Housing Markets and the Role of Real Estate Agents

Derek G. Stacey *
Department of Economics,
Queen’s University
Kingston, Ontario,
Canada, K7L 3N6
staceyd@econ.queensu.ca

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Abstract

A model of the market for housing is developed using a search framework with asymmetric information. A seller sets a reservation price and runs an auction when there is more than one interested buyer, and buyers implement competitive bidding strategies. Heterogeneity on the seller side reflects differences in willingness to sell. The inability to commit to a list price prevents sellers from using price posting as a signaling device. In particular, patient sellers mimic impatient sellers in order to drive up the final sale price by increasing the probability of a bidding war. Consequently, illiquidity in the housing market is rendered more severe because of adverse selection and inefficient entry on the demand side. Introducing real estate agents as service providers that can improve the expected quality of a match can in some circumstances segment the market and alleviate information frictions.

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1 Introduction

A wide range of empirical work has established several stylized facts about housing market prices and selling times. The correlations between prices and liquidity and the observed price dispersion in housing markets point to search theory as an appropriate modeling technique. While existing search models of the housing market can account for a wide range of the empirical trends, I argue that off-the-shelf search frameworks are not consistent with casual observations of the real estate market. For instance, some of these models do not allow for multiple offers by competing bidders, others ignore the possibility of renegotiating offers announced ex ante when there are ex post incentives to do so, and few provide insight about the role of real estate agents in the housing market. A suitable theory of the housing market should (i) employ a method of price determination that accounts for the strategic interaction between buyers and sellers; (ii) incorporate the documented heterogeneity in seller motivation and asymmetry of information; and (iii) provide intuition for the high demand for real estate services and the seemingly puzzling structure of listing contracts.

In this paper, I develop a model of the market for housing using a search framework with asymmetric information. I deviate from the usual price determination processes used in search models in order to more accurately reflect the interaction between buyers and sellers in real estate markets. In particular, I allow buyers to exploit their monopsony power when no other buyers are making offers, and I allow sellers to run sealed bid auctions to increase the price when several buyers are interested in purchasing the house. I discuss the competitive bidding strategies implemented by buyers and the determination of prices in more detail below.

Glower, Haurin, and Hendershott (1998) conduct a survey of home sellers and find substantial heterogeneity in terms of motivation to sell: some sellers have a strong desire to sell quickly, while other sellers are much more patient. Accordingly, I introduce heterogeneity on the seller side of the market to reflect differences in reservation values. A seller’s degree

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of patience can be a reflection of a job opportunity elsewhere or the seller’s arrangement to purchase her next home (i.e., the seller might have already bought a new home, and wants to sell the first home quickly in order to avoid double mortgage payments). Importantly, the seller’s willingness to sell is unobservable to the buyer. Seller heterogeneity and the asymmetry of information have important implications for the determination of house prices and the degree of liquidity in the real estate market: expected prices are lower and the volume of transactions declines. Intuitively, the inability to commit to a list price prevents sellers from using price posting as a signaling device. Instead, patient sellers mimic impatient sellers in order to drive up the final sale price by increasing the probability of a bidding war. Consequently, illiquidity in the housing market is rendered more severe because of adverse selection and inefficient entry on the demand side.

I extend the model to include real estate agents as service providers that can improve the expected quality of a match. In North American housing markets, sellers typically hire real estate agents to provide expert advice about setting a list price, market their house, and negotiate on their behalf. The real estate agent’s commission is usually expressed as a percentage of the sale price, and the listing contract often contains a clause that the commission is owed to the agent once they secure a “ready, willing, and able buyer.” By modeling the listing contract in this way, I find that in some circumstances, real estate agents can offer incentive compatible contracts to segment the market by seller type. This alleviates the information problem and increases liquidity in the housing market. Moreover, it generates the appropriate relationships between list price, sale price, and time on the market. In other circumstances, a pooling contract dominates the pair of incentive compatible real estate agreements. Consequently, patient sellers mimic anxious sellers in an attempt to attract enough buyers to generate a bidding war. Observations consistent with this type of equilibrium arise in especially “hot” real estate markets, and the seller’s behaviour is sometimes referred to as “artificially stimulating a bidding war.” A recent article on YourHome.ca describes this type of multiple offers strategy in the Toronto housing market: “For highly sought-after neighbourhoods, agents in Toronto may deliberately underprice a home to at-
tract more buyers... The hope is to create an auction mentality that will cause buyers to
bid higher.”

This paper is related to the recent literature that applies search theory to model the
housing market (Wheaton, 1990; Arnold, 1999; Krainer, 2001; Albrecht et al., 2007; Díaz
and Jerez, 2010; Head, Lloyd-Ellis, and Sun, 2010; Albrecht, Gautier, and Vroman, 2010).
With a few exceptions, most of the literature either assumes random matching with prices
determined through bargaining, or directed search with sellers posting non-negotiable prices.
While I argue that these frameworks are inconsistent with real-world observations of buyer-
seller interaction in housing markets, these papers have nevertheless succeeded in explaining
a wide range of empirical facts about real estate markets. Head, Lloyd-Ellis, and Sun (2010)
and Díaz and Jerez (2010) use directed search to model the housing market. In this type of
framework, setting a low list price attracts more buyers and reduces the expected time on
the market. Díaz and Jerez (2010) calibrate their model to the U.S. economy, and are able to
account for price volatility and the correlations between prices, sales volume, and time on the
market. Head, Lloyd-Ellis, and Sun (2010) develop new stylized facts about housing markets
using data from U.S. cities, and construct a model to account for the dynamics of house prices
and construction rates. Albrecht et al. (2007) introduce heterogeneity in terms of motivation
to buy/sell, which has implications for price dispersion and the comovement of house prices
and time on the market. In their model, types are fully observable and a random matching
framework with Nash bargaining precludes market segmentation. My approach differs from
these papers in that I specifically model the strategic interaction between buyers and sellers
in the process of price determination. Moving away from Nash bargaining and non-negotiable
price posting towards a setting that more closely resembles the mechanism observed in North
American real estate markets has important implications for housing liquidity and residual
price dispersion.

2 “House sellers, buyers balk at bidding wars” by Tony Wong, posted on YourHome.ca on February 27,
2010. Similar evidence appears in “Home buyers still face bidding wars” by Tony Wong, published in The
Toronto Star on August 4, 2008; “Real estate bidding wars make a comeback” by Tony Wong, published in
The Toronto Star on May 31, 2009; “Preparation can ease stress of bidding war” by Mark Weisleder, published
on YourHome.ca; and “Book aims to forearm buyers for bidding wars” by Ellen Roseman, published in The
Toronto Star on September 9, 2009.
A few other studies have adopted a similar approach. Arnold (1999) deviates from the usual price posting assumption by modeling the negotiations between a buyer and seller with a Rubinstein bargaining game where the list price is the initial offer.\(^3\) His framework is only appropriate for situations wherein a seller matches with a single buyer: he cannot account for bidding wars that result in houses selling above the asking price, which plays an important role in this paper. The model presented here is perhaps closest to Albrecht, Gautier, and Vroman (2010). They impose only partial commitment to the posted price in the sense that a seller can run an auction when she receives multiple offers. They also introduce heterogeneity on the seller side in an environment with private information. I argue that their framework imposes strong assumptions in order for the equilibrium to be fully separating. By relaxing these assumptions, the equilibrium is necessarily pooling. The housing market is then plagued by illiquidity as a result of adverse selection and inefficient entry of buyers relative to an environment with a separate submarket for each type of seller. Then, by introducing real estate agents in a realistic manner, I investigate when separation can be restored and the implications for prices and liquidity in the housing market.

