Nevertheless, I think it would be good to see a concrete explanation of the 'great use' that each group (policy-makers, homebuyers, etc.) could do.

We very much agree with the reviewer's comment. We have therefore provided some specific examples/explanations in relation to how the results of the study could be useful to different groups of real estate stakeholders.

Comment 8: How could the lessons learnt from this paper be applied/related to the development of bubbles in the housing market? I think that covering this would be of interest for many readers.

We are of the view that "the development of bubbles in the housing market" is beyond the scope of our study, given that we did not really study/ empirical test the relationship between the underlying economic fundamentals (such as demand and supply factors) and actual property transaction prices. We believe that it would be necessary to look at the underlying macroeconomic fundamentals over a long period of time before we could make any judgements as to whether the market is in a bubble. We would like to point out that the main objective of our paper is on studying the formation of asking price, not on final sale price. Simply looking at (average) asking prices of the dwellings we examined does not permit us to make any reliable inference about housing bubbles (if any).

Additional Questions:

1. Originality: Does the paper contain new and significant information adequate to justify

publication? (i.e. is it a contribution to knowledge?): The topic is important. However, there is a strong local focus (the paper only refers to Scottland) which make it original, while at the same time could be of less interest for other researcher investigating markets outside the UK. This could be corrected while appropriately linking the findings to a broader context.

2. Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored to your knowledge?: I think it is 'average'. I am asking for additional references in my report.

3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts, or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the research methods employed appropriate?: Yes.

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: I have indicated a few suggestions to improve the concluding part. The results are presented clearly although I think a strong connection with what other authors have done is missing. A revised version should definitely include that.

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: There is room for improvement. My report is asking for these details.

6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the field and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: Yes quality of communication is acceptable.

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Referee: 2

Recommendation: Accept

Comments:
Information transparency and pricing strategy in the Scottish housing market.

Thanks for asking for an assessment of this manuscript. The manuscript reports an interesting topic. However, I have some reservations about this version. Firstly, the abstract is not included.

However, the major shortcoming of this study is the inherent weakness in the research background. There are no concise, convincing, and supporting reasons why this research is needed in Scotland. The writing style is not academic. References are not provided for most of the statements made in the manuscript. The discussion is firmly regional and highly opinionated. The references cited are dated.

We thank you for the comments. We have elaborated on the research objectives and background and why the research is important (in a manner suggested by the first reviewer). We have also added 18 more highly relevant references to enrich the LR and link our paper to similar findings in the existing literature, making it less subjective and opinionated, as well as less regional. We have included a number of recently published papers as references to increase the "currency" of the research.

There is no clear section for research methodology in the manuscript. It is very important to provide the research methodology for a manuscript like this. The section should detail the justification for the constructs in the manuscript. The "Data and Empirical models"[sections 4 and 5] should part of the research methodology. The results and discussion require rethinking. The discussion should be expanded and current references should be provided to support the findings.

We thank you for the comments given by the reviewer. We have included a long paragraph to describe the research methodology (hedonic modelling and spatial lag modelling), explaining why SLM is utilised with references to the existing literature.

We also thank the reviewer for suggesting that Section 4 and Section 5 should be merged (under Research Methodology). However, on second thought, we are of the view that the two sections should be separate as they are, given the long length of each section. Indeed a lot of similar studies in the literature discuss Data and Research Methodology separately. We believe that merging the two sections would reduce the overall readability of the paper.

The findings should be compared with the findings elsewhere. With respect to H2, the R-squared and adjusted R-squared are low. How will these results influence the conclusions? Please provide detailed discussion with respect to H3 and please clarify

equation 9 and the results associated with it. With respect to H2, floor, WC, heating, and glazed?

We have compared our research findings with those of other studies, particularly in relation to the spatial autocorrelation effects and the impact of hedonic variables on property value. We have also explained why a low R2 (or adjusted R2) should not affect the conclusions of our study (please refer to footnote 19). We have removed H3 from the text (it was just a typo from an earlier version of this manuscript, we apologise for that). We have provided more clarifications in relation to Equation 9 as well as the results on the hedonic variables the reviewer mentioned.

Please describe the shortcomings of this research clearly and rewrite the conclusion to be concise and focused on the results and discussion of this research.

We have included a paragraph which describes the shortcomings of our research. We have also removed a large chuck of the first paragraph in Section 7 to make the conclusion more concise and succinct. The new version focuses mainly on the key findings in relation to H1 and H2 of the paper based on the *Discussion Section*.

Best wishes from this referee

Additional Questions:
1. Originality: Does the paper contain new and significant information adequate to justify publication? (i.e. is it a contribution to knowledge?): To high extent

2. Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored to your knowledge?: To a less extent

3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts, or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the research methods employed appropriate?: To some extent

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: To some extent

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial

impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: To some extent

6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the field and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: To a very high extent

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DEADLINE: 24-Mar-2021

Information transparency and pricing strategy in the Scottish housing market

1. Introduction

Pricing strategy has been an important concept in both theoretical and empirical modelling of housing transactions which is envisaged to impact upon the number of bids, final transaction price and the length of time to sell a home (Kang and Garnder, 1989; Yavas and Yang, 1995; Forgey et al., 1996; Arnold, 1999; Anglin et al., 2003; Pryce, 2011, Thanos and White, 2014). Equally, the evaluation of asking prices is also important in the valuation process, where estimated market value is derived from recently transacted comparable sale prices. As such, bias in the asking prices of comparable properties can distort the market value estimate of the subject property, which in turn could lead to a divergence between the market value estimate and the sale price (Rabianski, 1992).

It is widely accepted that there is a degree of information asymmetry in most housing markets between sellers and buyers. This occurs when sellers and their agents have better knowledge of a property's qualities and location, whereas buyers are perceived to be less well informed (Lin and Vandell, 2007; Pope, 2008; Wong et al., 2012, Nanda and Ross, 2012). This effect of the improvement in information symmetry has been examined by a number of studies (for example, Pope, 2008; Nanda and Ross, 2012). Whilst numerous studies have investigated the impact of the introduction of property condition disclosure regulations on the selling prices, more limited analysis has been undertaken to examine the potential changes in the pricing strategy of the sellers.

In Scotland, the improvement in information transparency on housing transactions was also enforced by regulations. The Home Report scheme was introduced in December 2008, requiring the seller of a residential property to provide a Single Survey, an Energy Report, and a questionnaire when listing the property on the market. The Scottish government introduced the scheme with three main objectives: to improve information about a property's condition, to address the cost and efficiency issue associated with multiple valuations and surveys, and to address the problems created by the practice of setting artificially low asking prices (Black et al. 2015). Indeed, this artificial setting of low asking prices[1] has traditionally been common

[1] The "asking price" in the "price over" (which is explained in section 2) context is not the reservation price that sellers would expect to achieve, or it is a ceiling price in many housing markets where buyers normally

practice in Scotland, especially during periods of market upturns and sustained growth. This approach whilst benefitting sellers from the uncertainty and competition among potential buyers, has been heavily and publicly criticised for leading people, who cannot afford the property, paying for surveys to be undertaken. Consequently, to evaluate the extent to which the scheme met the initial objectives, the Scottish government carried out a five-year review in 2014. The findings emanating from the review illustrated that, on first showing, the scheme appeared to be successful, nonetheless, when specifically addressing the issue relating to the setting artificially low asking prices, the government's review was far less conclusive on how much this is due to poorer market conditions.

