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An Empirical Model of the Market for Resale Homes

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A model of the search process for a house is formulated, where both buyers and sellers are permitted adaptively to alter reservation prices. Houses on the market in a given period are sold or withdrawn or search for a buyer is continued. The empirical predictions are examined for single-family residential homes.

1. INTRODUCTION

It has been stressed, notably by Rothschild [10] and Kohn and Shawell [5] that a search process explicitly embeds information obtained over the duration in the marketplace. In particular, reservation prices are altered in the light of observed offers. This adaptive response has empirical and econometric implications.

The interest in this paper focuses on the housing market, where list prices at the time of market entry are readily available. Buyers search for sellers, and sellers search for buyers. While some of the theoretical implications of search in these markets have been explored, notably by Ioannides [3], and Sweeney [11], the empirical aspects of the problem have not been extensively considered. We develop a model with testable implications which explains search behavior as an adaptive process. This permits many theoretical questions surrounding transactions on housing to be brought to a direct test. The distribution of reservation prices by sellers interacts with the distribution of price offers. On the basis of this interaction, houses on the market in a given period are sold or withdrawn or search for a buyer is continued. In the next period information from the previous period is incorporated in a reestimation.

The conclusions are not confined either to housing markets in particular or to durable markets in general. The ability to estimate models for search of different duration can be used to explain "hard-core" idleness and the level of search activity for a resource. The implications of the adaptive model are confronted with data for suburban residential housing transactions to illustrate its applicability.

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2. HOUSE SALE TRANSACTIONS

Buyers have a distribution of price offers for houses and sellers a distribution of reservation prices. Individual buyers and sellers vary in their degree of information. The terms "buyers" and "sellers" are used generically to represent searchers on both sides of the market. Freedom not to transact is permitted for all participants.

Price distributions arise for several reasons. Some potential buyers of resale homes are better able to evaluate characteristics such as the condition of a furnace, plumbing, or wiring than others. Since the ability is not necessarily observable, consequent price differences cannot easily be associated with an explanatory variable. Apart from information differences, agents can be unaware of the actions of others. Offers for purchase of a house are not made on a securities exchange floor, and hence there is a dispersion of offers. Similarly, sellers of a given house generally have incomplete information on listing and acceptance prices associated with other houses on the market. Even if reported prices are known, sellers have imperfect knowledge of the parameters of the hedonic function required for adjustment of observable quality differences, and are unable to control for unobservable quality differences.

Price dispersions also arise from bargaining strategies. Preferences on duration desired in the market determine reservation prices. Sellers wishing a swift transaction set a relatively low acceptance price. Sellers willing to hold out maintain firm list prices and search longer for buyers. These arguments obtain even if goods are of uniform quality.

The first stage in the construction of this adaptive model of the housing market is the derivation of the list and offer price distributions. A prospective seller lists his house on the market at the beginning of the search period according to the relation

$$P_{\mathrm{L}}^{0} = \tilde{\phi}^{0}(X_{\mathrm{L}}^{0})e^{\epsilon_{\mathrm{L}}^{0}}, \tag{1}$$

where $X_{\mathrm{L}}^{0} = (X_{1,L}^{0}, \ldots, X_{K,L}^{0})$ is a set of K characteristics determining P_{L}^{0} and $\epsilon_{\mathrm{L}}^{0}$ is a random disturbance. The list price is based on access to information on general market conditions, but prior to the receipt of any bids. Because of house characteristics and seller search strategies, there is a distribution of list prices over the market.

Prospective buyers have an offer function for the houses on the market, determined by house and household characteristics. The offer function is

$$P_{\mathrm{S}}^{0} = \tilde{\theta}^{0}(X_{\mathrm{S}}^{0})e^{\epsilon_{\mathrm{S}}^{0}}, \tag{2}$$

where $X_{\mathrm{S}}^{0} = (X_{1,\mathrm{S}}^{0}, \ldots, X_{M,\mathrm{S}}^{0})$ is the set of M characteristics. The interaction between the list and offer distributions drives the market for resale homes.