In most models of housing markets, real estate agents are unnecessary and therefore excluded from the analysis. There are a few exceptions, such as Arnold (1992), Yavaş (1992), Yavaş and Yang (1995), Williams (1998), and Loertscher and Niedermayer (2008). Most models with real estate agents focus on the principal-agent relationship between the seller (the principal) and the realtor (the agent). Yavaş (1992) and Yavaş and Yang (1995) analyze the search effort of the real estate agent, while Arnold (1992) considers the incentives for conveying truthful information about the conditions of the real estate market to aid with setting an appropriate list price. The attention of empiricists has also been aimed at the principal-agent problem in the market for real estate services. Levitt and Syverson (2008b) and Rutherford, Springer, and Yavaş (2005) find evidence to support the hypothesis that sellers’ and their agents’ incentives are misaligned by comparing the selling prices and duration on the market in transactions data with an independent variable to indicate when

\(^3\)See also Horowitz (1992), Chen and Rosenthal (1996) and Carrillo (2005) for models of real estate markets where the list price represents full commitment to a price ceiling in subsequent negotiations.
the real estate agent is also the owner of the home. In this paper, I abstract from the principal-agent approach and instead focus on the services provided by real estate agents and the incentive compatibility of listing contracts. Real estate agents do not affect the matching function directly, but instead influence the expected quality of a match. When a buyer visits a house on the market, he learns his valuation of the seller’s unit. An idiosyncratic random variable therefore represents the quality of the match between a buyer and the seller’s house. I assume that real estate agents can use their expert knowledge of the market to influence the distribution from which the buyer’s valuation is drawn. Providing such services is costly, so real estate agents demand a commission. By constructing listing contracts to reflect the type of contract we typically observe between a seller and her real estate agent, I show that the value of real estate agents is not limited to the services they provide, but can also include the benefits of market segmentation: information revelation and an increase in the volume of trade.

This paper also contributes to the search literature, and in particular the study of markets with search frictions and private information. Guerrieri, Shimer, and Wright (2010) present a search environment with sellers possessing private information about the quality of their asset. When buyers can commit to a take-it-or-leave-it trading mechanism, the authors show that screening can at least partly alleviate the symptoms of adverse selection in a competitive search environment. Delacroix and Shi (2007) present a model with adverse selection where sellers can post non-negotiable prices as a means of directing search, and also as a signal of the quality of their asset. In contrast, relaxing the assumption of full commitment to the announced take-it-or-leave-it offer is an important element in this paper, and seems more realistic in the context of real estate markets. Menzio (2007) relaxes the commitment assumption in a model of the labour market and shows that cheap talk can sometimes credibly convey information when wages are determined through bilateral bargaining. An important feature of the present environment is the difference between the process of price determination in a bilateral match (one seller and one buyer) and a multilateral match (one seller and multiple buyers). Julien, Kennes, and King (2006) highlight the implications of
this setup for residual price dispersion in a theory of the labour market in an environment with full information. Under asymmetric information, I show that the incentive to exploit ex post opportunities hinders truthful information revelation. Another paper that considers a similar type of environment is Kim (2009). He shows that auctions can fully or partially segment the market when there is private information about the quality of the asset. The aforementioned papers involve private information about the quality of the asset (or job vacancy in the context of Menzio’s labour market). Here, the hidden information is the seller’s motivation, which is independent of the buyer’s valuation. This, along with the inability to commit to ex ante offers, impedes screening, signaling, and endogenous market segmentation.

The next section presents the model of the housing market with homogeneous sellers. Section 3 introduces heterogeneity in seller motivation and discusses how information frictions give rise to housing illiquidity. Real estate agents are introduced in Section 4. Section 5 discusses the set of stylized facts about residential real estate markets that are consistent with the model. Section 6 concludes.

2 The Model: Homogeneous Sellers

There is a fixed measure $S$ of sellers, and a measure $B$ of buyers determined by free entry. Sellers are ex ante homogeneous (for now), and have reservation value, $c$. Buyers pay a cost $\kappa$ to enter the market for housing and visit a home listed for sale. Buyers are ex ante homogeneous. Upon visiting a house, however, the value $v$ that they assign to home ownership is a match specific random variable, depending on the idiosyncratic quality of the match. The random variable is designed to capture the fact that houses are what Menzio and Shi (2011) call “inspection goods.” The subtle differences between units that are only observable by visiting and inspecting a house result in variation in buyers’ ex post valuations. For convenience, a buyer visits a home and values it at $v_L$ with probability $1 - q$ (he likes the house) and $v_H$ with probability $q$ (he loves the house). In Section 4 I introduce real estate
agents that can use their expert knowledge of the market and provide marketing services to increase the probability that a potential buyer’s valuation is high.

If a buyer meets a seller and a transaction takes place at price $p$, the payoff to the seller is $p - c$, and the payoff to the buyer is $v_i - p$, where $i \in \{L, H\}$ refers to the quality of the match between the buyer and the house. Buyers are unable to coordinate their search activities, which generates both an unsold stock of housing and bidding wars in equilibrium. The matching process of buyers and sellers is governed by the urn-ball matching function, $M(B, S) = S(1 - e^{-\theta})$, where $\theta = B/S$ is the ratio of buyers to sellers, or market tightness. More specifically, the probability that a seller is matched with exactly $k$ buyers follows a Poisson distribution,

$$\frac{\theta^k}{k!e^\theta}, \quad k = 0, 1, 2, \ldots$$

I deviate from the price determination mechanisms typically used in off-the-shelf search models. Nash bargaining is inappropriate for modeling the interaction between buyers and sellers in housing markets with multilateral matches (i.e., when several buyers visit the same house), especially in settings with private information. Price posting by sellers requires commitment, even though ex post there are incentives for sellers to allow buyers to bid the price up above the list price. For the same reason, take-it-or-leave-it offers by buyers are unrealistic since there are ex post incentives to bid competitively with other potential buyers, or to offer a lower amount in a bilateral match (i.e., when no other buyers are matched with the same seller). Instead, I propose a different mechanism to reflect these important dimensions of house price determination. In a bilateral match, the buyer makes a take-it-or-leave-it offer, but if other buyers are interested in the same house, they bid competitively for the purchase.

**Buyers’ Bidding Strategies**

If a buyer is the only one to visit a particular house (a bilateral match), he is free to make an offer without worrying about competing bidders. In such cases, the buyer is a monopsonist,
and makes a take-it-or-leave-it offer of \( c \). When more than one buyer shows up (a multilateral match), they compete for the house. This is essentially a private value sealed bid auction where the number of other bidders is unobservable. Type \( L \) buyers compete à la Bertrand and bid \( v_L \). If all bidders are of type \( L \), the seller randomly selects among the buyers bidding \( v_L \), so that each bidder has an equal probability of purchasing the home. Type \( H \) buyers play a mixed bidding strategy, which can be represented by a distribution function \( F : (v_L, b) \rightarrow [0,1] \), where \( b \leq v_H \) is the endogenously determined highest bid. Since all type \( H \) buyers are identical, I assume symmetric bidding strategies. Bidders are indifferent between bids in \( (v_L, \bar{b}] \). A type \( H \) buyer bidding \( b > v_L \) close to \( v_L \) wins the auction if none of the other bidders are of type \( H \). A higher bid increases the probability of winning the auction if other bidders are of type \( H \), but reduces the payoff if the bid is successful in winning the auction.

This process of price determination is more appealing than the alternatives for several reasons. First, it does not assume that bilateral negotiations take place even when there are other potential buyers ready and willing to pay more. Second, it does not impose full commitment to posted prices on the part of sellers or announced willingness to pay by buyers. Other search-theoretic models of the housing market allow sellers to post non-negotiable list prices (Díaz and Jerez, 2010; Head, Lloyd-Ellis, and Sun, 2010). This restricts the seller’s ability to extract a larger share of the trade surplus when her house is desired for purchase by multiple buyers, as well as the buyer’s ability to drive a hard bargain when he is the only potential buyer. In the competitive search framework of Guerrieri, Shimer, and Wright (2010), the uninformed party has the ability to commit to posted terms of trade. This environment also seems ill-suited for a model of housing markets as it prevents buyers from renegotiating once matched.

There are a few papers that explore auctions in a market with buyers choosing bidding strategies that take into account the possibility of other buyers competing for the same asset (Satterthwaite and Shneyerov, 2007; Kim, 2009; Albrecht, Gautier, and Vroman, 2010). The difference here is that a potential buyer knows whether or not he is involved in a bidding
A seller has a vested interest in disclosing this information, since the presence of other buyers bids up the price of her house. Finally, the mechanism proposed here does not require a constant bargaining parameter that is independent of the number of buyers, as in the random search framework with Nash bargaining (Leung and Zhang, 2006; Albrecht et al., 2007). An attractive feature of the model is that monopsonists can extract all of the surplus in a transaction, but as the number of buyers in a multilateral match increases, so does the seller’s expected share of the surplus.