Accordingly, this paper attempts to complement the government review and provide some additional evidence as to the evaluation of potential changes in pricing strategy as a result of the implementation of the Home Report scheme. In this regard, we examine the potential changes in the relationship between asking and seller's perceived reservation price and further explore the explanations for such changes using auction theories relative to the Scottish sealed bid context. Using housing transaction data pre and post the introduction of the Home Report, we empirically test whether there has been a significant statistical difference in asking price relative to the "value" of the property since the introduction of the scheme.

The remainder of the paper is structured as follows: Section 2 discusses the background of the Scottish housing market and the rationale for the enactment of the Home Report scheme. Section 3 explores the theories relative to pricing strategy in housing auctions with Section 4 offering descriptions of the data used within the empirical analysis. Sections 5 and 6 explain the empirical modelling and provide a discussion of the empirical findings, with Section 7 drawing conclusions.

2. Background of the Scottish housing market

The Scottish housing market has some unique characteristics. The dominant selling mechanism is the "price over" system, where properties on the market are listed as "offers over" or "price over" an amount set. When there is more than one potential buyer, the seller

negotiate downward from an asking price. It acts more like a "guide price", which sends a signal to potential buyers that the seller is expecting to achieve a certain amount above of this price (Pryce, 2011).

sets a "closing date" on which, offers from all the bidders are submitted in the form of first price sealed bid auction, and the highest offer tends to be accepted[2]. Gibb (1992) suggests that through uncertainties and opportunities created by this sealed bid system, sellers can capture economic rent. This is also supported by game theory which indicates that sealed bid auctions favour sellers in a strong market where the number of potential bidders is relatively large, and bidders are likely to be "risk averse"[3]. However, this system could be viewed as an "unethical system" from a buyer's perspective mainly because it leaves estate agents open to accusations of setting artificially low asking prices to create fictitious competition, leading people who cannot afford the property paying for surveys.

In 2008, a new regulation - the Home Report was introduced to the Scottish housing market. By law, dwellings[4] listed on the market from the 1st December 2008 are required to have a Home Report undertaken. This report consists of a Single Survey, an energy report and a questionnaire. The Single Survey is a level 2 Homebuyers Survey and Valuation (HSV) equivalent survey[5], which includes a valuation. It should be highlighted that many mortgage lenders accept this valuation as the collateral value of the property. Sellers are responsible for the cost of the home Report, and any potential buyer can access the report via selling agents and property solicitor centres free of charge.

The scheme was introduced with three overarching objectives. The government believed that the scheme would improve housing market stability by providing the essential information about the properties to the buyers. However, this was met with concerns pertaining to the upfront cost of the scheme and also in relation to potential conflict of interests in the sense that "*the surveyor must produce a report that will be used by both the seller and buyer, two parties that have opposing interests in the property transaction – particularly in regards to the valuation and the repair categories*" (Black, et al. 2015:5).

[2] Sellers may also consider other conditions of the offer, such as proposed entry date.
[3] Bidders being risk averse refers to the fear of not being able to win the auction.
[4] This includes all private properties listed in the market, excluding "right to buy" properties, and some of the new developments.
[5]According to Royal Institute of Charter Surveyors (RICS), level 2 HSV shows the condition of the property, and includes a market valuation and insurance rebuild costs. It also provides guidance to legal advisors and advice on defects that may affect the value of the property such as repairs, and ongoing maintenance.

The government's five-year review of the scheme included both a public consultation[6] and a research study[7] where all three objectives of Home Report were evaluated. Whilst the public consultation found that the majority of the respondents considered the scheme to be an improvement, it did still highlight concerns regarding the setting of unrealistic asking prices. Indeed, the findings indicated that while the valuation helped prevent the occurrence of artificially low asking price (to a certain degree), it is less useful in doing so in a rising market (Robertson & Blair, 2014). That said, the research study also suggested that relatively poorer market conditions could also have contributed in addressing the issue of artificially low asking prices (Black, et al. 2015). Further, the findings of the government's five-year review of the Home Report is based on both qualitative data and descriptive analysis. In this regard, it acknowledges but fails to control for the effect of changes in market conditions on pricing behaviours. With the use of a rich set of market transaction data for a specific case study area, North East Scotland, this paper complements the government review by providing further quantitative evidence on the effectiveness of the policy objective in relation to price setting in the housing market.

3. Seller's pricing strategy in Scottish housing market

In most housing markets, asking prices are typically set by agreement between the seller and the acting agent. This is determined according to knowledge of the acquisition price, the costs of improvements and maintenance, housing attributes, and the selling prices of similar properties nearby. Selling agents have insightful local market knowledge and more comprehensive information and data on recent transactions, based on which they advise their clients on a pricing strategy. As highlighted by Thanos and White (2014), asking prices are therefore set according to the strategic behaviour of sellers with private values, as well as a perception of the "common value" element in the market advised by selling agents – the "expert advice".

Search model analysis as proffered by Yavas and Yang (1995:366) argues that asking price serves as a signalling function "*that maps the listing price to the seller's valuation of the*

[6] Chartered surveyors, legal profession and estate agent respondents, local authorities, construction industry respondents, consumer, advice & campaign groups and property management, maintenance and conservation respondents were consulted.

[7] The research study surveyed 928 households in Scotland.

property". This implies that a lower asking price signals that the seller might accept a lower price, therefore increases the probability of sale and increases the expected selling price through this channel (Horowitz 1992; Yavas & Yang, 1995; Pryce, 2011). However, in a market where the asking price serves as a ceiling price, a lower asking price also reduces the upper end of the potential bids distribution, thus reduces the expected sale price (Horowitz 1992; Yavas & Yang, 1995). Consequently, sellers in such markets often face a trade-off between the time on the market (selling quickly) and achieving a higher sales price.

In the Scottish housing market, the "price over" asking price is not a ceiling price, the common "expert advice", certainly prior to the introduction of the Home Report, was to set an asking price below that of the expected selling price to achieve a high price (Levin and Pryce, 2007). In a sense, the "price over" amount is equivalent to a starting price in a conventional auction. There are two conflicting theories regarding the influence of starting price in auctions. The first suggests that a low starting price reduces the barrier to an auction, therefore increases the number of potential bidders (Ariely and Simonson, 2003; Kamins et al., 2004; Simonson and Ariely, 2005). This auction theory suggests that the optimal bid from each bidder in a sealed price auction rises as the number of bidders increases under both the "private value" and "common value" models[8], implying that a higher selling price is expected with greater number of bidders (Wilson, 1997; Laffont, 1996). Indeed, Ooi et al. (2006) illustrate such relationships in a theoretical model based on "private value", and also provide empirical evidence that supports the theoretical analysis using sealed price auction data on land transactions in Singapore. Equally, research undertaken by Levin and Pryce (2007) employed a simulation model based on a hypothetical database of 30,000 house valuations in the Scottish "price over" system. Their results found that the probability of extreme bids (high selling price) increased from over 5% to 18% when the number of bidders rises from 1 to 4.