While the list prices for houses on the resale market are observable, reservation prices are not. The reservation price is the minimal offer at which a sale takes place. Reservation prices can be expressed as

$$P_R^0 = \lambda^0 P_L^0, \tag{3}$$

where λ^0 is the reservation–list ratio, assumed constant over the market. Sellers will not list at this reservation price, since such a policy immediately eliminates larger offers, and this implies $\lambda^0 < 1$.

Suppose a seller receives an acceptable offer on his house. The conditional joint probability distribution of disturbances in (1)–(2) is

$$f^0\left(\epsilon_L^0, \epsilon_S^0 | \lambda^0 P_L^0 \le P_S^0\right) = \frac{g^0\left(\epsilon_L^0, \epsilon_S^0\right)}{\Pr\left(\lambda^0 P_L^0 \le P_S^0\right)}, \tag{4}$$

where $f^0(\cdot)$ is the conditional distribution, $g^0(\cdot)$ the unconditional distribution, and $\Pr(\lambda^0 P_L^0 \le P_S)$ the probability that a seller will accept an offer. It is noted that the complete distribution $g^0(\cdot)$ is not observable because no data on offers are available for those houses where offers are refused.

Suppose there are N houses on the market for the first time in the first period superscripted by zero. Assume that T^0 are sold in the first period. Then the likelihood function or probability of observing the data of the market is

$$L^0 = \prod_{j=1}^{T} f^0(P_L^0, P_S^0 | \lambda^0 P_L^0 < P_S) \Pr(\lambda^0 P_L^0 \le P_S) \prod_{\substack{0 \\ j=T^0+1}}^{N} \Pr(\lambda^0 P_L^0 > P_S^0) \tag{5}$$

as functions of the parameters underlying $\tilde{\phi}^0(\cdot)$, $\tilde{\theta}^0(\cdot)$, and λ^0, the adjustment parameter. In the group of householders $(N - T^0)$ who reject all offers received, there are two subgroups. One set of sellers, the "discouraged" group by analogy with labor market theory, discontinues listing and withdraws. The second group continues in the market.

Our first task is to derive the probability that an offer will be rejected, as a seller seeks to continue searching in the market. Substituting (3) in (1) and taking logarithms

$$\ln P_R^0 - \ln \lambda^0 = \phi^0(X_L^0) + \epsilon_L^0 \tag{6}$$

and in (2),

$$\ln P_S^0 = \theta^0(X_S^0) + \epsilon_S^0, \tag{7}$$

where $\theta^0 \equiv \ln \tilde{\theta}^0$ and $\phi^0 \equiv \ln \tilde{\phi}^0$. An owner accepts an offer if $P_S^0 \geq \lambda^0 P_L^0$, implying that

$$\theta^0(X_S^0) - \phi^0(X_L^0) \geq \epsilon_L^0 - \epsilon_S^0 \tag{8}$$

is the acceptance condition. Suppose that ϵ_L^0 and ϵ_S^0 are distributed multivariate normal with

$$E(v^0) = 0 \qquad \text{and} \qquad V(v^0) = \Sigma^0 \otimes I_{T^0}, \tag{9}$$

where $v^0 = (\epsilon_S^0 \epsilon_L^0)$, I_{T^0} is an identity matrix of rank T_0, and

$$\Sigma^0 = \begin{bmatrix} \delta_{LL}^0 & \delta_{SL}^0 \\ \delta_{SL}^0 & \delta_{SS}^0 \end{bmatrix} \tag{10}$$

is a matrix of covariances associated with each house. The probability that a transaction will occur is

$$\Pr\left[(\delta^0)^{-1/2}(\theta^0(X_S^0) - \phi^0(X_L^0)) \geq (\delta^0)^{-1/2}(\epsilon_L^0 - \epsilon_S^0)\right], \tag{11}$$

where $\delta^0 = \delta_{LL}^0 + \delta_{SS}^0 - 2\delta_{SL}^0$. However, the right side of this inequality is a standard normal variate so

$$\Pr\text{ (a transaction will occur in the first period)}$$
$$= (2\Pi)^{-1/2} \int_{-\infty}^{(\delta^0)^{-1/2}\{\theta^0(X_S^0) - \phi^0(X_L^0)\}} \exp\left(\frac{-1}{2} Z^2\right) dZ, \tag{12}$$

where $Z = (\delta^0)^{-1/2}$ $(\epsilon_L^0 - \epsilon_S^0)$. Here Z is distributed $N(0, 1)$. Hence by maximizing the likelihood function, parameter estimates can be used to measure the proportion not transacted. A maximum likelihood estimate of λ^0 can be performed by a grid search in (5).