**Expected Payoffs and Free Entry**

The expected payoff of visiting a house as a type $L$ buyer is

$$U_L(q, \theta) = e^{-\theta}(v_L - c) + \sum_{k=1}^{\infty} \frac{\theta^k}{k!e^\theta} (1 - q)^k \frac{v_L - b}{k + 1} = e^{-\theta}(v_L - c)$$

The first term is the the payoff in the monopsony case, which occurs with probability $e^{-\theta}$. The second term is the payoff in a multilateral match with $k = 1, 2, \ldots$ other buyers, which is zero for a type $L$ buyer since $b = v_L$. The expected payoff of visiting a house as a type $H$ buyer with bidding strategy $b \sim F$ is

$$U_H(q, \theta) = e^{-\theta}(v_H - c) + \sum_{k=1}^{\infty} \frac{\theta^k}{k!e^\theta} \sum_{j=0}^{k} p(j; k, q) F(b)^j (v_H - b)$$

where $p(j; k, q) = \binom{k}{j} q^j (1-q)^{k-j}$ is the probability mass function for the binomial distribution with parameters $k$ and $q$. It is the probability that exactly $j$ out of the $k$ other bidders are of type $H$ when $q$ is the probability of a high quality match when a buyer visits a house on

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4Sellers/real estate agents have strategic ways to credibly convey this information to competing bidders. For example, an open house followed by a deadline for submitting offers leads to a scenario with competing bidders in the same location at the same time, where buyers can observe that they are in competition for the house. Alternatively, I could allow sellers to inform potential buyers after the initial offer that there are competing offers and provide opportunity to resubmit. Intermediation by real estate agents adhering to a code of ethics would prevent sellers from being untruthful about the existence of competing offers.
the market. Then

\[
U_H(q, \theta) = e^{-\theta(v_H - c)} + \sum_{k=1}^{\infty} \frac{\theta^k}{k!} e^\theta \sum_{j=0}^{k} \binom{k}{j} q^j (1 - q)^{k-j} F(b)^j (v_H - b)
\]

\[
= e^{-\theta q (1-F(b))} (v_H - b) + e^{-\theta} (b - c)
\]

(3)

The mixed bidding strategy requires indifference over bids. Bidding just above \(v_L\) is in the set of optimal bids, since this is just enough to win the auction if every other potential buyer is of type \(L\). The expected payoff for this bidder is

\[
U_H(q, \theta) = e^{-\theta q (v_H - v_L)} + e^{-\theta} (v_L - c)
\]

(4)

The expected payoff to a buyer bidding any \(b\) in \((v_L, \bar{b}]\) has to be the same as the expected payoff above. Equating (3) and (4) and solving for \(F(b)\) uncovers the bidding strategy:

\[
F(b) = \frac{1}{\theta q} \log \left( \frac{v_H - v_L + e^{-\theta (1-q)} (v_L - b)}{v_H - b} \right)
\]

(5)

The highest bid \(\bar{b}\), defined by \(F(\bar{b}) = 1\), is therefore

\[
\bar{b} = v_L + \left( \frac{1 - e^{-\theta q}}{1 - e^{-\theta}} \right) (v_H - v_L)
\]

(6)

The expected payoff of entering the housing market as a potential buyer reflects the two possible match qualities:

\[
U(q, \theta) = q U_H(q, \theta) + (1 - q) U_L(q, \theta) = e^{-\theta} (v_L - c) + q e^{-\theta q} (v_H - v_L)
\]

(7)
The expected payoff to a seller is

\[
V(q, \theta) = \theta e^{-\theta}(c - c) + \sum_{k=2}^{\infty} \frac{\theta^k}{k!e^\theta} \left[ (v_L - c) + \sum_{j=0}^{k} p(j; k, q) \int_{v_L}^{\bar{b}} (b - v_L) dF^j(b) \right]
\]

\[
= \left[ 1 - (1 + \theta)e^{-\theta} \right] (v_L - c) + \sum_{k=2}^{\infty} \frac{\theta^k}{k!e^\theta} \sum_{j=0}^{k} \binom{k}{j} q^j(1 - q)^{k-j} \int_{v_L}^{\bar{b}} (b - v_L) dF^j(b)
\]

(8)

Using the bidding strategy \( F \), the highest bid \( \bar{b} \), and solving yields the following expression for the expected payoff to a seller:

\[
V(q, \theta) = \left[ 1 - (1 + \theta)e^{-\theta} \right] (v_L - c) + \left[ 1 - (1 + \theta q)e^{-\theta q} \right] (v_H - v_L)
\]

(9)

A complete derivation of \( V(q, \theta) \) is provided in Appendix A. Finally, free entry of buyers determines the equilibrium buyer-seller ratio, \( \theta \):

\[
U(q, \theta) = e^{-\theta}(v_L - c) + q e^{-\theta q}(v_H - v_L) = \kappa
\]

(10)

### 3 The Model: Heterogeneous Sellers

Heterogeneity on the seller side reflects differences in willingness to sell. Consistent with the evidence documented by Glower, Haurin, and Hendershott (1998), some sellers are desperate to sell quickly, while other sellers are more patient. As an extreme example, imagine a young worker who needs to sell her home and move to another city before the start date of her new job. She is likely willing to sell at a low price if it means a shorter time on the market. Next consider an old woman who puts her house on the market with the intention of moving into a retirement home. If she is anything like my grandmother, she is much more willing to hold out for a higher sale price and delay nursing home entry. The fact that most sellers are also buyers in the housing market is likely another source of heterogeneity in seller motivation. Some sellers might have already submitted offers to purchase another
home. Illiquidity in the housing market means that they may either find themselves servicing
two mortgages, or have the purchase fall through if it was a conditional-on-sale offer. In a
dynamic setting, preferences over price and liquidity would affect the discount rate. In a
static setting, heterogeneous reservation values is sufficient for capturing this phenomenon.
A fraction $\sigma$ of sellers are anxious or impatient sellers with a low reservation utility, $c_A$. The
remaining $1 - \sigma$ of sellers are relaxed/patient, with a high reservation utility, $c_R > c_A$. If a
seller accepts a buyer’s offer of $b$, the payoff to the seller is $b - c_h$, $h \in \{A, R\}$. In addition,
differences in sellers’ willingness to sell is an important source of asymmetric information in
the housing market, since reservation values are unobservable to buyers.

**Buyers’ Bidding Strategies**

In a bilateral match, a buyer is free to make an offer without worrying about competing
bidders. In such cases, the buyer is a monopsonist, and makes a take-it-or-leave-it offer of
either $c_A$ or $c_R$:

$$\max \{ \sigma(v - c_A), v - c_R \}$$

(11)

If $\sigma(v - c_A) > v - c_R$, there is a selection problem, and a monopsonist will offer $c_A$, knowing
that if the seller is of type $R$, the offer is rejected and there is no transaction. Otherwise,
the monopsonist will offer $c_R$ and trade will occur regardless of the seller’s type. In a
multilateral match, buyers again compete for the house in an auction. This is the same as
in the homogeneous seller case, since the bidding strategies do not depend on the seller’s
motivation to sell.

**Expected Payoffs and Free Entry**

The derivations of the expected payoff functions in the heterogeneous seller case are relegated
to Appendix B, but the solutions are introduced and explained in this section. The expected
payoff to a buyer depends on the match specific quality, $v_i$, $i \in \{L, H\}$. For a low quality
match, the expected payoff is

$$U_L(q, \sigma, \theta) = \begin{cases} 
\sigma e^{-\theta}(v_L - c_A) & \text{if } \sigma > \frac{v_{L} - c_{R}}{v_{L} - c_A} \\
e^{-\theta}(v_L - c_R) & \text{if } \sigma \leq \frac{v_{L} - c_{R}}{v_{L} - c_A}
\end{cases}$$

(12)

while a high quality match bears the following payoff in expectation:

$$U_H(q, \sigma, \theta) = \begin{cases} 
e^{-\theta q}(v_H - v_L) + e^{-\theta} [v_L - \sigma c_A - (1 - \sigma)v_H] & \text{if } \sigma > \frac{v_{H} - c_{R}}{v_{H} - c_A} \\
e^{-\theta q}(v_H - v_L) + e^{-\theta}(v_L - c_R) & \text{if } \sigma \leq \frac{v_{H} - c_{R}}{v_{H} - c_A}
\end{cases}$$

(13)

Taking into account the random match quality, the expected payoff to a potential buyer of entering the housing market is

$$U(q, \sigma, \theta) = q U_H(q, \sigma, \theta) + (1 - q) U_L(q, \sigma, \theta),$$

or

$$U(q, \sigma, \theta) = q e^{-\theta q}(v_H - v_L) + \begin{cases} 
e^{-\theta} [\sigma(v_L - c_A) - q (1 - \sigma)(v_H - v_L)] & \text{if } \sigma > \frac{v_{H} - c_{R}}{v_{H} - c_A} \\
e^{-\theta} [q(v_L - c_R) + \sigma(1 - q)(v_L - c_A)] & \text{if } \frac{v_{L} - c_{R}}{v_{L} - c_A} < \sigma \leq \frac{v_{H} - c_{R}}{v_{H} - c_A} \\
e^{-\theta}(v_L - c_R) & \text{if } \sigma \leq \frac{v_{L} - c_{R}}{v_{L} - c_A}
\end{cases}$$

(14)

The three separate cases, defined by the fraction of anxious sellers, arise because the cut-off for offering $c_A$ in a bilateral match is different depending on the quality of the match. In a type $H$ match, the adverse selection problem must be relatively more severe before the buyer risks offering $c_A$. In such cases, no transaction will occur if the seller happens to be a patient type, since the offer is below her reservation value, $c_R$.