[8] It is worth noting that auction theories tend to distinguish between two models that make assumptions on the information possessed by participants concerning the valuation of the auction subject in question, namely the "independent private value" and "common value" models. With the independent private value model, each bidder is assumed to have his own valuation and different realisations of the value of the auction subject (Paarsch and Hong, 2006). Knowing other bidders' valuations will not change the bidder valuation. In a "common value" model, the actual value is the same for all bidders. Bulow and Klemperer (2002) suggest that a house's value has both elements, but due to complicity, housing auctions are normally modelled under either value.

This confirms that the setting of low asking prices to attract bidders in the Scottish offers over system therefore seems to be a logical strategy.

Arguably, the winning bid is also influenced by bidders' risk aversion, in a sealed bid environment. Risk aversion does not alter bidder's behaviour in an open auction, because they, in theory, will stop bidding if the reservation price is reached[9]. However, in a sealed auction, a risk averse bidder (who has the fear of losing) may also be willing to pay a premium – in the form of a higher bid – for the insurance of winning (Maskin and Riley, 1985)[10]. As Pryce (2011) contends, this provides an explanation for the supposed popularity of the offers over system during market upswings, as buyers are more "desperate" to buy: dwellings are selling relatively fast, and buyers face higher opportunity costs to viewing as the probability of viewed dwellings being sold to other buyers increase. By setting low asking price, the seller increases the probability of viewings, thereby increases the probability of a viewer submitting a bid due to the risk of not finding a better alternative during his search period.

An alternative theory regarding starting price is that the initial price represents what Tversky and Kahenamn (1974) describe as an anchor. More specifically, a low starting price would indicate a low value and result in fewer bidders and a low(er) winning bid (Ariely and Simonson. 2003). Empirical studies examining this concept have tended to find mixed effects of starting price on the final winning bid in online English auctions (Ariely and Simonson, 2003; Lucking-Reiley et al., 2007). However, there has been limited analysis of starting price in sealed bid real estate auctions. It is important to note that the influence of starting price on the final selling price in an auction is likely to diminish if salient reference prices are available (Ariely and Simonson, 2003). For example, if consumers have a well-established reference price for an auctioned subject, the starting price may have relatively small effect on the final price. This may explain the rationale of using methods such as those adopted in the Home Report to address the problems associated with the setting of artificially low asking prices. The fundamental change with the scheme is that the Home Report Valuation acts as a "price marker" for buyers and is often used in negotiation over price (Black et al., 2015). Since the valuation serves as the reference price, it is more likely to serve the "signalling function" of seller's reservation price. Importantly, it also indicates the collateral value for mortgage

[9] Ignoring irrational exuberance.
[10] see Maskin and Riley, 1985 for a full discussion of their theoretical model for this argument.

purposes, therefore reduces the level of uncertainty for the buyers. With all these respects, the valuation is likely to determine the potential bids distribution, and there is less incentive for the sellers to set an asking price that derives hugely from the valuation. Arguably, the effect of the Home Report scheme is that the "price over" asking price has become more correlated to valuations, which are normally obtained through the comparable method using market transactions of recently sold nearby properties.

Based on the discussion above, we posit, firstly, that spatial autocorrelation of asking prices to selling price of properties in proximity should have increased since the implementation of the Home report as property prices are determined, to a large degree, on the basis of values of nearby properties. Empirically testing this proposition serves to establish whether the Home Report has achieved its objectives in relation to market transparency on one hand and inform future policy decisions on the other. Secondly, along the same line of logic, it is surmised that the Home Report should have reduced the difference between the asking price and the underlying value of the subject property given an increased level of transparency in the property price discovery process. The degree of such price deviation, we conjecture, should be dependent to the neighbourhood characteristic as well as property-level attributes. Therefore, this paper sets out to test the following three hypotheses in relation to the determination of asking prices of properties in Scotland:

Hypothesis 1 (H1): since the introduction of the Home Report, spatial autocorrelation of asking prices to selling price of nearby properties has become more pronounced; and

Hypothesis 2 (H2): the introduction of the Home Report has reduced the deviation of asking price from the underlying value of the property.

Hypothesis 3 (H3): the degree of deviation of asking price from the value of the property is determined by neighbourhood and property attributes.

By testing the above three hypotheses with market transactions data pre- and post-introduction of the Scheme, we should be able to empirically corroborate whether, and to what extent, the Home Report Scheme has achieved its stated objectives, and whether the property market has become more informationally efficient in terms of pricing.

4. Data

Transaction data on private residential properties from Aberdeen Solicitors Property Centre (ASPC)[11] was obtained on the basis of the non-disclosure agreement between University of Aberdeen and ASPC. The dataset covers the housing market in Aberdeen and Aberdeenshire (Figure 1)[12], and contains information on the physical attributes of the property, information on asking and selling prices, listing dates, transaction dates, and the method of sales.

[insert figure 1 here]

While the dataset commences in 1984, this study focuses on the time period between the second quarter of 1998 and the second quarter of 2013. This is due to the availability of geographical coordinates that are used in the analysis. In total, there are 79,648 observations in the data from (Q2 1998 to Q2 2013), 90% of which are successful transactions, with less than 10% of these properties withdrawn from ASPC without being sold. In total, 70,642 observations are used in the empirical modelling stage (Section 5), due to missing and incomplete variables. Table 1 provides a summary of the variables included in the empirical analysis and their descriptions.

[insert Table 1]

During the time period, over 82% of the properties in the dataset were marketed as "price over", whereas "fixed price" dominates the remaining 18% of the sample. The proportion of properties marketed as "price over" varies according to market conditions, ranging from 60% in the late 1990s to over 90% in mid 2000s. Following the 2008 Global Financial Crisis, the market witnessed a reduction of properties marketed as "price over", however the popularity of this selling mechanism started to increase again in 2010, symbolic of the start of the market recovery phase. By 2013, 87% of properties in Aberdeen were marketed as "price over".

Since the valuations of the properties are not available in the dataset[13], a limitation of the research is that we cannot directly observe how asking price is set relative to the valuation of

[11] ASPC was the first Solicitors Property Centre established in the UK, and serves as a central marketing place for residential properties and small commercial properties in the region. Approximately 90% of private residential properties in North East Scotland are marketed through ASPC.