Assume that of the $(N - T^0)$ durables not transacted, C^0 remain unsold and continue in the market. These houses trade in an environment where information from the first-period parameters in $\theta^0(X_S^0)$ and $\phi^0(X_S^0)$ and λ^0 is completely available. The likelihood function can consequently be expressed as

$$L^1 = \prod_{j=1}^{T^1} f^1(P_L^1, P_S^1 | \lambda^1 P_L^1 \leq P_S^1, \theta^0(X_S^0), \phi^0(X_S^0), \lambda^0)$$
$$\times \Pr(\lambda^1 P_L^1 \leq P_S^1 | \theta^0(X_S^0), \phi^0(X_S^0), \lambda^0) \prod_{j=T^1+1}^{C^0} \Pr(\lambda^1 P_L^1 > P_S^1) \tag{13}$$

for these homes. The process can be generalized to an arbitrary number of periods but for convenience only two will be considered. The likelihood function incorporates information from the previous market period. Sellers of houses are updating information in reconstructing their offer distributions.

3. ACCEPTANCE AND WITHDRAWAL FROM THE MARKET

The model can be used to predict the sales rate of houses. In a two-period case, from (12)

$$\begin{aligned} 1 - \Pr &(\text{a transaction occurs in period } 0) \\ &= \Pr(\text{dropping out in } 0) \\ &\quad + \Pr(\text{continuing to list in period } 1), \end{aligned} \tag{14}$$

where the left side of the equation is known from the ML estimation. The dropouts are those who have attempted to sell their houses by listing, but have been unsuccessful and have withdrawn. The second term is the holdover of houses remaining on the market. The two components cannot be separated solely by (14) since there are two unknowns and one equation. However, a similar equation holds for those looking in the next period where

$$\begin{aligned} 1 - \Pr &(\text{a transaction occurs in period } 1 \mid \text{continuation from } 0) \\ &= \Pr(\text{no transaction at end of period } 1) \end{aligned} \tag{15}$$

in the two-period model. The right side of this equation expresses the fact of a limited upper bound on duration. For the housing market, this is an exact description from regulations on formal listing with a real estate agent or multiple listing service. A contractual requirement stipulates removal at a specific time.

From (14) and (15) there are three right-side unknowns and two equations. The model is closed by

$$\begin{aligned} 1 - \Pr &(\text{a transaction occurs in period } 0 \text{ or period } 1) \\ &= \Pr(\text{dropping out in period } 0) \\ &\quad + \Pr(\text{no transaction at end of period } 1), \end{aligned} \tag{16}$$

where the left side of the model is derived by estimation over the entire market duration. The solution of (14)–(16) in terms of the market ML estimates and the notation of the estimable model houses unsold in any period are given by

$$\Pr\text{ (no transaction at end of period 1)}$$
$$= (2\Pi)^{-1/2} \int_{(\delta^1)^{-1/2}(\theta^1(X_S^1) - \phi^1(X_L^1))}^{\infty} \exp\left(-\frac{1}{2}Z^2\right) dZ \qquad (17)$$

and the measure of withdrawals from house listing is

$$\Pr\text{ (dropping out in period 1)}$$
$$= (2\Pi)^{-1/2} \int_{(\delta^2)^{-1/2}(\theta^2(X_S^2) - \phi^2(X_L^2))}^{\infty} \exp\left(-\frac{1}{2}Z^2\right) dZ$$
$$- \int_{(\delta^1)^{-1/2}(\theta^1(X_S^1) - \phi^1(X_L^1))}^{\infty} \exp\left(-\frac{1}{2}Z^2\right) dZ, \qquad (18)$$

where the superscript 2 refers to the combined first and second periods. The total stoppage or discontinuance over the entire market duration is the sum of (17) and (18). Finally, the probability of continuing in the market after period 0 is