The expected payoff to patient seller is

$$V_R(q, \sigma, \theta) = [1 - (1 + \theta)e^{-\theta}] (v_L - c_R) + [1 - (1 + \theta q)e^{-\theta q}] (v_H - v_L)$$

(15)

This expression is identical to the homogeneous seller case since the payoff to a type $R$ seller in a bilateral match is zero regardless of whether or not a transaction takes place. A
motivated seller, on the other hand, has the following expected payoff:

\[ V_A(q, \sigma, \theta) = \left[ 1 - (1 + \theta)e^{-\theta} \right] (v_L - c_A) + \left[ 1 - (1 + \theta q) e^{-\theta q} \right] (v_H - v_L) \]

\[
+ \begin{cases} 
0 & \text{if } \sigma > \frac{v_H - c_R}{v_H - c_A} \\
q\theta e^{-\theta} (c_R - c_A) & \text{if } \frac{v_L - c_R}{v_L - c_A} < \sigma \leq \frac{v_H - c_R}{v_H - c_A} \\
\theta e^{-\theta} (c_R - c_A) & \text{if } \sigma \leq \frac{v_L - c_R}{v_L - c_A} 
\end{cases} 
\] (16)

The last term reflects the positive surplus for a type \( A \) seller in a bilateral match whenever the buyer offers \( c_R \) (i.e., when there is no adverse selection problem).

To close the model, free entry of buyers determines the equilibrium buyer-seller ratio, \( \theta \):

\[ U(q, \sigma, \theta) = \kappa \] (17)

**Remarks**

The equilibrium of this model is a random search equilibrium with both types of sellers attracting buyers in a single market. The information problem generates additional illiquidity in the housing market due to adverse selection and inefficient entry. When \( \sigma \) is high (\( \sigma > (v_H - c_R)/(v_H - c_A) \)), the adverse selection problem is severe in the sense that buyers make take-it-or-leave-it offers in bilateral matches that get rejected whenever the seller is less motivated to sell. Failure to trade in a match even when the surplus is positive reduces the number of transactions in the real estate market relative to a full information benchmark. Even when \( \sigma \) is low (\( \sigma \leq (v_L - c_R)/(v_L - c_A) \)), the private information about the seller’s motivation makes houses less liquid. When buyers offer \( c_R > c_A \) in a bilateral match and their share of the surplus in a transaction with an impatient seller is reduced, fewer buyers find it worthwhile to participate in the housing market. This is an implication of the free entry condition. Finally, for intermediate values of \( \sigma \), both issues arise: fewer buyers enter the market because the buyers’ payoff is less in a bilateral type \( H \) match, and unconsummated matches occur between a type \( R \) seller and a type \( L \) buyer.
Both buyers and sellers may benefit from a mechanism that allows sellers to reveal their type. If sellers can differentiate themselves, buyers can direct their search. More buyers will visit the impatient sellers, knowing that a lower offer will be accepted in a bilateral match. Past studies have proposed the list price as means of signalling private information (Albrecht, Gautier, and Vroman, 2010; Delacroix and Shi, 2007). In this framework, the list price is not a credible signaling device: Type $R$ sellers will list their house at a low price, mimicking the type $A$ sellers in order to attract more buyers. This increases the probability that a bidding war will drive the selling price upward. Unlike in Menzio (2007)’s model of partially directed search, there is no post-match effect to discourage such mimicking. In the event of a bilateral match, a type $R$ seller gets a payoff of zero regardless of whether the buyer offers $c_R$ (leaving the seller with none of the surplus) or $c_A$ (in which case the seller simply rejects the offer and gets a payoff of zero). This result is stated formally in Proposition 3.1.

**Proposition 3.1** Suppose sellers can costlessly communicate with buyers through negotiable list prices. A correlation between the list price and the seller’s reservation value is unsustainable, and the equilibrium reduces to that in the random search environment with uninformative list prices.

*Proof.* In Appendix C.

In Albrecht, Gautier, and Vroman (2010), sellers are forced to sell whenever a buyer offers her asking price. This seems like a strong and unreasonable assumption. They suggest that the commitment to sell when a *bona fide* offer is received is part of the contract with a real estate agent, although real estate agents are not explicitly part of their model. In the next section, I investigate whether real estate agents can fulfil the role of a signalling mechanism in the housing market. I argue that some real estate agents market themselves as being able to sell houses quickly, while others focus on attracting the right type of buyer and bringing in the highest possible price for a home. Offering separate incentive compatible real estate contracts can segment the market, allow buyers to direct their search, and help overcome
the problem of asymmetric information. It turns out that in some cases, the type of real estate contract that is often observed in housing markets is conducive to market separation.

4 Real Estate Agents

I add real estate agents to the model as a way of endogenizing $q$, the likelihood of a high quality match when a buyer visits a house for sale. Intuitively, real estate agents (REAs) have access to more detailed information about the characteristics of houses and the preferences of prospective buyers. Acquiring and using this knowledge by offering marketing services improves the average quality of a match. In addition, REAs can also work with a seller to increase the probability that a potential buyer assigns a high value to the house by decluttering, painting, repairing, renovating, decorating, and staging the home. Of course, increasing $q$ is costly. Let $\phi(q)$ be the cost function associated with increasing the probability of a type $H$ match from 0 to $q \in [0, 1]$. The cost function satisfies the following properties: $\phi(0) = 0$, $\phi'(q) > 0$ and $\phi''(q) \leq 0$ for all $q \in (0, 1)$.

Assume, perhaps implausibly given the allegations in the report by the Federal Trade Commission and U.S. Department of Justice (2007), that the market for REAs is frictionless and perfectly competitive. A REA offers a contract $(q, z, \hat{p})$: $q$ is the quality of their service expressed in terms of the probability that each prospective buyer values the house at $v_H$ rather than $v_L$; $z$ is the real estate agent’s fee, expressed as a percentage of the sale price; and $\hat{p}$ is the list price. A linear commission structure is chosen to reflect the listing contracts commonly observed in residential real estate markets. Most REAs in large U.S. cities charge a commission rate between 5 and 7 percent (Hsieh and Moretti, 2003; Federal Trade Commission and U.S. Department of Justice, 2007). The REA’s commission is then contingent on receiving an offer at or above the list price. Even if the seller rejects an offer $b \geq \hat{p}$, it is considered that the REA has provided the agreed upon services and secured a

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5Most, but not all real estate brokers adopt fixed-rate fee structures. There appears to be an emergence of flat-fee, limited service brokers in real estate markets as well (Hendel, Nevo, and Ortalo-Magne, 2009; Levitt and Syverson, 2008a).
“ready, willing, and able” buyer. The seller must still pay the commission. The “ready, willing, and able” clause, (hereinafter, the RWA clause), is critical for generating a separating equilibrium. This structure of real estate contract is often enough to dissuade patient sellers from mimicking impatient ones and entering the hotter market. The contract introduces a cost to rejecting a take-it-or-leave-it offer in a bilateral match.

Zero profit conditions determine the competitive real estate fee schedule, \( z(q) \):

\[
  z(q) = \frac{\phi(q) - \hat{z}(\hat{p} | q, \sigma, \theta)}{\sigma E[p_A | q, \sigma, \theta] + (1 - \sigma) E[p_R | q, \sigma, \theta]},
\]

(18)

where \( E[p_A | q, \sigma, \theta] \) and \( E[p_R | q, \sigma, \theta] \) are the expected selling prices when the home owner is anxious or relaxed, and \( \hat{z}(\hat{p} | q, \sigma, \theta) \) is the expected fees collected as a result of rejected offers at or above \( \hat{p} \).