[12] The map of Aberdeen Housing Market defined by local authorities is presented in Figure 1, it covers Aberdeen city local authority jurisdiction as well the commuting towns in Aberdeenshire.

[13] Before the introduction of the Home Report, valuations are instructed by buyers, and often multiple valuations were carried for the same properties by different buyers, such information was not recorded by ASPC.

the market. The asking-selling price spread - "price premium", is calculated as a percentage difference between the transaction price and the asking price[14] for each quarter for both "price over" transactions and "fixed price" transactions. Figure 2 shows the average deflated house price with reference to the right hand side vertical axis, the average price premium for "price over" transactions and "fixed price" transactions with reference to the left hand side vertical axis during the time period. The average house price is affected by both national and local oil and gas dominated economic conditions.

[insert figure 2 here]

It is evident that fluctuations in "price over" premiums are much more pronounced in the time series, with an average of around 6% observed in the late 1990s and early 2000s, and over 40% in the second quarter of 2007. These changes undoubtedly reflect the market upturn witnessed across most, if not all, advanced economies caused by financialisation and macroeconomic conditions. Notably, the very large premiums between 2006 and early 2008 are not due to a few extreme values in the sample. This is in line with the explanations on market conditions' influence on pricing strategy discussed in the previous section.

The signs of subprime mortgage crisis started in the second quarter of 2007, during which time, both house prices and offers over premiums peaked. The decreases of average house price commenced from Q3 2007, which was accompanied by a decline in price premiums. Nevertheless, "price over" premiums were still relatively large throughout the first three quarters of 2008. Notably, the first quarter of 2009, shortly after the introduction of the Home Report with observed price premiums for "price over" transactions reducing significantly to below 5% on average. Although the average house price also experienced a decrease simultaneously, the price decline was relatively insignificant. The average price premium for properties sold as "fixed price" on the other hand shows much less variation throughout the property cycle. Indeed, Figure 1 suggests that although market conditions play an important role in determining "price over" premiums, given the relatively high average price in Aberdeen post-GFC, there may be other forces that fundamentally changed the way in which the "price over" mechanism works.

[14] Price premium = (sold price – asking price) / asking price

5. Empirical models

Testing H1

To test H1, we start with the following hedonic equation:

$$lnP_{i,t} = c + \sum_{k=1}^{K} \beta_k S_k + \delta \sum_{k=1}^{n} W_{i,j} lnP_{j,t-h} + \varepsilon \quad \text{..... (Equation 1)}$$

$$with\ i \neq j$$

where $P_{i,t}$ is the asking price of property i at time t; c is a constant term; S_k is a bundle of structural characteristics of the subject property described in Table 1. β_k is the implicit price for the corresponding S_k. Since it is conjectured that sellers also use evidence of recently sold nearby properties when they set asking price, asking price is therefore expected to correlate with nearby properties transaction prices. To account for such pricing behaviour, a spatiotemporal term $\sum_{k=1}^{n} W_{i,j} lnP_{j,t-h}$ is included in the equation. $P_{j,t-h}$ is the actual transaction price of property j at time *t-h,* with $h = 2\ months$[15], $W_{i,j}$ is a spatial weight that reflects the degree as well as the structure of spatial proximity between properties i and j. Mathematically, $W_{i,j}$ can take one of the following forms:

$$W_{i,j} = \frac{1}{d_{i,j}} \quad \text{.....(Equation 1.1)}$$

$$W_{i,j} = \frac{1}{d_{i,j}^2} \quad \text{.....(Equation 1.2)}$$

$$W_{i,j} = \frac{1}{e_{i,j}^d} \quad \text{.....(Equation 1.3)}$$

where $d_{i,j}$ denotes the Euclidean distance measured in meter between property i and j; $W_{i,j}$ is so constructed since it is reasonable to assume that sellers would place heavier weight on more proximate properties in setting property price. The most typical measures (see Cliff and Ord, 1981, Basu, 1998 and Dublin, 1998) include inverse distances (Equation 1.1), inverse distances raised to some power (in Equation 1.2, we use distance-squared), and inverse exponential distance (Equation 1.3). Moreover, given that $\sum_{k=1}^{n} W_{i,j} = 1$, the spatial autoregressive term $W_{i,j} lnP_{j,t-h}$ suggests a weighted average of spatially lagged price

[15] We also used longer periods, and two months lag produced the highest spatial correlation coefficient.

information. The parameter δ therefore can indicate the degree to which sellers extract price information from prior sales to ascertain asking prices, and hence H1 can be tested. If past information is relevant and applicable, δ should be non-zero and statistically significant. In other words, housing prices are spatially auto-correlated. Finally, $\varepsilon_{i,t}$ is an error term that measures the effects stemming from missing variables, misspecification of the model, measurement errors and inadequate sampling. This specification essentially assumes a linear functional form and fixed parameters.

It must also be highlighted that while neighbourhood attributes are commonly employed and explicitly measured in a typical hedonic model, they are intentionally left out in our analysis. We surmise that the inclusion of $W_{i,j} ln P_{j,t-h}$ can indeed capture a set of neighborhood features pertaining to the socioeconomic and physical make-up of the neighbourhood and accessibility to various urban services and amenities. In addition, variables that are normally used to control for market conditions are not included in Equation (1) for the same reason. The omission of such variables should thus avoid potential statistical nuisances associated with over-specification of our models.

In addition to the spatial autoregressive variable, a dummy variable, $Withdrawn$, is included in the hedonic equation to explicitly discern properties that are withdrawn from the market after listing. Modifications of the equation yields Equation (2) below:

$$ln P_{i,t} = c + \delta \sum_{k=1}^{n} W_{i,j} ln P_{j,t-h} + \sum_{k=1}^{K} \beta_k S_k + \lambda Withdrawn + \varepsilon$$

.....(Equation 2)

where $Withdrawn$ takes the value 1 if the property is withdrawn from the market, and 0 otherwise; and λ is coefficients to be estimated. It is expected that overpriced properties are more likely to experience difficulties to sell, some of which may even be withdrawn from the market.

To test H1, which is deduced from the proposition that sellers have become more prone to infer asking prices based on actual prices of nearby recently transacted properties since the introduction of the Home Report Scheme, thereby increasing the spatial autocorrelation of the property prices, Equation (2) is thus modified by including a dummy variable, Dec_{2008}.

The variable is designed to interact with $W_{i,j}lnP_{j,t-h}$. Dec_{2008} has a value of 1 if the observation occurs on or after 1st December 2008, and 0 otherwise. Accordingly, we develop Equation (3) as follows:

$$lnP_{i,t} = c + \rho\, Dec_{2008} \times \sum_{k=1}^{n} W_{i,j}lnP_{j,t-h} + \delta \sum_{k=1}^{n} W_{i,j}lnP_{j,t-h} + \sum_{k=1}^{K} \beta_k S_k + \lambda Withdrawn + \varepsilon$$

$$with\ i \neq j \ldots\ldots \text{(Equation 3)}$$

The coefficient of ρ is expected to be positive and statistically significant, if sellers have indeed given more weight to nearby transactions when they set asking prices for the subject properties since the introduction of the Home Report. In other words, we should observe a stronger spatial autocorrelation between asking prices and nearby transaction prices after the scheme came into effect.

