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Bargaining over Residential Real Estate: Evidence from England

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BARGAINING OVER RESIDENTIAL REAL ESTATE: EVIDENCE FROM ENGLAND

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BARGAINING OVER RESIDENTIAL REAL ESTATE: EVIDENCE FROM ENGLAND

Abstract

This paper presents and investigates a new data set of individual residential property transactions in England. The main novelty of the data is the record of all listing price changes and all offers made on a property, as well as all the visits by potential buyers for a subset of the properties. We analyze individual seller and potential buyers behavior within property transaction histories. This leads us to establish a number of stylized facts pertaining specifically to the timing and terms of agreement in housing transactions, and more generally, to the sequence of events that occur from initial listing to sale agreement. We assess the limitations of existing theories in explaining the data and propose an alternative theoretical framework for the study of the strategic interactions between buyers and sellers that is consistent with the empirical evidence.

JEL Classification: D4, R0, L0.

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1 Introduction

The sale of a house is a typical example of a situation that entails strategic interactions between a seller and a set of potential buyers. When a house is put on the market, the seller posts a listing price and waits for potential buyers to make offers. When a match between the seller and a potential buyer occurs, bargaining takes place, leading possibly to a sale agreement. At any point in time while a house is still on the market, the seller has the option of revising the listing price.

This paper presents and investigates a new data set of individual residential property transactions in England. The main, novel features of our data are the record of all listing price changes and all offers ever made on a property since initial listing. In addition, we have a complete record of visits by potential buyers, called viewings, for a subset of transactions in our sample. We are therefore in a unique position to analyze the behavior of buyers and sellers within individual transaction histories and the extent to which the sequence of events leading to a transaction affect the sale price.

The picture of the house transaction process that emerges from the data can be summarized as follows. The listing price influences the arrival of offers, which ultimately determines the timing of the sale. As time on the market increases, the arrival rate of potential buyers decreases and the probability of a listing price revision increases. The longer the time the property remains on the market, the lower the level of offers relative to the listing price, the higher the probability a match is successful, and the lower the sale price relative to the listing price.

A relatively high initial listing price results in a higher sale price but also a longer time on the market. Listing price reductions concern primarily properties which have not received any offer while being on the market for a substantial period of time (in fact, a period equal to the average time to sale). Proportionally, decreases in listing price are also substantial (in fact, greater than the average percentage difference between the sale price and the initial listing price).

Almost 40 percent of sales occur at the first offer ever received. One third of the potential buyers whose first offer is turned down walk away from the negotiation. The remaining two thirds continue bargaining with the seller and are observed to make up to four consecutive, increasing offers before either they succeed in purchasing the property or the negotiation terminates without an agreement.

One third of all matches between the seller and a potential buyer are unsuccessful. The vast majority of sellers whose first match is unsuccessful end up selling at a higher price, but a few end up accepting a lower offer. The higher the number of matches in a transaction history, the higher the sale price. These are just a few of the salient features observed in the data.

To date, the lack of adequate data has limited the scope of empirical research on housing transactions.[1] Existing data sets typically include property characteristics, time to sale, initial listing price, and sale price. They do not contain information on the buyer's side of the transaction (e.g., the timing and terms of offers made by potential buyers), or on the seller's behavior between the listing and the sale of a property (e.g., the seller's decision to reject an offer or to revise the listing price). This explains why most of the empirical literature on housing transactions has either focused on the determinants of the sale price or on the role of the listing price and its effect on the time to sale.[2]

Recent attempts to overcome some of the data limitations by supplementing conventional data sets with additional information have generated valuable insights. For example, Genesove and Mayer (1997) build a data set for the Boston condominium market where they are able to uncover the financial position of each seller. They find that sellers with high loan-to-value ratio tend to set a higher initial listing price, have a lower probability of sale but, if and when they sell, obtain a higher price. Glower et al. (1998) conduct a phone survey to obtain information on each seller's motivation (e.g., whether or not they have a planned moving date), for a real estate transaction data set for Columbus, Ohio. The evidence suggests that sellers convey information about their willingness to sell (i.e., their reservation value), through the listing price.[3] Levitt and Syverson (2002) identify instances where real estate agents sell their own property, in a sample of transactions from suburban Cook county, Illinois. They find evidence that the informational advantage of agents induces distortions in the terms and timing of sales.

In addition to providing a valuable resource for empirical research on housing transactions, our data raises new challenges for theoretical research on the strategic interactions between buyers and sellers.[4] We assess the limitations of existing theories in explaining

[1] This is also true for other markets where the transaction process involves search, matching and bargaining, since the lack of data on rejected offers is pervasive.

[2] See, e.g., Horowicz (1992) and Zuelke (1987).

[3] Similar evidence is reported, for example, in Anglin et al. (2001), Genesove and Mayer (2001), Knight et al. (1998) and Springer (1996).

[4] For existing theoretical models of the behavior of buyers and sellers in the housing market see, e.g., Arnold (1999), Chen and Rosenthal (1996a) and (1996b), Coles (1998), Horowitz (1992), Yavaş (1992), and Yavaş and Yang (1995).

the data and propose an alternative framework that is consistent with the empirical evidence. Our analysis highlights the importance of accounting for incomplete information in the matching and bargaining environment where buyers and sellers interact in order to explain the sequence of events in the housing transaction process as well as its outcome.

The remainder of the paper is organized as follows. Section 2 describes our data set and provides institutional details of the residential real estate market in England. Section 3 reports the results of our descriptive empirical analysis of the process leading to the sale of a property, from its initial listing to a sale agreement. In Section 4, we summarize our main findings, discuss the limitations of existing theories, present an alternative theoretical framework, and assess its empirical implications.

2 Data

In England, most residential properties are marketed under sole agency agreement. This means that a property is listed with a single real estate agency that coordinates all market related activities concerning that property from the time it is listed until it either sells or is withdrawn.

Agencies represent the seller only. Listing a property with an agency entails publishing a sheet of property characteristics and a listing price.[5] The listing price may be revised at any time at the discretion of the seller. Potential buyers search by visiting local real estate agents and viewing properties. A match between the seller and a potential buyer occurs when the potential buyer makes an offer. Within a match, the general practice is for the seller to either accept or reject offers. In the event the seller rejects an offer, the potential buyer either makes another offer or walks away. If agreement occurs, both parties engage the administrative procedure leading to the exchange of contracts and the completion of the transaction. This procedure typically lasts three to eight weeks. During this period, among other things, the buyer applies for mortgage and has the property surveyed. Each party may cancel the sale agreement up to the exchange of contracts.

For each property it represents, the agency keeps a file containing a detailed description of the property, its listing price, and a record of listing price changes, offers, and terms of the sale agreement, as required by law. The information contained in each individual file is also recorded on the accounting register that is used by each agency

[5] Although not legally binding, the listing price is generally understood as a price the seller is committed to accept.

to report to the head office. Although all visits of a property by potential buyers are arranged by the listing agency, recording viewings is not required either by the head office or by law. However, individual agencies may require their agents to collect this information for internal management purposes.