**Definition 4.1** Let \( \mathcal{Q} \) denote the set of zero profit contracts:

\[
  \mathcal{Q} = \left\{ (q, z) \bigg| 0 \leq q \leq 1, \ z = \frac{\phi(q) - \hat{z}(\hat{p} | q, \sigma, \theta)}{\sigma E[p_A | q, \sigma, \theta] + (1 - \sigma) E[p_R | q, \sigma, \theta]} \right\}
\]

The real estate market can now be characterized by a competitive search framework. Recall that market tightness is determined by the demand side free entry condition and therefore depends on the probability of a high quality match, \( q \). The buyer-seller ratio can therefore be written \( \theta(q) \). Similarly, the share of impatient sellers, \( \sigma(q) \), is endogenously determined by sellers’ sorting into submarkets. In an equilibrium with free entry, optimal sorting of sellers, and REAs earning zero profit, the equilibrium expected payoffs are functions of \( q \), since buyers and sellers take into account how market tightness, the mix of seller types, and the commission fee vary with the seller’s choice of realtor.

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*In equilibrium, \( \hat{z}(\hat{p} | q, \sigma, \theta) = 0 \) either because the seller types that would reject an offer of \( \hat{p} \) choose a different real estate contract (in a separating equilibrium), or because a pooling contract with a list price chosen such that \( \hat{z}(\hat{p} | q, \sigma, \theta) = 0 \) dominates a pooling contract with \( \hat{z}(\hat{p} | q, \sigma, \theta) > 0 \).

*This imposes restrictions on out-of-equilibrium beliefs since there might not exist submarkets for all \( q \in [0, 1] \) in equilibrium. This is the usual competitive search assumption, and is typically deemed reasonable with a trembling hand type argument (see Moen (1997)).
**Definition 4.2** A *housing market equilibrium with real estate agents* is a function $\theta : [0, 1] \rightarrow [0, \infty]$, a function $\sigma : [0, 1] \rightarrow [0, 1]$, and a set of real estate contracts $\bar{Q}$ such that

1. prospective buyers’ make optimal entry decisions,

2. sellers sort into submarkets by selecting real estate agents/contracts that maximize their expected payoff, and

3. real estate agents offer a set of zero profit contracts $\bar{Q} \subset Q$ such that no deviating contract earns strictly positive profit.

It is not obvious whether the competitive search equilibrium separates sellers by type. The following approach is adopted: first solve for an equilibrium under the assumption that it is fully separating, then check whether a pooling contract is a profitable deviation. I find that in some circumstances, no profitable deviation exists and the equilibrium therefore involves two submarkets: one for each type of seller. For other parameter values, a pooling contract is profitable and the equilibrium reduces to the random search environment with adverse selection and inefficient entry.

**Solving for the Equilibrium**

Under the assumption that the equilibrium is separating, the solution to the following problem is part of the real estate contract designed for type $R$ sellers:

$$q_R = \arg \max_{q \in [0,1]} (1 - z(q))V_R(q, 0, \theta(q))$$  \hspace{1cm} (19)

where $z(q)$ is satisfies by the zero profit condition,

$$z(q)E[p_R|q, 0, \theta(q)] = \phi(q)$$  \hspace{1cm} (20)
and \( \theta(q) \) is implicitly defined by the free entry conditions,

\[
e^{-\theta(q)}(v_L - c_A) + qe^{-\theta(q)}(v_H - v_L) \leq \kappa, \quad \text{with equality if } \theta(q) > 0 \tag{21}
\]

for all \( q \in [0, 1] \). The list price is any \( \hat{p}_R \geq c_R/(1 - z(q_R)) \). Next, the real estate contract for type \( A \) sellers is the analogous problem with an additional choice variable, \( \hat{p}_A \), and the incentive compatibility constraint:

\[
(1 - z(q_R))V_R(q_R, 0, \theta(q_R)) \geq (1 - z(q_A))V_R(q_A, 1, \theta(q_A))
- \theta(q_A)e^{-\theta(q_A)} \min \left\{ z(q_A)\hat{p}_A, c_R - c_A \right\} \tag{22}
\]

where the minimization operator allows mimicking sellers to choose between rejecting the offer but paying the commission and going through with the transaction at the low price in a bilateral match. Thus, the penalty imposed by a real estate listing contracts is weaker in general than the forced sale assumption imposed by Albrecht, Gautier, and Vroman (2010). In some instances, namely when \( c_R \leq c_A/(1 - z(q_A)) \), the mechanisms are equivalent.

To check the profitability of a pooling contract, \((q_P, z(q_P), \hat{p}(q_P))\), the appropriate contract to consider is the one that maximizes the payoff to a type \( A \) seller but attracts both types:

\[
q_P = \arg \max_{q \in [0, 1]} (1 - z(q))V_A(q, \sigma, \theta(q)) \tag{23}
\]

subject to

\[
z(q) = \frac{\phi(q)}{\sigma E[p_A|q, \sigma, \theta(q)] + (1 - \sigma)E[p_R|q, \sigma, \theta(q)]} \tag{24}
\]

and

\[
U(q, \sigma, \theta(q)) \leq \kappa, \quad \text{with equality if } \theta(q) > 0 \tag{25}
\]

for all \( q \in [0, 1] \). The list price is any \( \hat{p}_P \geq c_R/(1 - z(q_P)) \).
Submarket Separation

Introducing REAs into the model does not automatically generate market segmentation because sellers of different types have similar preferences over real estate services. To illustrate this, consider the marginal effect of changing $q$ in a submarket with homogeneous sellers with reservation value $c$, and no REA fee, $z = 0$. The derivative of $V(q, \theta)$ with respect to $q$ is

$$
\frac{dV(q, \theta(q))}{dq} = \left[ \theta e^{-\theta(v_L - c)} + \theta q e^{-\theta q(v_H - v_L)} \right] \frac{d\theta}{dq} + \theta^2 q e^{-\theta q(v_H - v_L)} \tag{26}
$$

Market tightness, $\theta(q)$, is determined by the free entry condition, $e^{-\theta(v_L - c)} + q e^{-\theta q(v_H - v_L)} \leq \kappa$. Totally differentiating this condition and rearranging gives the relationship between $\theta$ and $q$,

$$
\frac{d\theta}{dq} = \frac{(1 - q\theta)(v_H - v_L)}{e^{-\theta(1-q)(v_L - c)} + q^2(v_H - v_L)} \tag{27}
$$

Substituting $d\theta/dq$ from (27) into the derivative (26) and simplifying yields

$$
\frac{dV(q, \theta(q))}{dq} = \theta e^{-\theta q(v_H - v_L)} \tag{28}
$$

This expresses the marginal effect of real estate services, $q$, on the expected payoff to a seller. Notice that the effect is independent of the seller’s reservation value, $c$. The implication is that $q$ is not an effective sorting variable for separating seller types. In many real estate agreements, however, the contract specifies the list price and includes a RWA clause. The purpose of the clause is to entitle the REA to a commission when a buyer makes an unconditional offer to purchase the home for the list price. I next show graphically that this form of contract is often enough to initiate separation. The obligation to pay the REA’s commission in a bilateral match discourages mimicking.

In a separating equilibrium, patient sellers are offered their most preferred real estate contract. The real estate services offered to anxious sellers, however, must be distorted from their most preferred bundle in order to induce separation. Figures 1 and 2 illustrate the expected payoffs and real estate contracts when the parameters allow for incentive compatible
contracts. The solid lines represent values in the homogeneous submarkets, the dashed line represents the type $A$ seller’s payoff in a pooling submarket, and the dash dotted line traces out the payoff of a type $R$ seller that deviates to the type $A$ submarket. In Figure 1, the incentive compatibility constraint is equivalent to the Albrecht, Gautier, and Vroman (2010) assumption in that a mimicking seller prefers to accept the offer given that they have to pay the commission regardless. In Figure 2, on the other hand, the constraint is weaker and offers would still be rejected in the event of a bilateral match if a type $R$ seller chose to enter the type $A$ submarket. In this case, the separating contract offered to impatient sellers overinvests in real estate services to tighten the incentive compatibility constraint, while in the latter case real estate services are underprovided relative to the first best contract. It is worth remarking that even when the incentive compatibility constraint has the same effect as the forced sale assumption in Albrecht, Gautier, and Vroman (2010), the disincentive to mimic in this setting is driven by the fact that REAs are explicitly modeled. Without a demand for the services provided by REAs, market separation could not be achieved.