$$\Pr\text{ (continuing to list)} = (2\Pi)^{-1/2} \int_{(\delta^0)^{-1/2}(\theta^0(X_S^0) - \phi^0(X_L^0))}^{\infty} \exp\left(-\frac{1}{2}Z^2\right) dZ$$
$$+ \int_{(\delta^1)^{-1/2}(\theta^1(X_S^1) - \phi^1(X_L^1))}^{\infty} \exp\left(-\frac{1}{2}Z^2\right) dZ$$
$$- \int_{(\delta^2)^{-1/2}(\theta^2(X_S^2) - \phi^2(X_L^2))}^{\infty} \exp\left(-\frac{1}{2}Z^2\right) dZ, \qquad (19)$$

which requires ML estimation of the short-term, long-term, and joint long–short search models. The lower bounds of the integrals contain parameters of the estimation and the physical characteristics of the durable. The latter, expressed in X_S and X_L, will generally be constant over the duration, but the three sets of parameters will differ, modified by adaptive experience.

4. DATA

The sample constitutes transactions in the resale market for single-family dwellings in a suburb of London, Ontario, over the period 1967–1975. The structural characteristics of the house may differ, and additions can be effected over the life history by various owners. Examples are the addition of a bedroom, bathroom, recreation room, or swimming pool. Detailed characteristics of this nature are available, since our source is the listing information as required by the city Multiple Listing Service (MLS). The sample contains information on 476 transactions on houses within this development over the period, which represents 40% of all sales in the given development.[2]

Duration data are available from date of listing to date of deaccession, whether through sale or withdrawl. Moreover, houses which were listed more than once during the period are also recorded. Second, data on listing prices are available at both date of listing and date of deaccession. From these series inferential procedures are used to estimate the reservation price.

Some further remarks are necessary on the appropriate specification of reservation price, a required datum for estimation of the model. There are three issues of measurement involved in sample selection. First, the reservation price represents the after-tax evaluation of a resource to a supplier. The closing or acceptance price can be measured before tax. This will lead to an inconsistent measurement of reservation prices and price offers as evaluated by the seller. Adjustment on the supply side of accepted prices to an after-tax basis is required; otherwise results will be biased in favor of acceptance of offers.[3]

This problem does not arise in the resale housing market in Canada, since sales of single-family residential dwellings are exempt from federal capital gains tax and provincial sales, land transfer, and land speculation taxes. The only exception is transactions in which purchasers are nonresidents of Canada, but such transactions affect largely resort and recreational property or houses close to the border with the United States. Although residence and identity of owners cannot be determined, it is assumed that the above issues are negligible in our data and that reservation and accepted prices are measured on the same base.

Second, reservation prices can be biased upward by including a return in a specific activity which cannot be recouped elsewhere. Holt [2] cites an example in the labor market, where respondents to reservation wage questions will cite wages at the last job held, which can include returns to nontransferable specific skills.

[2]At the same time, MLS transactions do not exhaust the set of house sales in the resale market. Houses can be sold privately without the aid of a realtor, or on exclusive list by a single realtor. In either case no listing would occur with MLS. To determine whether the MLS sample was representative of all transactions, a comparison was made with the *TEELA Monthly Sales Digest*, a publication listing closing (selling) prices and other information on all Canadian house sales. The proportion of total sales was estimated at 45% listed in MLS, and the distribution of data was consistent between the two.

[3]This problem is particularly acute in the labor market, where reservation wages can be quoted net of tax and wage rates gross of tax. For a resolution of some of these issues see Rosen [9].

5. EMPIRICAL RESULTS

5.1. Specification and Estimation

The specification of the model for empirical purposes requires a form for ϕ and θ. The form used is linear in the characteristics measured. This yields for (6) and (7)

$$\ln P_{\mathrm{R}}^{0} - \ln \lambda^{0} = \sum_{i=1}^{k} \beta_{i,\mathrm{L}}^{0} X_{i,\mathrm{L}}^{0} + \epsilon_{\mathrm{L}}^{0} \tag{20}$$

and

$$\ln P_{S}^{0} = \sum_{i=1}^{m} \alpha_{i,\mathrm{S}}^{0} X_{i,\mathrm{S}}^{0} + \epsilon_{\mathrm{S}}^{0}, \tag{21}$$

where the first component of X_{L} and X_{S} is unity, while $\alpha_{i,\mathrm{S}}^{0}$ and $\beta_{i,\mathrm{L}}^{0}$ are parameters to be estimated.