Testing H2

The second hypothesis formulated in this paper tests whether there is a reduction in deviation between asking price and the "value" of the property after the implementation of the scheme. More specifically, it tests whether potential house sellers are less inclined to market their properties by setting an unrealistically low asking price relative to the properties' potential market value after December 2008. To measure the degree of such pricing deviation, $Dev_{i,t}$[16] is used:

$$Dev_i = \frac{P_i^A}{P_i^E} \quad \ldots\ldots \text{(Equation 4)}$$

where P_i^A is the actual asking price of property i, and P_i^E is the estimated value of the property obtained from the following equation:

$$lnP'_{i,t} = c + \delta \sum_{k=1}^{n} W_{i,j}lnP_{j,t-h} + \sum_{k=1}^{K} \beta_k S_k + \varepsilon$$

$$with\ i \neq j \ldots\ldots \text{(Equation 5)}$$

Where $P'_{i,t}$ is the sale price of property i at time t. P_i^E is the fitted value of $P'_{i,t}$ for each dwelling obtained by estimating Equation (5).

[16] This follows the concept of degree of overpricing in Kang and Garder (1989); Yavas and Yang (1995); Donald et al (1996); Anglin et al (2003); and Pryce (2011). Seller's pricing strategy is presented by an asking price relative to the value of the property.

We further posit that $\mathrm{Dev_{i,t}}$ is a function of the structural variable $\mathrm{S_k}$, since sellers are expected to have better knowledge of the quality of the property, and their pricing strategy should reflect this accordingly. Pryce (2011) argues that the asking-selling price spread is likely to contain a locational convention γ_k^* (i.e. neighbourhoods may have implicit conventions on asking-selling price spread). However, γ_k^* is not directly observable in the dataset, we therefore use the standard deviation of the actual asking-selling price spread $\sigma_{i,k}$ within the neighbourhood k as a proxy for the locational convention:

$$\sigma_{i,\,k} = SD(Dev_k) \ldots\ldots \text{(Equation 6)}$$

Neighbourhood k is defined as a 3-kilometre radius circle[17] centred at property i. In addition, we only consider transactions that occur within the past two months prior to the sale of property i when computing $\sigma_{i,k}$. One would expect that within a neighbourhood k, if the standard deviation of asking-selling price spread $\sigma_{\gamma ik}$ is small, there is likely to be a "locational convention". On the other hand, if the variation in the asking-selling price spread is large, the evidence of locational convention γ_k^* should be less apparent. To test this, Equation (7) is constructed. $\sigma_{i,\,k}$ is expected to have a significant effect on $Dev_{i,t}$ and ω should be negative and statistically significant. Furthermore, it has been established that market conditions also play an important role in price setting (Pryce, 2011), hence, we posit that T, a time dummy variable (with a coefficient φ to be estimated) measured on a monthly basis, should affect $Dev_{i,t}$:

$$lnDev_{i,t}=\mathrm{c} + \sum_{\mathrm{k}\,=\,1}^{\mathrm{K}} \beta_{\mathrm{k}} \mathrm{S_k} + \omega\sigma_{i,\,k} + \varphi \mathrm{T} + \varepsilon \ldots\ldots \text{(Equation 7)}$$

Lastly, Dec_{2008} is added to Equation (8) to test H2. We believe that the Home Report should have a market-wide impact on how sellers set their initial prices. In particular, the practice of setting artificially low asking prices to draw more potential house buyers to bid will cease to a large extent. Accordingly, we re-write Equation (7) as follows:

$$lnDev_{i,t}=\mathrm{c} + \Omega Dec_{2008} + \sum_{\mathrm{k}\,=\,1}^{\mathrm{K}} \beta_{\mathrm{k}} \mathrm{S_k} + \omega\sigma_{i,\,k} + \varphi \mathrm{T} + \varepsilon \ldots\ldots \text{(Equation 8)}$$

Ω is expected to be positive and statistically significant.

We estimate the equations using Ordinary Least Squares (OLS) methods. Our models are designed in such a way that only past events can exert influence on current events but not vice versa. This can largely avoid statistical inference problems such as endogeneitiy in the spatial lag terms. Provided that the error terms of the equations are independent and identically distributed, the OLS estimator will be asymptotically efficient and consistent. The summary statistics of the variables are shown in Table 2.

[17] The choice of the size of neighbourhood k is not arbitrarily determined. Indeed, the size of Aberdeen city (including Old Aberdeen) is roughly equal to that of a 3-km radius circle.

[Insert Table 2 here]

6. Regression results and discussions

Results for H1

Table 3 presents the regression results for Equation (1) to (3) using the three specifications of spatial weight respectively. The p-value for each variable is given in brackets. The last three rows of the table display the R-squared, adjusted R-squared and F-statistics of the models.

[Insert Tables 3 here]

Most coefficients estimated using Equation (1) in all three measures of spatial weight show the expected signs and are statistically significant at the 1% level. For example, sellers are prone to demand a higher price for qualities such as extra bedrooms, public rooms, bathrooms, central heating, garage(s), double glazing, and cloak room (WC). New properties also tend to have a higher asking price. Dummy variable $Garden$ yields negative coefficients with all three spatial weighting specifications, which seems to be counter-intuitive. However, these coefficients became statistically insignificant once selling mechanisms and withdrawn properties are specified.

In regard to testing H1, which states that asking prices are assumed to be spatially linked to prices of nearby properties sold within the previous two months. We observe that the coefficient of the spatial lag term, δ, is 0.0339, 0.1599, and 0.1131 under that three different spatial specifications, and is statistically significant at the 1% level. This confirms our view that the housing prices are spatially auto-correlated. Of significance is the positive sign of the coefficient, which implies that house prices seem to move in tandem with one another: a higher (*lower*) price of a neighbouring property will generally result in a higher (*lower*) asking price of the subject property. Interestingly, the effect of $\mathrm{W_{i,j}}ln\mathrm{P_{j,t-h}}$ are very different across the three specifications with the size the magnitude of the variable appearing to be larger when non-liner measures (as in Equation 1.2 and Equation 1.3) are employed. Overall, the models achieve an explanatory power of around 50%.

As a modification of Equation (1), Equation (2) is designed to examine how properties that are withdrawn from the market are priced differently by the sellers. The coefficients on Withdrawn, significant at the 1% level, range from 0.1390 to 0.1769 across the three spatial weight specifications, suggesting that this category of properties tend to be priced 15%-19% higher than the others, *ceteris paribus*.