Figure 3 illustrates an example when the conditions of the housing market are not conducive to separation. It is too costly to distort the motivated seller’s listing contract to satisfy the incentive compatibility condition. REAs then choose to offer a pooling contract, which is the situation illustrated in Figure 4. Whether the equilibrium is separating or pooling depends on the parameters values. Two important factors are the relative shares of patient and impatient sellers, captured by $\sigma$, and the degree of market tightness, which is affected by the entry cost, $\kappa$. When $\sigma$ is close to 0 or 1, sellers are a relatively homogeneous group and a pooling equilibrium tends to arise. Intermediate values of $\sigma$ are more likely to generate a separating equilibrium. The ratio of buyers to sellers, $\theta$, affects whether or not real estate agents can successfully segment the market. When $\kappa$ is low, the ratio of buyers to sellers is high. It is then more difficult to satisfy the incentive compatibility constraint, since the penalty for mimicking only occurs in an unlikely bilateral match. This is consistent with observations of the Toronto real estate market, where artificially stimulated bidding wars are occurring in high-demand neighbourhoods.
Remarks

Does it seem reasonable that REA contracts are designed to alleviate information frictions in the housing market? I argue that both empirical evidence and casual observation of real estate markets support the conjecture that REAs function as a signalling mechanism. The empirical results are provided by Johnson, Springer, and Brockman (2005), who compare house prices when the seller’s REA decides not to advertise the listing in the Multiple Listing Service (MLS). They calculate the average sale price of a house to be more than 6 percent higher for homes that are marketed without the MLS, after controlling for the documented characteristics of homes. This trend is consistent with the idea that separate bundles of real estate services are offered to attract different types of buyers. A REA that lists homes though the MLS will attract many buyers (in expectation), while a REA with targeted expertise will attract fewer buyers but can generate higher offers by finding the right type of buyer. The emergence of flat-fee, limited service brokers alluded to by Hendel, Nevo, and Ortalo-Magné (2009) and Levitt and Syverson (2008a) is also consistent with the model if the equilibrium is a separating one as in Figure 2 where the quality of real estate services provided to patient sellers is less than those provided to motivated sellers. The flat-fee contracts are not problematic for incentive compatibility as long as the full-commission agents are designing appropriate listing contracts to attract type A sellers.

Casual observation of the residential real estate market in Kingston, Ontario, is also consistent with the proposed theory. At one extreme, there are Don and Jamie Wyld with Century 21, father and son, who undoubtedly market themselves as REAs for sellers that want to sell quickly. According to his website, Don has spent six years as “#1 in most properties sold in Canada.” Jamie’s website contains a discussion about setting an appropriate list price. He includes a bullet list with six disadvantages to setting a high list price, but only one negative outcome associated with an asking price that is too low. Through personal interaction with other local REAs, I learned that some realtors will outright reject a prospective client if she does not agree to a list price that is sufficiently low. At the other extreme, consider Diane and Marjorie Cooke, mother and daughter, with Royal LePage.
They market themselves to sellers that want to obtain the highest possible price for their home. According to their website, the Cooke team will help stage a home, conduct open houses, and provide a seller with information about up-to-date trends in the housing market that will help the seller make choices that contribute the most to the sale price. Clearly, different REAs in the same city are offering distinct bundles of services.

5 Empirical Implications of the Model

A wide range of empirical work has established stylized facts about residential real estate markets. In what follows, I discuss the empirical evidence and how it relates to the theoretical analysis.

Price Dispersion

Empirical work on housing markets has documented price dispersion that cannot be explained by the differing characteristics of houses. For example, Leung, Leong, and Wong (2006) find quality-controlled price dispersion in the Hong Kong real estate market. Plazzi, Torous, and Valkanov (2008) document dispersions of returns and rental growth rates in U.S. commercial real estate markets. There are three sources of residual price dispersion in the theoretical model. First, coordination frictions in the housing market lead to a spread between the take-it-or-leave-it offer \( c \) in a bilateral match and the competitive offers of at least \( v_L \) in a multilateral match. Second, the idiosyncratic match specific quality and the sealed bids further disperse sale prices in the interval \((v_L, \bar{b})\). Thus, even in the benchmark model with homogeneous sellers, there is substantial price heterogeneity from these two sources.
Specifically, the distribution function is given by,

\[
\Gamma(p|q, \theta) = \begin{cases} 
0 & \text{if } p < c \\
\frac{\theta e^{-\theta}}{1-e^{-\theta}} & \text{if } p \in [c, v_L) \\
\frac{e^{-\theta q[1-F(p)]}-[1-\theta q[1-F(p)]]}{1-e^{-\theta}} & \text{if } p \in [v_L, \bar{b}] \\
1 & \text{if } p > \bar{b}
\end{cases}
\]  

(29)

Finally, seller heterogeneity in a separating equilibrium with real estate contracts implies price disparity even when matches are bilateral. Figure 5 plots the cumulative distribution functions of sale prices in the two submarkets.

**Transaction Price, Sales, and Time on the Market**

In a dynamic setting, one can analyze the relationship between the price of a house and the time it takes to sell. In a static environment, a similar notion applies. A long time on the market in a dynamic framework is analogous to a low probability of a sale in a static setting. To avoid unnecessary complications, the model presented above is static. Nevertheless, a correlation between the price of a house and the probability of a sale in the static model implies the reverse correlation between the price of a house and the time on the market in the data.

The empirical literature has identified a positive correlation between price and time on the market for an individual house, but a negative correlation between the aggregate house price level and the average time on the market. Merlo and Ortalo-Magné (2004) present an analysis of housing market transactions in England and find evidence of the former trend. They find that houses that remain on the market for a long time tend to sell at higher prices. Glower, Haurin, and Hendershott (1998) find a similar pattern in the data collected from real estate transactions in Columbus, Ohio. In the model with real estate agents, the positive correlation between price and time on the market is implied by \( \theta_R < \theta_A \), which has to be the case in a separating equilibrium. In a pooling equilibrium, or in the benchmark model without REAs, the appropriate negative correlation between price and the probability
of a sale appears whenever $\sigma(v_L - c_A) > v_L - c_R$. That is, impatient sellers can sell more quickly and at a lower price when adverse selection results in only type $L$ sellers trading in a bilateral match.

Krainer (2001) estimates a negative correlation between the general price level and the average time on the market. He characterizes real estate market as “hot” if prices and sales are rising and selling times are falling, and “cold” if markets have falling prices and illiquid housing. In the context of the model, consider an aggregate shock that increases the value that buyers assign to home ownership, $v_L$. Recall that the transaction price of a house when buyers compete in a bidding war is at least $v_L$. In response to the positive shock, tightness in the market, $\theta$, will increase according to the free entry condition. Therefore, an increase in $v_L$ drives the average price upward, and the response of market tightness implies a higher probability of a transaction. Equivalently, it implies a shorter time on the market in a dynamic setting. The same intuition applies to both submarkets in the model with real estate agents and market separation. Thus, the model predicts correlations of sale prices, the volume of transactions, and the implied time on the market that are consistent with the empirical evidence.

List Price, Sales, and Time on the Market

The evidence is less clear about the relationship between list price and time on the market. The data analysis by Merlo and Ortalo-Magné (2004) suggests that the listing price influences the arrival of buyers, which affects the time it takes to sell a house. A high initial list price is associated with real estate that remains on the market for a long time, but sells at a higher price. A plausible story is that list prices are strategically chosen to signal the seller’s reservation value. In the model without real estate agents, the list price cannot be used as a credible signal of seller motivation (see Proposition 3.1). The benchmark model therefore yields no predictions about list prices. When real estate agents are introduced, however, the empirical implications are consistent with the trends observed by Merlo and Ortalo-Magné (2004) whenever real estate contracts are incentive compatible. In a pooling equilibrium, on
the other hand, the correlations between list price and the other variables disappear. It is worth noting that Glower, Haurin, and Hendershott (1998) find no significant relationship between seller motivation and initial list price. It could be that the real estate market studied by Merlo and Ortalo-Magné (2004) can be characterized by a separating equilibrium with incentive compatible real estate contracts, while housing transactions analyzed by Glower, Haurin, and Hendershott (1998) occurred in a market characterized by a pooling equilibrium.