The characteristics determining house sales and list prices and their coefficients are permitted to vary across equations. This variation accounts for part of any difference between expected sales and list prices. Differences will remain even if characteristics and coefficients are constant, since list prices are above sale prices. So $\ln P_{\mathrm{R}}^{0} - \ln \lambda^{0} = \ln P_{\mathrm{S}}^{0}$ on such a house, or the adjustment coefficient is the difference between expected selling and reservation prices. In such a case $\ln \lambda^{0}$ can be identified by imposing the restriction $\alpha_{1,\mathrm{S}}^{0} = \beta_{1,\mathrm{L}}^{0}$ on the equations. Given constant characteristics and coefficients, there is no inherent reason for list and sales prices to differ, other than because of the initial listing premium. This is not the only possible identifying restriction. If λ^{0} depends on characteristics, a more complex form depending on the other parameters is necessary.

The variables used as exogenous in explaining the two equations for reservation and selling prices are indicated in Table 1. Included in each equation is a brokerage variable. Firm variables have been used in a model of house determination developed by Edelstein [1]. As in his model, it is hypothesized that large firms, because of market power and economies of scale, are able to extract higher prices from sellers than smaller firms. To account for this possibility, a firm size variable for the company representing the seller is included in the reservation price equation but not the selling price equation. A variable for firm size of the company representing the buyer is included in the selling price but not the reservation price equation.

The form (20)–(21) constitutes the model for the first period in the market, considered to be 0–4 weeks of listing. A second period of listing is

TABLE 1
Variable Listing, Reservation Price, and Acceptance Price Equations[a]

Variable	Associated parameters	
Included in X_S and X_L		
Number of bedrooms (BEDS)	$\alpha_{1,S}$	$\beta_{1,L}$
Number of bathrooms (BATH)	$\alpha_{2,S}$	$\beta_{2,L}$
Number of other rooms (NORMS)	$\alpha_{3,S}$	$\beta_{3,L}$
Age (AGE)	$\alpha_{4,S}$	$\beta_{4,L}$
Included in X_S but not X_L		
Size of selling firm[b] (BUYER)	$\alpha_{5,S}$	
Included in X_L but not X_S		
Size of listing firm[b] (LISTER)		$\beta_{5,L}$
Owner-occupancy status (OWNOCC)		$\beta_{6,L}$

[a]Associated parameters for ML estimation are denoted by Greek symbols, and variable names used are given in parentheses.

[b]This variable was constructed by associating a separate code for all real estate companies listed as members of MLS, some 150 in all. Aggregation was then performed into large companies, or those companies each effecting more than 3% of sale transactions, with a dummy value of unity, and small companies, with a value of zero. A similar procedure is applied to the listing firm. The variable OWNOCC is unity for those families who were owner-occupiers.

viewed as comprising houses on the market for 5–12 weeks.[4] Another period corresponds to 0–12 weeks, and each of these remaining two models has an equation system such as (20)–(21). The sample period is divided into three subperiods for 1967–1969, 1970–1972, and 1973–1975. Each of the three durational models is estimated for the three time periods, making a total of nine.

Maximum likelihood estimation proceeds along the lines discussed. The search adjustment coefficient $\ln \lambda^0$ is estimated by imposing the equation restriction $\beta^0_{1,L} + \ln \lambda^0 = \alpha^0_{1,S}$. From this restriction λ^0 becomes identifiable. The likelihood function is maximized with respect to the parameters $\alpha^0_{i,S}$, $i = 2, \ldots, M$, $\ln \lambda^0$, and $\beta^0_{i,L}$, $i = 1, \ldots, K$, using an iterative version of the seemingly unrelated regression technique. This involves estimating the variance–covariance matrix $\hat{\Sigma}$ at each stage, and transforming the equations by iterating on $\hat{\Sigma}$ until this matrix is arbitrarily close to an identity matrix. This procedure is identical to ML estimation if the