Our data set was obtained from the records of four real estate agencies in England.[6] Three of these agencies operate in the Greater London metropolitan area, one in South Yorkshire. Our sample consists of 780 complete transaction histories of properties listed and sold between June 1995 and April 1998 under sole agency agreement.[7] Each observation contains the property's characteristics as shown on the information sheet published by the agency at the time of initial listing, the listing price and the date of the listing. If any listing price change occurs, we observe its date and the new price. Each match is described by the date of the first offer by a potential buyer and the sequence of buyer's offers within the match. When a match is successful, we observe the sale agreed price and the date of agreement which terminate the history. In addition, for the properties listed with one of our Greater London agencies (which account for about a fourth of the observations in our sample), we observe the complete history of viewings. Since events are typically recorded by agents within the week of their occurrence, we use the week as our unit of measure of time.

Our data spans two geographic areas with different local economic conditions and two different phases of the cycle in the housing market. While the local economy in Greater London has been experiencing a prolonged period of sustained growth, this has not been the case in South Yorkshire. Furthermore, from June 1995 to April 1998, the housing market in the Greater London metropolitan area went from a slow recovery to a boom. While this transition occurred gradually, for ease of exposition we refer to 1995-96 as the recovery and to 1997-98 as the boom.

Table 1 contains an overview of some of the features of our data. Column 1 refers to the properties in our sample located in South Yorkshire. Columns 2 and 3 refer to properties located in Greater London that were listed during the recovery and the boom, respectively. Column 4 refers to the overall sample. Several observations are noteworthy. First, more active housing markets (e.g., Greater London *vs.* South Yorkshire) appear to be characterized by higher sale price relative to listing price, fewer listing price changes, more offers, and more matches. Most of these observations hold true when we compare

[6]These agencies are all part of Halifax Estate Agencies Limited, one of the largest network of real estate agents in England.

[7]Each entry in our data was validated by checking the consistency of the records in the accounting register and in the individual files. Observations with inconsistent or incomplete records were dropped.

booming markets to dull markets (e.g., Greater London in 1997-98 *vs.* 1995-96). Overall, properties in our sample, on average, sell at about 96% of their listing price after being on the market for 11 weeks. More than three quarters of all properties sell without any revision of their listing price. The average number of matches and the average number of offers indicate that most properties are sold to the first potential buyer who makes an offer on the property, but not necessarily at their first offer. In addition to the information reported in Table 1, note that for the sub-sample of 199 properties for which viewings records are available, the average number of viewings per property is equal to 9.5 and the average number of viewings per week on the market is equal to 1.7.

Table 1: Overview

	Yorkshire 95-98	London 95-96	London 97-98	Overall 95-98
Number of observations	343	239	198	780
Average initial listing price	£40,665	£86,783	£99,820	£69,812
% transactions with a price change	35.28	17.99	8.59	23.21
Average number of matches	1.26	1.62	1.53	1.44
Average number of offers	1.73	2.91	2.38	2.26
Average sale price	£37,989	£83,524	£97,168	£66,964
Sale price/listing price (%)	93.4%	96.2%	97.3%	95.9%
Average weeks to sale	15	10	7	11

Table 2 contains descriptive statistics of the main characteristics of the properties in our sample.[8] The variables FLAT, TERR, SEMI, and DET are dummy variables for the type of property. They denote flats, terraced, semi-detached, and detached properties, respectively. The variables B1, B2, B3, and B4 are dummy variables which stand for one, two, three, and four or more bedrooms, respectively. GARAGE indicates whether the property has a garage. TOTA is the total area measured in square meters, NBATH is the number of bathrooms, and APPL is the number of appliances listed on the characteristic sheet published by the agent.[9] As we can see from column 7, most properties in our sample have either two or three bedrooms (77 percent). Semi-detached properties are the most represented (38 percent). Terraced properties, detached houses, and flats, account for 27, 15, and 20 percent of the sample, respectively. The remainder of the table illustrates the type of housing sold in each of the local markets we consider.

[8] These characteristics are only a subset of the ones listed in the information sheet published by the agency at the time of initial listing. The additional variables were excluded from our analysis since they appear to have no significant effect on prices.

[9] Agents typically list the major appliances to be left with the property. The number of such appliances was the only information recorded in the data set.

Table 2: Property characteristics

	Yorkshire 97-98		London 95-96		London 97-98		Overall 95-98	
Variable	Avg	Std Dev	Avg	Std Dev	Avg	Std Dev	Avg	Std Dev
FLAT	0.026	0.16	0.264	0.442	0.439	0.498	0.204	0.403
TERR	0.318	0.466	0.222	0.416	0.263	0.441	0.274	0.446
SEMI	0.464	0.499	0.389	0.489	0.202	0.403	0.375	0.484
DET	0.192	0.395	0.125	0.332	0.096	0.295	0.147	0.355
TOTA	66.1	17.5	59	22.1	53.93	18.07	60.8	19.8
NBATH	1.24	0.576	1.42	0.615	1.29	0.519	1.31	0.579
GARAGE	0.426	0.495	0.377	0.486	0.263	0.441	0.369	0.483
APPL	0.793	1.19	1.25	1.5	0.949	1.17	0.973	1.306
B1	0.006	0.076	0.184	0.388	0.263	0.441	0.126	0.332
B2	0.306	0.462	0.31	0.463	0.323	0.469	0.312	0.463
B3	0.592	0.492	0.364	0.482	0.353	0.479	0.461	0.499
B4	0.096	0.295	0.142	0.35	0.061	0.239	0.101	0.302

Before turning our attention to the analysis of the data, a few remarks are in order. First, our data refers to complete transaction histories only, from initial listing to sale agreement. In particular, properties that are listed and then withdrawn from the market before a sale agreement are not in our sample. For this reason, the emphasis of the paper is on the events leading to the sale of a property and on the behavior of buyers and sellers during this process.[10]

Second, while none of the properties in the data set were sold at a formal auction, it is nevertheless possible that two or more buyers found themselves bidding on the same property at the same time. Sifting through the records of transaction histories, we detect the occurrence of about 30 *de facto* auctions out of 780 transactions. The properties concerned sold at a higher than average price relative to effective listing price. In fact, such *de facto* auctions account for all instances in the data where the sale price is above the listing price (except for small differences due to rounding up). All the qualitative and quantitative findings of our analysis are robust to the exclusion of these transaction histories from the data set.

Third, the cancellation of a sale agreement is not a rare phenomenon. In our sample, 1 out of 5 agreements is cancelled. Agents' records indicate that cancellations are usually due to the arrival of new information such as a bad inspection outcome or failure to obtain mortgage. A sale agreement may also be contingent upon the successful completion of

[10]Withdrawals are not infrequent. Based on a preliminary investigation we estimate that as many as 25 percent of all listings may end up being withdrawn prior to a sale.

other transactions (e.g., the purchase of a house by the seller). Hence, cancellations may also be induced by the failure of related transactions. Here we implicitly assume that parties bargain in earnest. That is, we assume that the right to cancel a sale agreement does not distort the behavior of the parties involved in a housing transaction and that the object of a negotiation is the sale of a house.