Equation (3) incorporates an interaction term, $Dec_{2008} \times \mathrm{W_{i,j}}ln\mathrm{P_{j,t-h}}$, to the model, which is designed to examine whether property sellers rely more on prior sales from the neighbourhood in ascertaining asking prices after the inception of the Home Report scheme. We find that the coefficients on the interaction term with all three specifications are around 0.05 and significant at the 1% level. This confirms our belief that after December 2008, asking

prices are more spatially dependent on nearby sale prices by virtue of the price discovery process of the sellers given a more informationally efficient housing market.

Results for H2

Equation (7) is formulated to investigate the determinants of pricing strategy, which is measured as the asking price relative to the estimated value derived from our hedonic model. Equation (8) further incorporates a dummy variable that indicates the introduction of the Home Report to test H2. Table 4 depicts the regressions results for H2 under the three spatial weighting specifications.

[insert Table 4]

Examining the results for Equation (7), locational convention measure $\sigma_{i,\,k}$ yields negative and significant coefficients with Equation (1.2) and (1.3) specifications. This is in line with our expectation that in a neighbourhood where there is a higher variation in the asking-selling price spread, the effect of locational convention should be less apparent with sellers being more likely to set asking prices that diverge more from the underlying values. The results also reveal that some housing attributes exhibit statistically significant effect on the dependent variable, suggesting that sellers do consider certain housing attributes such as number of bedrooms and heating systems when pricing their properties.

Lastly, Dec_{2008} is incorporated to Equation (8) to test H2. Its coefficient is 0.0523, 0.0274, 0.0397 under the three spatial weight specifications (1.1), (1.2), and (1.3) respectively. In all three cases, the coefficients are significant at the 1% level. Mathematically, it can be interpreted that there is a reduction in asking price-valuation deviation. More specifically, the ratio between asking price and the value of the property is 3%-5% closer to 1. This suggests that the marketing strategies employed to set unrealistically low asking prices by the sellers have become less evidenced since the introduction of the Home Report scheme, however the magnitude of such effect is relatively small.

In terms of R-squared and adjusted R-squared, our models achieve an explanatory power of around 40% for all the three spatial weight specifications. The estimation is marginally improved when location convention measure is taken into consideration. One might argue that the relatively low R-square could undermine the validity of the findings of the study. However, the main emphasis of this paper is on whether the Scheme affects the way sellers determine asking prices, *not* on the discovery of various determinants of valuation deviation of real estate price formation. Therefore, it should be highlighted that only the improvement of R-square, as well as the signs and statistical significance of the variables of interest in the models that are of crucial relevance to our research.

As a robustness test, we generate Equation (9) by discarding all statistically insignificant structural variables with p-value below 1% in Equation (8). It is shown that the results are highly consistent with those of the other models.

7. Concluding Remarks

Understanding the underlying price determination process and dynamics of real estate is important from the viewpoints of buyers, sellers and other stakeholders, especially in a market that is characterised by information inefficiency, a diverse composition of market players as well as heterogeneity of quality of housing. This study aims to empirically evaluate the effectiveness of the Home Report Scheme introduced and implemented in Scotland in 2008, which was designed to improve information efficiency about property condition as well as address the often-criticized malpractice of setting artificially low list prices by property sellers. To achieve this, we examine how sellers determine asking prices in an information search context with the use of a large number of real estate transactions in the North East of Scotland. By subjecting the analysis in a hedonic setting that explicitly incorporates a spatial process of price discovery using spatial lag modelling techniques and controls for a large number of housing attributes (i.e. to test H1), we find strong *prima facie* evidence that property sellers have become more prone to rely on prior sales to form asking prices since the Scheme came into effect, as indicated by an elevated level of spatial autocorrelation in the sample house prices across all statistical models examined. The once-common practice of setting artificially low asking price with the aim to attract buyers seems to have dwindled to a certain extent. In other words, after the introduction of the Scheme, real estate sellers seem to have set prices on a basis that is more closely in line with the general market conditions and the underlying value of property. The results of testing H2 in our analysis, which compares price divergence pre- and post- 2018, further confirms this conjecture.

A major learning outcome of this study is to provide robust evidence-based justifications for necessary government interventions to help address issues associated with market failures stemming from information asymmetry between buyers and sellers within a property market. Prior to the introduction of the Home Report, problems concerning the propensity of property sellers in Scotland artificially lowering initial asking prices were rife, placing potential buyers in a relatively weaker bargaining position. Indeed, an early investigation by Akerlof (1970) suggests that information asymmetry, which deters market participants from making mutually advantageous trade in a free enterprise economy, is particularly more widespread in markets dominated by second-hand assets such as direct real estate. This is due to the fact that sellers of second-hand homes are better informed about the quality of the dwellings than the buyers, and consequently creating an unlevel playing field when it comes to pricing. Our empirical results support the view that government should play a more active role in facilitating transactions in the real estate market by putting forward measures that counteract such information asymmetry in property pricing, ensuring a higher degree of market transparency which could result in enhanced market information efficiency and equitability that benefit not only the market players but also the society at large.

From a methodological stance, this study demonstrates how housing policies can be empirically evaluated and scrutinised in the framework of spatial hedonic price modelling,

which is one of the greatest departures from the mainstream real estate literature. Existing approaches to examining institutional arrangements of housing market have been predominately normative or descriptive in nature, often producing elusive and subjective explanations, conclusions and implications that cannot be hypothesised and/or validated with empirical data. Last but not least, we believe that the findings of the study yield both theoretical and practical insights into real estate price formation, which are of great use and interest to policymakers, real estate developers, individual homebuyers, financial institutions and property professionals.

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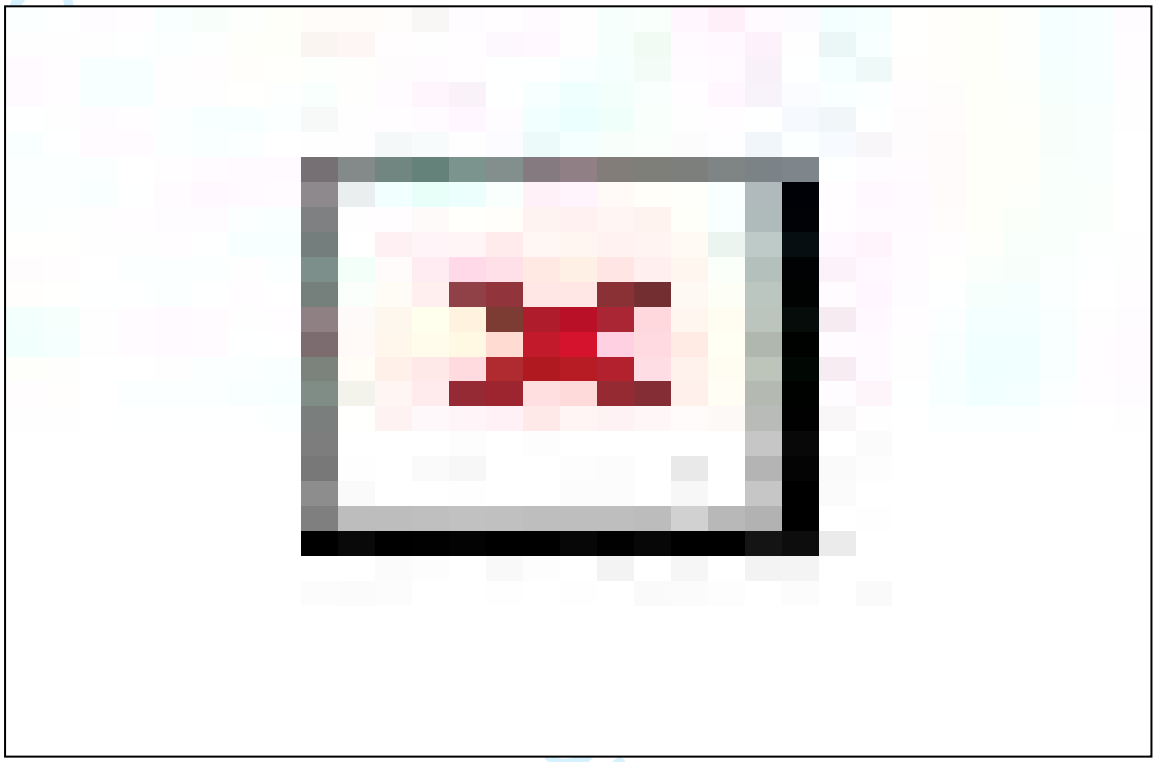
Figures and tables