[4]The upper bound on the second listing period is institutionally determined at 12 weeks. Houses to be listed with MLS are stipulated to be available for this maximal period. If unsold at the end of the period, the owner must complete all forms and procedures for relisting. In our sample, few owners were willing to do this, possibly because of the lemon signal of a long duration.

procedure yields convergent results.[5] The algorithm used is the Gauss–Newton method, described in Malinvaud [8].[6]

Estimation of the model of duration 0–4 weeks corresponds to period 0 of (20)–(21). The model for 5–12 weeks of search is initialized with the first model estimates, yielding

$$\ln P_{\mathrm{R}}^{1} - \ln \lambda^{1}(\ln \hat{\lambda}^{0}) = \sum_{i=1}^{m} \beta_{i,\mathrm{L}}^{1}(\hat{\beta}_{i,\mathrm{L}}^{0}) X_{i,\mathrm{L}}^{1} + \epsilon_{\mathrm{L}}^{1} \tag{22}$$

and

$$\ln P_{\mathrm{S}}^{1} = \sum_{i=1}^{m} \alpha_{i,\mathrm{S}}^{1}(\hat{\alpha}_{i,\mathrm{S}}^{0}) X_{i,\mathrm{S}}^{1} + \epsilon_{\mathrm{S}}^{1}, \tag{23}$$

where starting values are indicated in parentheses. Finally, the model is estimated for the entire period 0–12 weeks, with no feedback or adaptive response permitted on the parameters.[7] This estimation is carried out for each of the three sample periods.

5.2. Adjustment of Reservation Prices

The complete set of parameter estimates is reported in Table 2. The age coefficient can be interpreted as a rate of depreciation, while the remaining house-specific coefficients represent the rate of return on a room. The adjustment test can be applied by qualitative examination of $\ln \lambda$. Since ML estimates are invariant, the premium of list prices on average can be estimated by exponentiating the $\ln \lambda$ estimates and subtracting unity. These are reported in Table 3. In 1967–1969, a house on the market for 0–4 weeks at time of sale was listed at 3.64% more than the selling price. Whether λ declines over the duration listed depends on the relative elasticity of list and selling prices with respect to duration. In 1967–1969 and 1973–1975 the list-selling differential increases with duration, while it decreases in 1970–1972. We conclude that no evidence exists for monotone increases of λ with duration.

[5] See Kmenta and Gilbert [4].

[6] See Malinvaud [8, p. 343].

[7] Estimation of a system involving data for 0–4, 5–12, and 0–12 weeks simultaneously would not correspond to a meaningful economic model, since the sequential nature of decisions would be destroyed. Our hypotheses are of the monotonicity form, and direct comparison will at least not lead to a rejection of the null hypothesis. For a discussion of these issues, see Lau [7].

TABLE 2
Maximum Likelihood Estimates[a]