3 Descriptive Empirical Analysis

In this section, we analyze the details of the process leading to the sale of a property, from its initial listing to a sale agreement. The first step in this process is the setting of the listing price on the part of the seller. In section 3.1, we analyze the choice of the initial listing price and whether, when, and to what extent sellers revise their decision. The next step is the occurrence of matches between the seller and the potential buyers who choose to make offers on a property. We describe the occurrence of matches in section 3.2 and the sequence of offers within and across matches in section 3.3. The final step of the transaction process is the sale of a property. In section 3.4, we analyze the timing and terms of the sale agreement. Restricting attention to the sub-sample of properties for which information on viewings is available, we analyze the role played by viewings in the process leading to the sale of a property in section 3.5.

To investigate the effects of local market conditions on transaction histories, throughout our analysis we use agency-specific dummy variables, labelled AGENCY1, AGENCY2, AGENCY3, and AGENCY4, where AGENCYi is equal to 1 if the property is located in the local market where agency i operates and 0 otherwise ($i = 1, 2, 3, 4$). Note that agencies 1, 2, and 3 list properties located in different communities within the Greater London metropolitan area, while agency 4 operates in South Yorkshire. To account for aggregate dynamics in the English housing market we specify a linear trend for the month in our sampling period when each property was listed, MONTH, and an additional linear trend for the properties located in Greater London, MONTHGL.

3.1 Listing Price

We begin our analysis by investigating the relation between the initial listing price of a property and its observable characteristics using the standard hedonic framework. The results of a regression of the initial listing price (ILISTP) on the property characteristics, agency dummies, and the trend variables MONTH and MONTHGL are reported in Table

3.[11] Note that the default property is a one bedroom semi-detached house located in South Yorkshire (i.e., the local market where agency 4 operates).

Table 3: Initial listing price

Variable	Estimate	Standard Error
FLAT	−16687*	2932
TERR	−7486*	1762
DET	20787*	2287
TOTA	522*	56
NBATH	6256*	1384
GARAGE	6377*	1609
APPL	3801*	532
B2	14380*	2490
B3	11748*	2945
B4	19205*	4510
AGENCY1	24997*	3694
AGENCY2	58303*	4107
AGENCY3	46357*	3652
MONTH	158	117
MONTHGL	861*	159
INTERCEPT	−24739*	4097
R^2	.80	

All of the parameter estimates associated with the property characteristics included in the hedonic regression are statistically significant at conventional levels and have the expected sign and reasonable magnitudes.[12] The variables included in our regression jointly account for 80 percent of the observed variability in the initial listing price. This level of explanatory power is comparable to what is typically found in the literature on hedonic models of housing prices.[13] Overall, initial listing prices depend to a large extent on the observable characteristics of the properties. The hedonic model, however, cannot fully account for the variability in initial listing prices. The estimated coefficients of the agency dummies and the time trend for Greater London indicate that, after controlling for property characteristics, more active housing markets and booming markets are associated with higher listing prices.

[11] In this table as for all other estimations below, we only report whether each parameter estimate is significantly different from zero at the 5 percent level. We indicate this occurrence with the superscript *.

[12] Given the size of its estimated coefficient, the variable APPL must be capturing more than the monetary value of what it accounts for.

[13] Recent work which incorporates variables accounting for the details of all local public amenities generates higher values for the regression's R^2 (e.g., Cheshire and Sheppard 2000). These details are not available in our data.

The first novelty of our data set is the information on listing price changes. This information is summarized in Table 4. About one fourth of all sellers change their listing price at least once.[14] Before a first price change, they wait 11 weeks on average. Recall from Table 1 above that the average time to sale is also 11 weeks. This observation suggests that sellers who change their listing price wait a significant amount of time before doing it. In more active markets price changes are less frequent.

Table 4: Listing price changes

	Yorshire 95-98	London 95-96	London 97-98	Overall 95-98
Price change distribution:				
% properties with 0	65	82	91	77
% properties with 1	26	14	8	18
% properties with 2+	9	4	1	5
First price change:				
Average % price decrease	6.3	3.4	2.6	5.3
Average weeks since listing	12	10	9	11
% properties with no offer yet	92	71	80	86
Second price change:				
Average % price decrease	4.8	2.6	-	4.4
Average weeks since first price change	9	7	-	8
% properties with no offer yet	72	67	-	70

In the vast majority of cases, sellers who decrease their listing price have no prior response from prospective buyers: in 86 percent of the cases, price changes occur before an offer was ever received. To explore whether this finding is indicative of a robust relation between the lack of offers and the probability of a listing price reduction, we estimate a flexible functional form hazard (Flinn and Heckman 1982) for the probability of a first listing price revision in any given week since initial listing.[15] The flexible functional form for the hazard function we consider here is given by:

$$P(ELISTP_t \neq ILISTP | ELISTP_{t-1} = ILISTP) = e^{\beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3 + \beta_4 X_{1,t} + \beta_5 X_2}, \quad (1)$$

where t denotes weeks since initial listing, $ILISTP$ the initial listing price, $ELISTP_t$ the effective listing price at time t, $X_{1,t}$ the vector of time-varying covariates and X_2 the vector of time-invariant covariates.[16] The set of time-invariant variables we consider includes

[14] Only 9 transactions involved 3 listing price changes, the maximum observed in our sample.

[15] This approach consists of approximating the baseline hazard function with a polynomial function in time, where the order of the polynomial function is chosen to best fit the data.

[16] Since not all sellers revise their listing price, some observations are censored. We correct for censoring in the estimation which is carried out by maximum likelihood.

property characteristics, agency dummies, MONTH, MONTHGL, and the initial listing price. Our specification also includes a time-varying variable denoting the highest offer received each week as a proportion of the effective listing price (HOELISTP). HOELISTP is set to zero when no offer is received and thus captures both whether or not an offer is received and the relative level of the offer.

Table 5: Time to first price change

Variable	Estimate	Standard Error
FLAT	0.034	0.396
TERR	0.221	0.210
DET	0.267	0.269
TOTA	0.147	0.648
NBATH	−0.251	0.178
GARAGE	0.103	0.194
APPL	0.010	0.067
B2	0.353	0.340
B3	0.175	0.385
B4	0.633	0.520
AGENCY1	1.371*	0.443
AGENCY2	0.922	0.573
AGENCY3	0.724	0.482
MONTH $\times 10^{-2}$	3.758*	1.010
MONTHGL $\times 10^{-2}$	−4.407*	1.972
ILISTP $\times 10^{-5}$	−1.262*	0.539
HOELISTP	−0.772*	0.343
T $\times 10^{-1}$	3.154*	0.462
$T^2 \times 10^{-2}$	−1.415*	0.235
$T^3 \times 10^{-4}$	1.532*	0.274
INTERCEPT	−5.047*	0.527

As reported in Table 5, all terms of the cubic specification of the baseline hazard are significant displaying the following non-monotonic pattern: the probability of a price revision increases first up to 15 weeks, it then decreases until week 47 before rising again.[17] Receiving a high offer decreases the probability of a price change. A high initial listing price also decreases the probability of a listing price change. Price changes are more likely in the later part of our sampling period as indicated by the positive coefficient associated with the variable MONTH. However, the probability of a price change decreases in a booming market, as indicated by the negative sign of the coefficient associated with MONTHGL and by the fact that this effect dominates the positive effect of MONTH.