Artificially Stimulated Bidding Wars

In real estate markets, it is sometimes the case that a seller lists her house at a low price, hoping to attract more buyers and generate a bidding war that drives up the final sale price. In the model with market segmentation, this would be equivalent to a type $R$ seller mimicking a type $A$ seller by listing her house in the type $A$ submarket. According to news reportage of the Toronto real estate market, this type of behaviour is typically observed in particularly “hot” neighbourhoods. Consider a housing market with incentive compatible real estate contracts. A shock that either raises the value of a house to a potential buyer, $(v_L, v_H)$, or lowers the cost of entering the market, $\kappa$, will increase the buyer-seller ratio, $\theta$. A large enough increase in $\theta$ is enough to violate the incentive compatibility constraint for the type $R$ sellers. The separating equilibrium then unravels because type $R$ sellers find it worthwhile to list their house at the low price, hoping to sell at a high price in a multiple offer situation.

The Structure of Real Estate Contracts

The listing agreement between a seller and her real estate agent typically specifies the commission as a fixed percentage of the sale price, and outlines the broker’s right to earn a commission when a suitable buyer is found. In the real estate agent literature, the listing contract is often studied from the perspective of a principal-agent relationship. Many have noted the apparent inefficiency in applying a fee structure that fails to completely align the
incentives of the seller and the agent. A better commission structure in a simple (linear) model of incentive compensation would require a lower intercept and a steeper slope. Nevertheless, real estate contracts with a constant percentage commission have persisted for decades (Federal Trade Commission, 1983; Federal Trade Commission and U.S. Department of Justice, 2007). In this paper, I analyze the listing contract from a different perspective and offer an alternative explanation for the structure of real estate contracts. I highlight the RWA clause as a mechanism to induce sellers to truthfully reveal their willingness to sell. Interestingly, the RWA clause would be less effective if the fee structure was altered according to the solution to an agency problem.

6 Conclusion

In this paper I present a model of the market for housing using a search framework that captures the realistic and strategic interaction between buyers and sellers in determining sale prices. The model reflects differences in sellers’ willingness to make a sale. Private information about a seller’s motivation leads to illiquidity in the real estate market. Some buyer-seller matches fail to result in a transaction despite the positive gains from trade. Reduced entry of buyers further impacts the volume of trade in the housing market. By introducing real estate agents into the model, there is a potential for housing market segmentation to alleviate the information problem and increases the number of transactions. When the adverse selection problem is too severe or the equilibrium buyer-seller ratio is too high, market segmentation can break down and situations arise wherein patient sellers mimic impatient sellers in order to drive up the final sale price by increasing the probability of a bidding war. This is another realistic feature of the model.

The model can account for many of the observed trends in the empirical literature on

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8For examples of theoretical analyses of the principal-agent relationship between a seller and her realtor, see Zorn and Larsen (1986); Anglin and Arnott (1991); Geltner, Kluger, and Miller (1991); Yavaş (1992); Arnold (1992). For examples of empirical work, see Rutherford, Springer, and Yavaş (2005); Levitt and Syverson (2008b).
real estate markets. Specifically, the model predicts relationships between prices and trade volume that are consistent with the data. Search frictions, ex post buyer heterogeneity, and differences in sellers’ reservation values imply price dispersion, which is also consistent with empirical findings. Another important stylized fact about housing markets is that most residential home sellers choose to enlist the services of a broker. This study contributes to the real estate agent literature by providing insight into the value real estate contracts bring to the housing market. Realtors provide valuable marketing/matching services, and their contracts offer a potential solution to the adverse selection problem.
Figure 1: A separating contract when a mimicking seller prefers to accept the take-if-or-leave-it offer.

Figure 2: A separating contract when a mimicking seller prefers to reject the take-it-or-leave-it offer.

Figure 3: A separating contract that can be dominated by a pooling contract.

Figure 4: The optimal pooling contract.
Figure 5: Price dispersion in type $A$ (solid line) and type $R$ (dashed line) submarkets.
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A Deriving the Seller’s Expected Payoff

The expected payoff to a seller is

\[ V(q, \theta) = \theta e^{-\theta} (c - c) + \sum_{k=2}^{\infty} \frac{\theta^k}{k! e^\theta} \left[ (v_L - c) + \sum_{j=0}^{k} p(j; k, q) \int_{v_L}^{\bar{b}} (b - v_L) dF^j(b) \right] \]

\[ = \left[ 1 - (1 + \theta) e^{-\theta} \right] (v_L - c) \]

\[ + \sum_{k=2}^{\infty} \frac{\theta^k}{k! e^\theta} \sum_{j=0}^{k} \binom{k}{j} q^j (1 - q)^{k-j} \int_{v_L}^{\bar{b}} (b - v_L) dF^j(b) \]  

(A.1)

A closed form solution can be obtained by solving (A.1) using the bidding strategy \( F \) in equation (5) and the highest bid \( \bar{b} \) from equation (6) in the main text. While this approach yields the correct expression for \( V(q, \theta) \), it is algebraically cumbersome. In this section I derive \( V(q, \theta) \) using a different and much simpler approach. First define the expected surplus associated with putting a house on the market, \( \tilde{V}(q, \theta) \). As long as one or more potential buyers show up, the surplus is at least \( v_L - c \). Specifically, the surplus is \( v_H - c \), unless all the buyers draw a low quality match. Therefore, \( \tilde{V}(q, \theta) \)

\[ \tilde{V}(q, \theta) = \sum_{k=1}^{\infty} \frac{\theta^k}{k! e^\theta} \left[ (v_H - c) + (1 - q)^k (v_L - v_H) \right] \]

\[ = (1 - e^{-\theta})(v_L - c) + (1 - e^{-\theta q})(v_H - c_L) \]  

(A.2)

The total expected gains from trade in the housing market is \( \tilde{V}(q, \theta) \) multiplied by the housing stock, \( S \). The share of the surplus going to buyers is \( B \cdot U(q, \theta) \). The difference is the sellers’ share of the surplus, \( S \cdot \tilde{V}(q, \theta) - B \cdot U(q, \theta) \). Dividing by \( S \) yields the expected payoff to an individual seller,

\[ V(q, \theta) = \tilde{V}(q, \theta) - \theta \cdot U(q, \theta) \]

\[ = (1 - e^{-\theta})(v_L - c) + (1 - e^{-\theta q})(v_H - c_L) - \theta \left[ e^{-\theta}(v_L - c) - q e^{-\theta q}(v_H - v_L) \right] \]

\[ = (1 - (1 + \theta)e^{-\theta}) (v_L - c) + [1 - (1 + \theta q)e^{-\theta q}] (v_H - v_L) \]  

(A.3)
B Deriving the Expected Payoffs in the Heterogeneous Seller Case

The expected payoff when the quality of the match is low is just the probability of a bilateral match, $e^{-\theta}$ multiplied by the monopsony payoff. In a multilateral match, Bertrand competitive drives a type $L$ buyer’s payoff to zero. Hence,

$$U_L(q, \sigma, \theta) = e^{-\theta} \max \{ \sigma(v_L - c_A), v_L - c_R \} = \begin{cases} \sigma e^{-\theta}(v_L - c_A) & \text{if } \sigma > \frac{v_L - c_R}{v_L - c_A} \\ e^{-\theta}(v_L - c_R) & \text{if } \sigma \leq \frac{v_L - c_R}{v_L - c_A} \end{cases} \quad (B.1)$$

On the other hand, when the quality of the match is high and the bidding strategy is $b \sim F$, the expected payoff is

$$U_H(q, \sigma, \theta) = e^{-\theta} \max \{ \sigma(v_H - c_A), v_H - c_R \} + \sum_{k=1}^{\infty} \frac{\theta^k}{k!} \sum_{j=0}^{k} p(j; k, q) F(b)^j (v_H - b)$$

$$= e^{-\theta} \max \{ \sigma(v_H - c_A), v_H - c_R \} + \sum_{k=1}^{\infty} \frac{\theta^k}{k!} \sum_{j=0}^{k} \binom{k}{j} q^j (1 - q)^{k-j} F(b)^j (v_H - b)$$

$$= e^{-\theta} \max \{ \sigma(v_H - c_A), v_H - c_R \} + e^{-\theta} \sum_{k=1}^{\infty} \frac{\theta^k}{k!} \sum_{j=0}^{k} \binom{k}{j} q^j (1 - q)^{k-j} F(b)^j (v_H - b)$$

$$= \begin{cases} e^{-\theta q(1-F(b))} (v_H - b) + e^{-\theta} [b - \sigma c_A - (1 - \sigma)v_H] & \text{if } \sigma > \frac{v_H - c_R}{v_H - c_A} \\ e^{-\theta q(1-F(b))} (v_H - b) + e^{-\theta} (b - c_R) & \text{if } \sigma \leq \frac{v_H - c_R}{v_H - c_A} \end{cases} \quad (B.2)$$