Figure 1. Housing market areas of Aberdeen city and Aberdeenshire.



Source: Aberdeen City Council

Figure 2, Asking-selling price premiums and average real house price in Aberdeen housing market 1998 Q2 to 2013Q2.

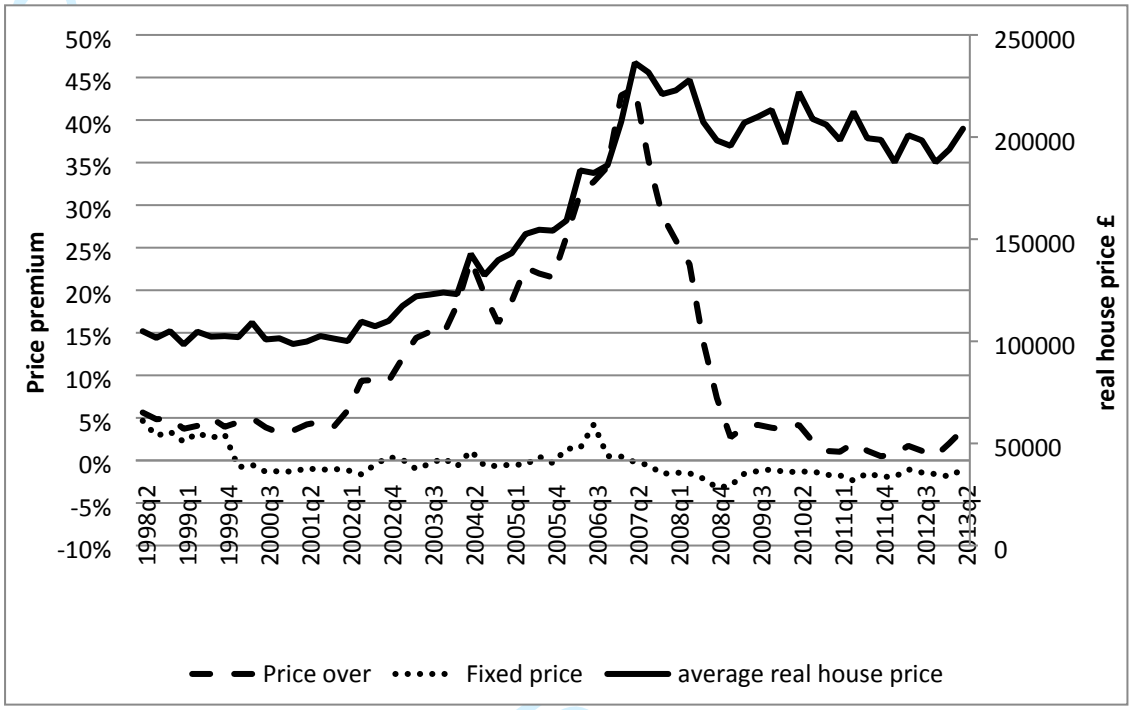


Table 1: descriptions of variables:

Variable	Description/Type
Heating type (Heating)	1 if property has central heating, =0 if property has no heating or any other form of heating
Double Glazed	1 if property has double glazing, otherwise =0
Garden	1 if property has garden(s), otherwise =0
Floor	Number of floor stories within the dwelling: 1 for flat and bungalows, 2 or more for multi-storey houses
Bathroom	Number of bathrooms.
Bedroom	Number of bedrooms
WC	Number of separate toilets/cloak rooms
Public	Number of public rooms, including kitchen, lounge, conservatory, play room, etc.
Dec_{2008}	1 if property was listed on and after December 1st 2008, otherwise =0
Garage	If a property has a garage(s)
New	1 if property is a new build, otherwise =0
Withdrawn	1 if property was withdrawn from the market, otherwise=0
Type D	1 if dwelling is detached property, otherwise=0
Type F	1 if dwelling is a flat, otherwise=0
Type N	1 if dwelling is non-detached property, otherwise=0
Dev	Ratio: the deviation between asking price and the "value" of the property after the implementation of the scheme.

Table 2: Descriptive statistics of the main variables

	Unit	Mean	Std. Dev.	Min	Max
$P_{i,t}$	GBP£	131 239	107 836	9000	3500000
$V_{i,t}$	GBP£	134 097	106 729	24077	6002596
$Dev_{i,t}$	Ratio	0.9999	0.0244	0.8320	1.3730
$SD(Dev_k)$	---	0.2761	0.0022	0.2017	0.3183
Heating	Dummy Var.	0.8128	0.3900	0	1
DoubleGlazed	Dummy Var.	0.8778	0.3274	0	1
Garden	Dummy Var.	0.5971	0.4904	0	1
Floor	Number	1.4585	0.5596	1	6
Bathroom	Number	0.9165	0.3599	0	4
Bedroom	Number	2.3297	1.1398	0	9
Garage	Number	0.3637	0.6038	0	8
WC	Number	0.1630	0.3784	0	3
Public	Number	1.4747	0.8033	0	14
Dec_{2008}	Dummy Var.	0.2450	0.4301	0	1
New	Dummy Var.	0.0058	0.0763	0	1
Withdrawn	Dummy Var.	0.0997	0.2970	0	1
Type D	Dummy Var.	0.1674	0.3733	0	1
Type F	Dummy Var.	0.5331	0.4989	0	1
Type N	Dummy Var.	0.2994	0.4580	0	1