[17] Likelihood ratio tests reject higher-order polynomial specifications in favor of the cubic specification reported here.

Table 6: Size of first listing price change

Variable	Estimate	Standard Error
FLAT	1.968	1.415
TERR	2.086*	0.809
DET	0.693	1.148
TOTA	.036	.025
NBATH	2.307*	0.641
GARAGE	−0.277	0.774
APPL	−0.398	0.293
B2	−0.654	1.369
B3	−0.230	1.491
B4	−0.454	2.144
AGENCY1	−0.440	1.841
AGENCY2	0.141	2.182
AGENCY3	−0.312	2.102
MONTH	0.036	0.050
MONTHGL	−0.035	0.082
WTFPC	0.113*	0.042
ILISTP $\times 10^{-}4$	−0.519*	0.223
NOOFF	0.121	0.932
INTERCEPT	1.237	2.289
R^2	.32	

Virtually all price changes are price decreases.[18] As shown in Table 4, the drop in price is typically substantial.[19] It is equal to 5.3 percent on average, which is greater than the average sale price discount relative to initial listing price (4.1 percent). In more active markets listing price reductions are smaller on average. To investigate which factors are systematically related to the size of listing price reductions, we run a regression of the first listing price revision (as a percentage of the initial listing price) on property characteristics, agency dummies, MONTH, MONTHGL, initial listing price, number of weeks between listing and price change (WTFPC), and a dummy variable equal to one if no offers were made on the property (NOOFF). The results are reported in Table 6.[20] The longer the time on the market before the change, the larger the drop. Also, the higher the initial listing price, the smaller the listing price revision in percentage terms. The lack of offers does not seem to have any effect on the magnitude of listing

[18] Of the three cases of listing price increases, one is minor, less than one percent. The other two are more substantial: one is an adjustment within a few days of initial listing, the other occurs three months after initial listing.

[19] Using data from Stockton, California, Knight (2002) also finds that when sellers change their listing price, the listing price at the time of sale is substantially below the initial listing price.

[20] The number of first listing price changes in our data is 181.

price changes. Also note that, holding everything else constant, the effect of market conditions disappears.

3.2 Matches

The second novelty of our data set concerns the record of all matches that occur between each seller in our sample and the potential buyers who choose to make offers on her property. This information is summarized in Table 7. Approximately 72 percent of all transactions occur within the first match. Only 10 percent of all sales occur after 3 or more matches.[21] About a third of all matches are not successful. On average, the success rate of first matches is higher than that of later matches. About three quarters of the sellers are matched with a potential buyer within ten weeks of putting their property on the market. More than ten percent within one week. Looking at differences across local markets, columns 1-3 in Table 7 illustrate that more active markets and booming markets are characterized by greater turnover: matches occur sooner, they are more frequent, and their success rate is lower.

Table 7: Matches

	Yorkshire 95-98	London 95-96	London 97-98	Overall 95-98
Matches per sale:				
Average	1.2	1.6	1.5	1.4
% properties with 1	79	64	68.1	71.7
% properties with 2	17.2	20.9	17.7	18.4
% properties with 3	2.6	8	9.1	5.9
% properties with 4+	1.2	7.1	5.1	3.9
Time to first match (weeks)				
Average	12	7	5	9
Median	8	5	3	5
% with match within 1 week	3.5	16.3	16.7	12.6
% with match within 10 weeks	61.2	80.3	87.4	73.7
Success rate:				
All matches	79.4	61.6	65.6	69.5
First match	81.6	66.5	72.2	74.6
Second match	70.8	58.1	54.0	61.1
Third match	69.2	47.2	50.0	51.9

[21] Only 10 transactions occur after 5 or more matches and the maximum number of matches in the sample is 7.

Figure 1 plots the average number of matches per week for all properties still on the market. This measure of the rate of arrival of matches increases from the first to the second week. Following this rise, the rate of arrival gradually decreases up to 21 weeks, before rising again. To explore further the dynamics of the rate of arrival of matches, we estimate a flexible functional form hazard (similar to the one above) for the probability the first match occurs in any given week since initial listing. The set of time-invariant variables we consider includes property characteristics, agency dummies, MONTH, and MONTHGL. Our specification also includes two time-varying variables denoting the effective listing price and the occurrence of listing price changes (DPC), respectively.[22]

Table 8: Time to first match

Variable	Estimate	Standard Error
FLAT	-0.058	0.170
TERR	0.087	0.099
DET	-0.226	0.131
TOTA$\times 10^{-2}$	0.399	0.306
NBATH	0.056	0.076
GARAGE	-0.024	0.092
APPL	0.011	0.031
B2	0.155	0.138
B3	0.218	0.161
B4	0.023	0.250
AGENCY1	0.786*	0.206
AGENCY2	0.606*	0.251
AGENCY3	0.666*	0.222
MONTH $\times 10^{-2}$	3.025*	0.615
MONTHGL $\times 10^{-2}$	0.197	0.872
ELISTP $\times 10^{-6}$	-1.417	2.097
DPC	0.243*	0.104
T $\times 10^{-2}$	-2.258*	1.065
$T^2 \times 10^{-4}$	4.990*	2.343
INTERCEPT	-3.392*	0.243

The maximum likelihood estimates and standard errors we obtain are reported in Table 8. All terms of the quadratic specification of the baseline hazard are significant displaying the following non-monotonic pattern: the probability of arrival of the first match decreases for the first 23 weeks since initial listing and then increases.[23] Holding

[22]DPC is a time-varying indicator variable that takes the value 0 prior to a listing price change and 1 from the occurrence of a listing price change on.

[23]Likelihood ratio tests reject higher-order polynomial specifications in favor of the quadratic specification reported here.

Figure 1: Matches per property on the market, per week

everything else constant, the probability of arrival of the first match increases with a listing price revision, but does not vary with the current level of the listing price. Also, more active markets are associated with a higher probability of arrival of the first match.

3.3 Offers

When a match occurs, the seller and the potential buyer engage in a bilateral bargaining process characterized by a sequence of buyer's offers that the seller either accepts or rejects. The third novelty of our data set is that it contains detailed information on all offers ever made on a property. This information is summarized in Tables 9, 10, and 11.