The second line applies the definition of the probability mass function for the binomial distribution, the third line makes use of the binomial theorem, and the final expression recognizes the McLaurin series of the exponential function. Indifference over bids in the support of $F$ (which includes the bid infinitesimally greater than $v_L$) implies that the expected payoff for this bidder is

$$U_H(q, \sigma, \theta) = \begin{cases} e^{-\theta q}(v_H - v_L) + e^{-\theta} [v_L - \sigma c_A - (1 - \sigma)v_H] & \text{if } \sigma > \frac{v_H - c_R}{v_H - c_A} \\ e^{-\theta q}(v_H - v_L) + e^{-\theta} (v_L - c_R) & \text{if } \sigma \leq \frac{v_H - c_R}{v_H - c_A} \end{cases} \quad (B.3)$$
Taking into account the random match quality, the expected payoff to a potential buyer of entering the housing market is

\[
U(q, \sigma, \theta) = qU_H(q, \sigma, \theta) + (1 - q)U_L(q, \sigma, \theta) = qe^{-\theta q}(v_H - v_L) + \left\{ \begin{array}{ll}
\theta e^{-\theta \left[ \sigma(v_L - c_A) - q(1 - \sigma)(v_H - v_L) \right]} & \text{if } \sigma > \frac{v_H - c_R}{v_H - c_A} \\
\theta e^{-\theta \left[ q(v_L - c_R) + \sigma(1 - q)(v_L - c_A) \right]} & \text{if } \frac{v_L - c_R}{v_L - c_A} < \sigma \leq \frac{v_H - c_R}{v_H - c_A} \\
\theta e^{-\theta (v_L - c_R)} & \text{if } \sigma \leq \frac{v_L - c_R}{v_L - c_A}
\end{array} \right.
\] (B.4)

The expected payoff to a relaxed seller is

\[
V_R(q, \sigma, \theta) = \sum_{k=2}^{\infty} \frac{\theta^k}{k!\theta^2} \left[ (v_L - c_R) + \sum_{j=0}^{k} p(j; k, q) \int_{v_L}^{\bar{b}} (b - v_L)dF^j(b) \right] = \left[ 1 - (1 + \theta)e^{-\theta} \right] (v_L - c_R) + \left[ 1 - (1 + \theta q)e^{-\theta q} \right] (v_H - v_L)
\] (B.5)

The last line uses the result from the homogeneous seller case, derived in Appendix A. A motivated seller, on the other hand, has the following expected payoff:

\[
V_A(q, \sigma, \theta) = \left[ 1 - (1 + \theta)e^{-\theta} \right] (v_L - c_A) + \left[ 1 - (1 + \theta q)e^{-\theta q} \right] (v_H - v_L) + \left\{ \begin{array}{ll}
0 & \text{if } \sigma > \frac{v_H - c_R}{v_H - c_A} \\
\theta e^{-\theta (c_R - c_A)} & \text{if } \frac{v_L - c_R}{v_L - c_A} < \sigma \leq \frac{v_H - c_R}{v_H - c_A} \\
\theta e^{-\theta (c_R - c_A)} & \text{if } \sigma \leq \frac{v_L - c_R}{v_L - c_A}
\end{array} \right.
\] (B.6)

where the last term reflects the positive surplus for type A sellers in a bilateral match with buyers bidding \( c_R > c_A \).
C Omitted Proofs

Proof of Proposition 3.1

Suppose (for the sake of contradiction) that list prices are informative. The housing market can then be characterized by at least two submarkets: One submarket for sellers with list price $\hat{p} \in \mathbb{P}_1$, and another submarket for sellers with list price $\hat{p} \in \mathbb{P}_2$, $\mathbb{P}_1 \cap \mathbb{P}_2 = \emptyset$.\footnote{Here, a submarket represents a group of sellers with list prices within a certain interval as opposed to identical list prices. The generality reflects the fact that a list price is merely a signal, and does not connote a contractual obligation on the part of the seller.} I first rule out a fully separating equilibrium, and then consider partial pooling.

Full Separation

In a fully separating equilibrium, there exists a type $A$ submarket and a type $R$ submarket. From the expressions derived in Section 2, the expected payoffs are

$$V_A(q, \theta_A) = [(1 + \theta_A)e^{-\theta_A} - 1](v_L - c_A) + [(1 + \theta_A q)e^{-\theta_A q}](v_H - v_L)$$

and

$$V_R(q, \theta_R) = [(1 + \theta_R)e^{-\theta_R} - 1](v_L - c_R) + [(1 + \theta_R q)e^{-\theta_R q}](v_H - v_L)$$

with submarket tightness determined by free entry conditions,

$$U(q, \theta_h) = e^{-\theta_h}(v_L - c_h) + q e^{-\theta_h q}(v_H - v_L) = \kappa, \quad h \in \{A, R\}$$

Consider a type $R$ seller deviating to the type $A$ submarket. Her payoff would be

$$V_R(q, \theta_A) = [(1 + \theta_A)e^{-\theta_A} - 1](v_L - c_R) + [(1 + \theta_A q)e^{-\theta_A q}](v_H - v_L)$$

Since

$$\frac{dV_h(q, \theta)}{d\theta} = \theta e^{-\theta}(v_L - c_h) + \theta q e^{-\theta q}(v_H - v_L) > 0$$
there is no incentive to deviate if and only if the buyer-seller ratio is higher in the type $R$ submarket:

$$V_R(q, \theta_R) > V_R(q, \theta_A) \iff \theta_R > \theta_A$$

Subtracting the free entry condition for the type $R$ submarket from the same condition for the type $A$ submarket yields

$$e^{-\theta_R}(c_R - c_A) + [e^{-\theta_A} - e^{-\theta_R}](v_L - c_A) + q[e^{-\theta_A q} - e^{-\theta_R q}](v_H - v_L) = 0$$

Rearranging,

$$\theta_A = \theta_R + \log \left( \frac{v_L - c_A + q(v_H - v_L)e^{\theta_R(1-q)}}{v_L - c_R + q(v_H - v_L)e^{\theta_R(1-q)}} \right)$$

From this expression, one can see that $c_A < c_R$ implies $\theta_A > \theta_B$: a contradiction.

**Partial Pooling**

Suppose first that type $R$ sellers participate in both submarkets. From the expressions introduced in Section 3, the expected payoff to a type $R$ seller does not depend on $\sigma$. Indifference between the two submarkets therefore requires $\theta_1 = \theta_2$. For the submarkets to be distinct, it must be that $\sigma_1 \neq \sigma_2$. But $\theta_1 = \theta_2$ and $\sigma_1 \neq \sigma_2$ violate the buyers’ free entry conditions unless $\sigma_1, \sigma_2 \leq (v_L - c_R)/(v_L - c_A)$. That is, the fraction of anxious sellers in both submarkets is low enough that buyers offer $c_R$ in a bilateral match. In other words, the list prices are meaningless and the equilibrium resembles the random search equilibrium.

Finally, suppose that type $A$ sellers participate in both submarkets. From the preceding paragraph, type $R$ sellers are only participating in one of the submarkets. Without loss of generality, let $\sigma_1 = 1$ and $\sigma_2 \in (0, 1)$. If $\sigma_2 > (v_H - c_R)/(v_H - c_A)$, indifference between submarkets requires $\theta_1 = \theta_2 = \theta$. The free entry conditions for buyers with $\sigma_1 = 1$ and $\sigma_2 = \sigma$ are

$$U(q, 1, \theta) = q e^{-\theta q}(v_H - v_L) + e^{-\theta}(v_L - c_A) = \kappa$$

and

$$U(q, \sigma, \theta) = q e^{-\theta q}(v_H - v_L) + e^{-\theta} [\sigma(v_L - c_A) - q(1 - \sigma)(v_H - v_L)] \kappa$$

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Subtracting one from the other yields a violation, \( v_L - c_A + q(v_H - v_L) = 0 \). The remaining possibility is that \( \sigma_2 \leq (v_H - c_R)/(v_H - c_A) \). From the expression for the expected payoff to a type A seller in Section 3, the extra surplus in a bilateral match in the type 2 submarket means that \( \theta_2 < \theta_1 \) to satisfy indifference between selling in either submarket. Recall, however, that type R sellers are only participating in submarket 1, which requires \( \theta_1 > \theta_2 \): a contradiction. \qed