Table 3: Regression results for Equations 1 to 3

Dependent Variable	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$	$\mathbf{P_{i,t}}$
Spatial Weight	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$
Independent Variables	**Eqn 1**	**Eqn 2**	**Eqn 3**	**Eqn 1**	**Eqn 2**	**Eqn 3**	**Eqn 1**	**Eqn 2**	**Eqn 3**
$W_{i,j}P_{j,t-h}$	0.0339	0.0390	0.0220	0.1599	0.1818	0.1255	0.1131	0.1294	0.0883
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$Dec_{2008} \times W_{i,j}P_{j,t-}$	----	----	0.0534	----	----	0.0518	----	----	0.0524
			(0.0000)			(0.0000)			(0.0000)
C	10.1342	10.2254	10.2355	8.8068	8.7396	9.1640	9.2912	9.2794	9.5441
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Heating	0.1994	0.2020	0.1888	0.2013	0.2047	0.1911	0.2001	0.2033	0.1904
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DoubleGlazed	0.0247	-0.0202	-0.0245	0.0116	0.0049	-0.0349	0.0128	0.0063	-0.0341
	(0.0000)	(0.0004)	(0.0000)	(0.0419)	(0.3833)	(0.0000)	(0.0259)	(0.2687)	(0.0000)
Garden	-0.0134	-0.0059	-0.0019	-0.0053	0.0049	0.0059	-0.0154	-0.0070	-0.0031
	(0.0140)	(0.2719)	(0.6778)	(0.3172)	(0.3470)	(0.1859)	(0.0441)	(0.1861)	(0.4889)
Bedroom	0.2661	0.2648	0.2470	0.2650	0.2632	0.2460	0.2655	0.2639	0.2464
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Floor	0.0339	0.0282	0.0241	0.0308	0.0237	0.0206	0.0382	0.0323	0.0271
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bathroom	0.0215	0.0188	0.0381	0.0137	0.0096	0.0432	0.0189	0.0155	0.0394
	(0.0000)	(0.0002)	(0.0000)	(0.0063)	(0.0521)	(0.0000)	(0.0002)	(0.0018)	(0.0000)
Garage	0.0992	0.1045	0.1100	0.1038	0.1107	0.1140	0.0961	0.1017	0.1077
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
WC	0.0388	0.0350	0.0261	0.0363	0.0318	0.0240	0.0350	0.0304	0.0228
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Public	0.1406	0.1420	0.1512	0.1422	0.1439	0.1527	0.1420	0.1437	0.1527
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Type D	0.0764	0.0636	0.0837	0.0751	030596	0.0802	0.0695	0.0539	0.0764
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Type F	0.0302	0.0208	0.0368	0.0237	0.0113	0.0289	0.0475	0.0389	0.0505
	(0.0000)	(0.0035)	(0.0000)	(0.0008)	(0.1041)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
New	0.6005	0.4858	0.5309	0.5811	0.4443	0.4999	0.5825	0.4502	0.5038
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Withdrawn	----	0.1390	0.1267	----	0.1769	0.1539	----	0.1663	0.1466
		(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)
Included Obs.	70642	70642	70642	70642	70642	70642	70642	70642	70642
R^2	0.5085	0.5218	0.6600	0.5293	0.5476	0.6759	0.5229	0.5399	0.6720
$Adjusted\ R^2$	0.5084	0.5217	0.6599	0.5292	0.5475	0.6759	0.5228	0.5398	0.6719
Prob (F Stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p-values are in brackets

Table 4: Regression results for Equations 7 to 9

Dependent Variable	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$	$Dev_{i,t}$
Spatial Weight	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/d_{i,j}^2}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$	$\mathbf{1/e_{i,j}^d}$
Independent Variables	**Eqn 7**	**Eqn 8**	**Eqn 9**	**Eqn 7**	**Eqn 8**	**Eqn 9**	**Eqn 7**	**Eqn 8**	**Eqn 9**
Dec_{2008}	----	0.0523	0.0522	----	0.0274	0.0272	----	0.0397	0.0395
		(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)
Locational	-0.9392	-1.2298	-1.4340	-2.1019	-2.1149	-2.1096	-1.5328	-1.5881	-1.6217
Convention	(0.1450)	(0.0562)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
C	-0.1070	-0.0504	----	0.1649	0.1530	0.1546	0.0056	-0.0036	----
	(0.5698)	(0.7888)		(0.0000)	(0.0000)	(0.0000)	(0.8679)	(0.9150)	
Heating	-0.0131	-0.0131	-0.0136	-0.0133	-0.0133	-0.0134	-0.0134	-0.0134	-0.0133
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DoubleGlazed	-0.0475	-0.0481	-0.0468	-0.0291	-0.0294	-0.0297	-0.0362	-0.0367	-0.0358
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Garden	0.0111	0.0108	0.0117	0.0018	0.0016	----	0.0053	0.0051	----
	(0.0017)	(0.0022)	(0.0000)	(0.6249)	(0.6522)		(0.1418)	(0.1581)	
Bedroom	-0.0073	-0.0075	-0.0063	-0.0064	-0.0065	-0.0036	-0.0069	-0.0070	-0.0050
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0002)	(0.0072)	(0.0001)	(0.0000)	(0.0009)
Floor	-0.0018	-0.0021	----	0.0006	0.0005	----	-0.0004	-0.0005	----
	(0.6347)	(0.5959)		(0.8862)	(0.9070)		(0.9258)	(0.8959)	
Bathroom	0.0494	0.0501	0.0505	0.0405	0.0409	0.0418	0.0440	0.0445	0.0445
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Garage	0.0169	0.0169	0.0228	0.0105	0.0105	0.0186	0.0130	0.0131	0.0198
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
WC	-0.0139	-0.0140	-0.0106	-0.0088	-0.0088	----	-0.0108	-0.0109	-0.0070
	(0.0002)	(0.0002)	(0.0037)	(0.0236)	(0.0227)		(0.0053)	(0.0050)	(0.0632)
Public	0.0065	0.0067	0.0079	0.0049	0.0049	----	0.0056	0.0057	0.0074
	(0.0010)	(0.0008)	(0.0000)	(0.0163)	(0.0148)		(0.0060)	(0.0051)	(0.0002)
Type D	0.0235	0.0237	----	0.0259	0.0261	----	0.0251	0.0253	----
	(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)	
Type F	-0.0028	-0.0034	----	0.0008	0.0005	----	-0.0003	-0.0007	----
	(0.5502)	(0.4698)		(0.8615)	(0.9099)		(0.9487)	(0.8794)	
New	-0.3389	-0.3408	-0.3390	-0.2912	-0.2923	-0.2913	-0.3094	-0.3108	-0.3105
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Included Obs.	64070	64070	64070	64070	64070	64070	64070	64070	64070
R^2	0.4435	0.4449	0.4446	0.3946	0.3950	0.3945	0.4005	0.4013	0.4009
$Adjusted\ R^2$	0.4420	0.4434	0.4431	0.3930	0.3934	0.3930	0.3988	0.3997	0.3994
Prob (F Stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p-values are in brackets