Table 9: Offers

	Yorkshire 95-98	London 95-96	London 97-98	Overall 95-98
Number of matches	432	388	302	1122
Distribution of offers per match:				
Average	1.37	1.79	1.56	1.57
% matches with 1	69.9	44.6	56.0	57.4
% matches with 2	23.4	34.5	33.1	29.9
% matches with 3	6.5	18.0	9.6	11.3
% matches with 4	0.2	2.8	1.3	1.4
First offer relative to listing price	92.4	94.3	95.6	94.0
Increments within match:				
First to second offer	5.22	2.64	2.33	3.26
Second to third offer	3.19	1.98	1.50	2.12
Percentage separations				
After one unsuccessful offer	36.6	28.3	31.1	31.5
After two unsuccessful offers	31.0	34.1	50.0	38.1
After three unsuccessful offers	50.0	65.6	71.4	66.7

Table 9 reports the main features of observed sequences of offers within matches. Potential buyers make up to four consecutive offers. On average, successive offers within a sequence increase at a decreasing rate. In more than half of the matches only one offer is exchanged. Almost 40 percent of sales occur at the first offer ever received, 54 percent occur at the first offer of a match. Upon rejection of their first offer, 68 percent of all potential buyers make a second offer. The remaining 32 percent walk away, hence terminating the negotiation. The incidence of separations increases with the number of rejected offers. That is, the fraction of potential buyers who terminate a negotiation

after having their first offer rejected is smaller than the fraction of potential buyers who do so after a second or third rejection.

In Table 10, we restrict attention to offer sequences within a match that are not censored by agreement with the seller (i.e., matches that terminate with a separation). The higher the number of offers in a match the lower the first offer relative to the listing price. In general, the higher the number of offers in a match, the higher the last offer relative to the effective listing price. It therefore appears that the more offers there are in a match, the broader the interval spanned by the offers. As we can see from columns 1-3 in Tables 9 and 10, in more active markets we observe a larger number of offers and offers that are on average closer to the listing price. Within offer sequences, however, we observe smaller increments.

Table 10: Spread of offers, unsuccessful matches

	Yorkshire 95-98	London 95-96	London 97-98	Overall 95-98
2 offers in match				
First offer relative to listing price	85.0	93.5	93.2	92.1
Last offer relative to listing price	88.6	96.6	95.9	95.2
3 offers in match				
First offer relative to listing price	-	90.9	92.3	91.1
Last offer relative to listing price	-	95.6	95.9	96.1

In Table 11, we compare the first offer in a match across different matches within a transaction history. On average, the first offer relative to the listing price is increasing in the number of matches in a transaction history. In particular, both in the aggregate as well as in each local market, the first offer in the first match is on average farther away from the listing price than the first offer in successive matches. To investigate which factors are systematically related to the level of the first offer in a match, we regress the first offer in a match as a percentage of the effective listing price at the time of the match (PERMFOEL) on the property characteristics, agency dummies, MONTH, MONTHGL, the number of weeks between initial listing and the occurrence of the match (WTMATCH), and a dummy variable equal to one if it is the first match and zero otherwise (MATCH1). The results are contained in Table 12.[24]

Ceteris paribus, the level of the first offer in a match relative to the listing price is lower the longer a property has been on the market and if it is the first offer ever made

[24] We report robust standard errors which account for the fact that observations are independent across properties but not across matches within the same transaction history.

Table 11: First offer relative to listing price

	Yorkshire 95-98	London 95-96	London 97-98	Overall 95-98
First match	92.2	93.9	95.3	93.5
Second match	93.2	94.7	96.6	94.7
Third match	92.2	95.5	97.3	95.6
Fourth match	93.4	97.1	97.2	96.6

on a property. Also, after controlling for property characteristics, time on the market, and order of matches, the level of the first offer in a match is closer to the effective listing price in more active housing markets.

Table 12: First offer relative to effective listing price

Variable	Estimate	Standard Error
FLAT	0.289	0.806
TERR	-2.135^*	0.626
DET	0.575	0.591
TOTA$\times 10^{-1}$	0.010	0.181
NBATH	0.422	0.381
GARAGE	0.577	0.432
APPL	0.163	0.244
B2	0.824	0.979
B3	1.263	1.141
B4	-0.631	1.812
AGENCY1	2.112	1.148
AGENCY2	-0.116	1.335
AGENCY3	2.313^*	1.134
MONTH	0.038	0.050
MONTHGL	0.029	0.054
WTMATCH	-0.076^*	0.031
MATCH1	-1.317^*	0.456
INTERCEPT	92.286^*	1.741
R^2	.14	

3.4 Sale Agreement

The timing and terms of the sale agreement for the properties in our sample are summarized in Table 13. In the table, the effective listing price denotes the listing price at the time of the sale agreement. Overall, properties in our sample sell at about 96% of their effective listing price and 13 percent of the properties sell at the listing price. The mean

and median time to sale are 11 and 7 weeks, respectively. In a booming housing market sale prices are on average closer to the effective listing prices, a larger fraction of sales occur at the listing price, and properties sell considerably faster.

Table 13: Sale price and time to sale

	Yorshire 95-98	London 95-96	London 97-98	Overall 95-98
Sale price vs effective listing price:				
Average as percent of listing price	95.0	96.8	97.6	96.2
% with prices equal	13.4	8.4	26.8	15.3
% with sale price greater	5.0	2.5	4.6	4.1
Time to sale				
Average	15	10	7	11
Median	10	7	5	7
Within 2 weeks	3.2	18.0	23.2	12.82
Within 20 weeks	75.8	89.1	93.94	84.49
Maximum	69	69	42	69

To investigate which factors systematically affect the timing of a sale agreement, we estimate a flexible functional form hazard for the probability a sale would occur in any given week since initial listing. The set of time-invariant variables we consider includes property characteristics, agency dummies, MONTH, and MONTHGL. Our specification also includes three time-varying variables denoting the effective listing price in each week, the number of offers received each week, and the highest offer received each week as a proportion of the effective listing price, HOELISTP.[25] Maximum likelihood estimates and standard errors are reported in Table 14.

The only estimated parameter that is significant is the one associated with the variable HOELISTP. Conditional on at least one offer being made on a property in any given week, the larger the best offer relative to the listing price, the higher the probability of a sale agreement. In particular, none of the terms in our quadratic specification in time is significantly different from zero.[26] This implies that the baseline hazard is constant. In other words, after conditioning on the arrival and the size of offers, the probability of a sale occurring in any given week is constant over time. These findings point to the rather obvious conclusion that the main determinant of whether a property sells in a given week is whether or not an offer is made and how high this offer is relative to the listing price.

[25] Recall that this variable is equal to zero if no offer is received in a week.

[26] The same result holds for any polynomial specification.

Table 14: Time to sale

Variable	Estimate	Standard Error
FLAT	0.094	0.329
TERR	0.098	0.187
DET	-0.067	0.288
TOTA$\times 10^{-2}$	0.152	0.677
NBATH	-0.058	0.157
GARAGE	-0.060	0.172
APPL	0.009	0.070
B2	-0.075	0.363
B3	-0.117	0.379
B4	-0.022	0.509
AGENCY1	-0.353	0.472
AGENCY2	-0.443	0.534
AGENCY3	-0.450	0.509
MONTH	-0.647	1.318
MONTHGL	0.764	1.751
ELISTP $\times 10^{-6}$	0.450	4.777
NOFFERS $\times 10^{-2}$	0.832	4.419
HOELISTP	6.607*	0.753
T $\times 10^{-3}$	3.825	23.703
$T^2 \times 10^{-5}$	-0.352	56.096
INTERCEPT	-6.217*	0.834

Figure 2 plots the sale price of each property relative to its effective listing price as a function of the number of weeks since initial listing.[27] A few relatively inexpensive properties (listed for less than £20,000) sell at a very large discount, up to 50 percent. In the vast majority of cases the sale price is below the listing price. A few transactions take place at a sale price above the listing price. These instances are due either to rounding up or to simultaneous bidding by competing buyers.[28]

Figure 2 suggests that the longer a property is on the market, the lower its sale price relative to its listing price. To explore whether this relation is robust, we regress the the sale price as a percentage of the listing price on the property characteristics, agency dummies, MONTH, MONTHGL, the initial listing price, and the number of weeks from initial listing to sale agreement (WTSALE). The results are contained in Table 15. The shorter the time on the market, the higher the sale price as a percentage of the listing

[27] About 11 percent of all properties took more than 26 weeks to sell and are omitted from the graph.

[28] The "luckiest" seller at this game had a listing price of £99,950. He turned down an offer at £85,000 two weeks after initial listing. A few days later, 4 buyers started bidding against each others, pushing the price up to £125,000.

Figure 2: Sale price and time to sale

price. An active housing market and a booming market are also associated with higher sale prices relative to listing prices.

Table 15: Sale price as a percentage of listing price

Variable	Estimate	Standard Error
FLAT	−1.946*	0.917
TERR	−2.734*	0.552
DET	0.311	0.717
TOTA	0.010	0.017
NBATH	-0.058	0.433
GARAGE	0.666	0.503
APPL	0.447*	0.167
B2	-0.289	0.779
B3	-0.013	0.921
B4	-1.058	1.411
AGENCY1	3.219*	1.182
AGENCY2	3.609*	1.296
AGENCY3	4.256*	1.159
MONTH	0.065	0.038
MONTHGL	-0.011	0.050
WTSALE	−0.170*	0.021
INTERCEPT	93.537*	1.408
R^2	.25	

In Table 16, we summarize information relative to sale agreements that follow an unsuccessful first match. In 13 percent of the cases properties sell at a price below the maximum offer in the first match, 20 percent sell for the same amount, and the remaining two thirds of the properties sell at a price above (see also Figure 3). On average, after an unsuccessful first match, sellers wait 6 weeks before reaching a sale agreement and realize a 4 percent gain relative to the best offer in the first match.[29]

Table 16: When first match unsuccessful

	Yorkshire 95-98	London 95-96	London 97-98	Overall 95-98
Additional weeks to sale	8	6	3	6
Gain as percent of max offer first match	5.1	3.2	3.8	4.0
Percent sales below max offer first match	13.9	19.8	3.2	13.1
Percent sales at max offer of first match	20.8	14.1	23.8	19.5

[29]This gain is large relative to the gain to the real estate agent who earns less than 2 percent of the incremental profit. This observation is consistent with the argument in Levitt and Syverson (2002).

Figure 3: Gain when rejected first match

3.5 Viewings

For a sub-sample of 199 properties located in the local market within the Greater London metropolitan area where one of our agencies operates, our data set contains complete viewing records. A viewing is recorded each time a potential buyer visits a property. Information on viewings is summarized in Table 17. On average, there are 9.5 viewings per transaction. Only 9 properties sell after one viewing. The median number of viewings is 7, the maximum is 51. The average number of viewings per week on the market is 1.7.

Table 17: Viewings

	London 95-98
Viewings per sale	
Average	9.54
Median	7
Minimum	1
Maximum	51
Viewings per week	
Average	1.74
Median	1.33
Minimum	.08
Maximum	11

As illustrated in Figure 4, the arrival rate of viewings over time displays a monotonic decreasing pattern that is similar to the one observed for the arrival rate of matches. The viewing rate gradually decreases with time on the market. The data does not display a discrete drop in the arrival rate of viewings after a week or two. Hence, there does not seem to be a stock of potential buyers waiting for new properties to be listed and going to view them upon listing. If there is, this stock is minimal relative to the regular flow of new potential buyers arriving on the local market in any given week.

To investigate whether there is a systematic relation between the rate of arrival of viewings and the listing price, we run a Poisson regression of the number of viewings per week, on the initial listing price, property characteristics, and MONTHGL.[30] The results are reported in Table 18. Holding everything else constant, a higher listing price is associated with a lower rate of arrival of viewings.[31]

[30]The estimation procedure controls for the fact that properties differ in their exposure time (i.e., weeks on the market).

[31]This result also obtains if instead of a Poisson model we consider more flexible functional forms for the stochastic process of the arrival of viewings.

Figure 4: Viewings per property on the market, per week

Table 18: Number of viewings

Variable	Estimate	Standard Error
FLAT	-0.062	0.119
TERR	-0.073	0.067
DET	0.063	0.072
TOTA$\times 10^{-2}$	-0.160	0.168
NBATH	-0.282^*	0.052
GARAGE	-0.125^*	0.052
APPL	-0.075^*	0.021
B2	0.955^*	0.091
B3	1.305^*	0.112
B4	1.815^*	0.188
MONTHGL$\times 10^{-1}$	0.298^*	0.034
ILISTP $\times 10^{-5}$	-0.395^*	0.154
INTERCEPT	-0.498^*	0.122
Pseudo R^2	.17	

Using the additional information on viewings we revisit some of the issues we addressed earlier and investigate the role played by viewings in the process leading to the sale of a property. In particular, we investigate the relation of viewings with listing price revisions, the arrival of matches, and the timing of sale agreements. For each week a property is on the market, we define two variables that measure the number of viewings in the week and the cumulative number of viewings from initial listing. We include these two additional explanatory variables in our econometric analysis of the time to first price change, the time to first match, and the time to sale. The results of these exercises can be summarized as follows. On the one hand, we find no relation between the occurrence (or the lack) of viewings and either the probability of observing a price change or the probability of a sale agreement. On the other hand, we find that the more viewings in a week and the greater the total number of viewings since initial listing, the higher the probability of receiving an offer that week.[32]

Overall, the results in this section indicate that, holding everything else constant, a lower listing price increases the arrival rate of viewings, which in turn increases the arrival rate of offers. Thus, the listing price affects the arrival of offers indirectly, by affecting the arrival of viewings.

[32]The maximum likelihood estimates of flexible functional form hazards for these probabilities which include the additional variables on viewings are not reported here to economize on space.

4 Discussion

In the previous section, we investigated a number of issues pertaining to the details of the process leading to the sale of a property, from its initial listing to a sale agreement. This process can be thought of as a combination of a dynamic optimization problem faced by the seller and a sequence of bargaining problems between the seller and each potential buyer who initiates a match by making an offer on the property. In this section, for each of these two aspects of the transaction process we summarize our key findings, compare them with the predictions of the existing theories, and discuss an alternative framework that is consistent with the empirical evidence.

4.1 Listing Price

The solution of the dynamic optimization problem faced by the seller yields an initial listing price and an intertemporal decision rule specifying whether, when, and to what extent she should revise the listing price as time goes by. The evidence shows that a sizeable fraction of sellers revise their listing price at least once. Those who do typically reduce it by a substantial amount after waiting a substantial period of time without receiving any offer. These findings are in stark contrast to the predictions of existing theories of sellers' behavior in the housing market.

With respect to the choice of the optimal listing price, it is typically assumed that the seller faces a trade-off between the rate of arrival of buyers and the sale price: a low listing price increases the arrival rate of buyers but precludes the possibility of sales at a high price (e.g., Haurin 1988). This assumption is consistent with our empirical evidence. Existing theoretical models, however, imply that in equilibrium, either the seller never revises the listing price (e.g., Arnold 1999, Chen and Rosenthal 1996a and 1996b, Horowitz 1992 and Yavaş and Yang, 1995), or she gradually lowers the listing price over time in a continuous fashion (e.g., Coles 1998).

We propose a simple extension that overcomes this shortcoming of existing theories. Suppose that potential buyers restrict their search to properties whose listing price is below a certain amount. Depending on their characteristics (e.g., income and preferences), different potential buyers will have different upper bounds on the listing price of the properties they are willing to consider.[33] As long as the distribution of these bounds in the population of potential buyers exhibits heaping at certain amounts, this

[33] Also, different potential buyers may search different types of properties.

buyers' search behavior will induce heaping of the distribution of listing prices at the same amounts.

To illustrate why this is true, consider first the case where the distribution of upper bounds characterizing the search behavior of potential buyers, $F(\cdot)$, is discrete and takes a finite number of values. When choosing her optimal listing price, a seller faces a fundamental trade-off between the rate of arrival of potential buyers and the level of the maximum potential offer. The higher the listing price, the lower the rate of arrival of potential buyers, but the higher the maximum potential offer. Suppose a seller does not list her property at a price that corresponds to one of the mass points of the distribution F. The marginal cost (in terms of a decrease of the arrival rate of potential buyers) of raising her listing price up to the nearest mass point is zero. On the other hand, the marginal benefit is positive since raising the listing price increases the maximum potential offer. Hence, no seller will list her property at prices that do not correspond to mass points of the distribution F. By continuity, a similar argument holds if the distribution F is continuous but exhibits heaping, in which case the distribution of listing prices will also exhibit heaping.

Consider next an environment where some sellers face a time constraint (e.g., a deadline). Then, given our assumption about the search behavior of potential buyers, the optimal listing price strategy of these sellers might entail lowering their listing price in a discrete fashion as time goes by. As described above, the choice of a listing price restricts the set of potential buyers by "excluding" those buyers whose upper bound is below the listing price. At any given time, the cost of choosing a given listing price instead of a lower one is a lower instantaneous rate of arrival of potential buyers, which implies a higher probability of remaining on the market. As time goes by (and the deadline approaches), the seller's continuation value of remaining on the market decreases, and hence the cost of missing potential sale opportunities increases. On the other hand, the benefit from a higher maximum potential offer remains constant. Therefore, it may be optimal for a seller to drop her listing price over time. Our previous result on the heaping of the distribution of listing prices implies that if a drop occurs it will be discrete. These implications of our analysis are consistent with the observations.

The distinguishing feature of the theoretical framework described above is the "segmentation" of the market, where the bounds of the segments are defined by the modes of the distribution of upper bounds characterizing the search behavior of potential buyers. This raises the question of whether our segmented-market hypothesis is supported by the data.

The first implication of our assumption about the search behavior of potential buyers is that the distribution of listing prices should exhibit heaping. Figure 5 displays the histogram of initial listing prices for the properties in our sample.[34]. As we can see from Figure 5, a large fraction of listing prices are bunched around the bounds of £5,000 segments (e.g., ..., £65,000, £70,000, £75,000, ...). In particular, about half of all initial listing prices in the sample are within £50 of these bounds. The same pattern emerges when we partition the sample into local markets for each particular type of property.

The second implication of the segmented-market hypothesis is that price changes that reposition a property from a market segment to a lower one should significantly increase the arrival rate of offers. On the other hand, price changes that leave a property in the same segment should have a negligible effect. To address these issues we estimate the probability of receiving the first offer in any given week since initial listing using a hazard specification similar to the one reported above (see Table 8), but where we replace the listing price change indicator variable DPC with two dummy variables indicating whether the change leaves the property in the same £5,000 segment (SAMESEG), or places it in a lower £5,000 segment (LOWERSEG), respectively.[35] The maximum likelihood estimates and standard errors are reported in Table 19. Holding everything else constant, a listing price revision that reallocates a property from a £5,000 segment to a lower one increases the probability of arrival of the first offer, while a change in the listing price that leaves the property in the same £5,000 segment has no effect on this probability.[36] Overall, our findings provide empirical support for the segmented-market hypothesis.

4.2 Matching, Bargaining and Sale Agreement

We now turn our attention to the matching and bargaining aspects of the process leading to the sale of a property. The terms of a sale agreement are the outcome of a negotiation between the seller and the (ultimate) buyer of the property. The evidence shows that the majority of sales does not occur at the first offer. Buyers whose first offer is turned down either increase their offer or walk away. A substantial fraction of matches are

[34]To make the graph more readable we excluded the 7 properties in our sample that are listed above £180,000

[35]SAMESEG and LOWERSEG are two time-varying indicator variables that take the value 0 prior to a listing price change and 1 from the occurrence of a listing price change on, depending of course on the nature of the price change. Note that in half of the cases, the revised listing price is in a lower segment.

[36]These results are robust to the inclusion of the actual size of the price reduction in the econometric specification—the coefficient of this additional variable is not significant and the coefficients of the other variables remain virtually unchanged. They also obtain in Poisson regressions of the overall rate of arrival of offers and of the rate of arrival of viewings.

Figure 5: Histogram of initial listing prices

Table 19: Time to first offer revisited

Variable	Estimate	Standard Error
FLAT	-0.050	0.169
TERR	0.063	0.100
DET	-0.237	0.132
TOTA$\times 10^{-2}$	0.405	0.305
NBATH	0.070	0.076
GARAGE	-0.030	0.092
APPL	0.007	0.031
B2	0.153	0.136
B3	0.218	0.158
B4	0.009	0.243
AGENCY1	0.777*	0.206
AGENCY2	0.586*	0.252
AGENCY3	0.656*	0.222
MONTH $\times 10^{-2}$	3.056*	0.616
MONTHGL $\times 10^{-2}$	0.218	0.866
ELISTP $\times 10^{-6}$	-1.370	2.091
SAMESEG	0.200	0.130
LOWERSEG	0.341*	0.139
T $\times 10^{-2}$	-2.309*	1.068
$T^2 \times 10^{-4}$	5.089*	2.342
INTERCEPT	-3.380*	0.243

unsuccessful. The vast majority of sellers who fail to reach an agreement within their first match end up selling at a higher price. However, a significant fraction end up eventually accepting a lower offer. These findings directly contradict the predictions of existing matching and bargaining theories of housing transactions.

With respect to the bargaining process between the seller and each potential buyer, it is typically assumed that when a negotiation begins, the value of the surplus to be divided (that is, the difference between the buyer's willingness to pay for the house and the minimum price at which the seller is willing to sell the house) is known to both parties (e.g., Nash 1950, Rubinstein 1982). Based on this assumption, existing theoretical models of housing transactions imply that agreement is reached on the first offer ever received and all matches between the seller and a potential buyer result in a sale (e.g., Arnold 1999, Chen and Rosenthal 1996a and 1996b, Yavaş 1992 and Yavaş and Yang 1995).

The results of our empirical analysis clearly point out the limitations of complete information bargaining models to study housing transactions, and suggest appealing to an alternative class of bargaining models that can account for salient features of the data. In a bargaining environment where the seller and the potential buyer of a property

possess some private information about how much they value the property, the occurrence of delays in reaching agreement and the possibility of a negotiation terminating with a separation rather than an agreement are common features of an equilibrium.[37]

Consider, for example, a bilateral bargaining environment where the potential buyer makes all the offers (which is the case in our data) and after any rejection there is a positive probability of an exogenous negotiation breakdown (e.g., because the potential buyer finds another property). In this environment, it may be optimal for the buyer to make a relatively low initial "screening" offer that is accepted only if the seller's valuation is relatively low. If the offer is rejected, the buyer updates his beliefs about the seller's valuation and may either walk away or increase his offer, unless of course the negotiation breaks down for exogenous reasons. Note that although a rejection may be followed by a higher offer, it may still be optimal for a seller with a relatively low valuation to accept the buyer's initial offer because of the risk of negotiation breakdown.[38]

Combining this bargaining framework with the long-term optimization problem faced by the seller described in Section 4.1, we can now analyze the behavior of sellers across negotiations over time. When some sellers face a time constraint for the sale of their property, their continuation value declines over time. As a result, the minimum offer they are willing to accept also declines over time. Hence, it may be optimal for a seller to reject an offer from a potential buyer early on and then accept a lower offer from another potential buyer at a later time.

In addition to providing an explanation for the empirical findings mentioned above, our theoretical analysis generates the following testable predictions. First, holding everything else constant, the probability of success of a negotiation should increase with the level of the offers and time on the market, and decrease with the number of previous unsuccessful negotiations. Second, the sale price should decrease with time on the market, and increase with with the number of negotiations. *Ceteris paribus*, our bargaining model implies that, within each negotiation, the higher an offer the more likely it is that the seller will accept it. As time goes by, our assumption that some sellers face a time constraint implies that the probability a seller will accept any given offer is increasing and hence the sale price is decreasing. Finally, consider two sellers who list identical properties in the same market at the same time. Given the same time on the market,

[37]See, e.g., the survey by Kennan and Wilson (1993) and the references therein.

[38]The strategies described here correspond to the unique perfect Bayesian equilibrium of a finite-horizon sequential bargaining game with one-sided incomplete information where the uninformed player makes all the offers (e.g., Sobel and Takahashi 1983). This equilibrium would also exist in an environment with two-sided incomplete information, where other equilibria would also arise (e.g., Cho 1990 and Cramton 1992).

our framework implies that the seller who previously experienced the most unsuccessful negotiations is more likely to have a higher valuation of her property than the other seller. Hence, her current negotiation is more likely to be unsuccessful. However, if it is successful, the sale price is more likely to be higher. Note that alternative theories that abstract from matching and bargaining would likely be silent with respect to these implications of our framework. Moreover, complete information bargaining models would predict no relation between the number of matches and either the probability of success of a negotiation or the sale price.

Table 20: Probability of success of a negotiation

Variable	Estimate	Standard Error
FLAT	0.060	0.288
TERR	0.248	0.184
DET	−0.193	0.202
TOTA$\times 10^{-2}$	−0.448	0.584
NBATH	−0.146	0.115
GARAGE	−0.298*	0.147
APPL	0.041	0.047
B2	−0.348	0.238
B3	−0.371	0.287
B4	−0.209	0.443
AGENCY1	−1.178*	0.405
AGENCY2	−1.441*	0.436
AGENCY3	−1.524*	0.392
MONTH$\times 10^{-1}$	-0.116	0.149
MONTHGL$\times 10^{-1}$	0.180	0.171
WTMATCH$\times 10^{-1}$	0.267*	0.073
MAXOELP	0.115*	0.017
NPMATCH	−0.454*	0.077
INTERCEPT	−8.348*	1.736

To test the first set of implications of our analysis we define the variable SUCCESS as a binary variable that equals one if bargaining within a match leads to a sale agreement and zero if it terminates with a separation. The results of a logit estimation where SUCCESS is the dependent variable and the set of independent variables includes property characteristics, agency dummies, MONTH, MONTHGL, the number of weeks between initial listing and the occurrence of the match, the maximum offer in the match as a percentage of the effective listing price at the time of the match (MAXOELP), and the

number of previous unsuccessful matches (NPMATCH), are reported in Table 20.[39] The results are consistent with the predictions of our theoretical framework.

To test the second set of implications of our analysis we regress the sale price (SALEP) on the property characteristics, agency dummies, MONTH, MONTHGL, the initial listing price, the number of weeks from initial listing to sale agreement, and the number of matches since initial listing (NMATCH). The results are contained in Table 21. Again, the results match the predictions of our theoretical framework. *Ceteris paribus*, the longer the time on the market, the lower the sale price. This is a well known empirical finding which is also consistent with other existing theories of housing transactions (e.g., Miller 1978, and Yavaş and Yang 1995). The finding that the sale price increases with the number of matches, however, is new and points to the role of incomplete information in the transaction process.

Table 21: Sale price

Variable	Estimate	Standard Error
FLAT	-869	563
TERR	-1190	336
DET	626	453
TOTA	9	11
NBATH	-395	264
GARAGE	101	306
APPL	194	103
B2	828	479
B3	1092	561
B4	530	859
AGENCY1	991	739
AGENCY2	548	885
AGENCY3	1833*	776
MONTH	18	23
MONTHGL	69*	31
ILISTP	0.942*	0.007
NMATCH	430*	153
WTSALE	−72*	13
INTERCEPT	−1086	872
R^2	.99	

Overall, these results highlight the importance of accounting for incomplete information in the strategic interactions between buyers and sellers in order to explain the

[39] We report robust standard errors which account for the fact that observations are independent across properties but not across negotiations within the same transaction history.

sequence of events that lead to housing transactions. Furthermore, we find that these events are significant determinants of the sale price.

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