Variable	1967–1969			1970–1972			1973–1975		
	0–4[b]	5–12	0–12	0–4	5–12	0–12	0–4	5–12	0–12
Specific to house									
AGE, $\hat{\alpha}_{1,S} = \hat{\beta}_{1,L}$	−0.0095	−0.0063	−0.0083	−0.0029	−0.0230	−0.0116	0.0041	0.0002	0.0014
	(0.0052)	(0.0029)	(0.0042)	(0.0045)	(0.0089)	(0.0042)	(0.0062)	(0.0011)	(0.0051)
NORMS, $\hat{\alpha}_{2,S} = \hat{\beta}_{2,L}$	0.0465	0.0789	0.0516	0.0974	0.1447	0.1019	0.0702	0.0872	0.0759
	(0.0178)	(0.0418)	(0.0155)	(0.0168)	(0.0362)	(0.0165)	(0.0305)	(0.0325)	(0.0260)
BRMS, $\hat{\alpha}_{3,S} = \hat{\beta}_{3,L}$	0.1180	0.1549	0.1320	0.1565	0.1427	0.1467	0.1705	0.2082	0.1612
	(0.0481)	(0.0612)	(0.0372)	(0.0364)	(0.0385)	(0.0352)	(0.0645)	(0.0625)	(0.0568)
BATH, $\hat{\alpha}_{4,S} = \hat{\beta}_{4,L}$	0.0445	0.0709	0.0486	0.0970	0.1465	0.1222	0.0695	0.0852	0.0761
	(0.0178)	(0.0319)	(0.0145)	(0.0169)	(0.0222)	(0.0155)	(0.0074)	(0.0222)	(0.0260)
Specific to seller									
LISTER, $\hat{\beta}_{5,L}$	−0.0119	−0.0210	−0.0155	−0.0255	−0.0357	−0.0305	−0.0203	−0.0285	−0.0246
	(0.0065)	(0.0062)	(0.0063)	(0.0063)	(0.0106)	(0.0112)	(0.0105)	(0.0145)	(0.0125)
OWNOCC, $\hat{\beta}_{6,L}$	−0.0761	−0.0239	−0.0230	−0.0232	−0.0443	−0.0313	−0.0268	−0.0355	0.0307
	(0.0082)	(0.0080)	(0.0075)	(0.0063)	(0.0162)	(0.0121)	(0.0174)	(0.0172)	(0.0173)
Specific to buyer									
BUYER, $\hat{\alpha}_{5,S}$	0.0144	0.0362	0.0262	0.0066	0.0222	0.0131	0.0181	0.0205	0.0193
	(0.0072)	(0.0135)	(0.0066)	(0.0022)	(0.0135)	(0.0028)	(0.0056)	(0.0057)	(0.0056)
Adjustment parameter									
$\ln \hat{\lambda}$	0.0358	0.0473	0.0455	0.0654	0.0397	0.0606	0.0428	0.0519	0.0442
	(0.0081)	(0.0156)	(0.0076)	(0.0341)	(0.0156)	(0.0220)	(0.0074)	(0.0200)	(0.0075)
Intercept	9.5759	9.2010	9.4684	9.3062	9.2748	9.1878	9.8233	8.1722	9.7705
	(0.2240)	(0.3601)	(0.1785)	(0.1758)	(0.3839)	(0.1707)	(0.2833)	(0.8545)	(0.2690)

[a] Asymptotic standard errors in parenthesis.
[b] Period of time a house had been on the market at time of sale (in weeks).

TABLE 3

Adjustment, Listing over Selling Prices (%)

Duration (weeks)	1967–1969	1970–1972	1973–1975
0– 4	3.64	6.76	4.37
5–12	4.84	4.05	5.33
0–12	4.66	6.25	4.52

5.3. *Withdrawal from Listing*

We are now in a position to compute some of the values of Section 4. Given equal evaluation, the sole cause of price differentials lies in the variables specific to each equation. By the iterative procedure in the ML estimation (10) reduces to an identity matrix for Σ^i, $i = 0, 1, 2$.

To evaluate (12), the probability that a transaction will occur in the first period, note that

$$\hat{\delta}^0 = \hat{\delta}^0_{iL} + \hat{\delta}^0_{SS} - 2\hat{\delta}^0_{SL} = \mathrm{tr}\hat{\Sigma}^0, \tag{24}$$

which is 2. Moreover $\theta^0(X^0_S) - \phi^0(X^0_L)$, given equal evaluation, depends only on household characteristics as represented by items 2 to 4 in Table 3. Consider an owner-occupied house listed with a large company, so LISTER = OWNOCC = 1. Assume that the house is sold to a buyer represented by a large company, so BUYER = 1. Then the upper integral limit in (12), using the notation of Table 1, is

$$(\mathrm{tr}\ \hat{\Sigma}^0)^{-1/2}\left[\hat{\alpha}^0_{5,\,S} - \hat{\beta}^0_{5,\,L} - \hat{\beta}^0_{6,\,L}\right], \tag{25}$$

which by the principle of invariance is a ML estimate conditional on the selection of the given characteristics. As noted earlier, the model can be closed by estimation of (18)–(20). The lower limit of integration in (18) is

$$(\mathrm{tr}\ \hat{\Sigma}^1)^{-1/2}\left[\hat{\alpha}^1_{5,\,S} - \hat{\beta}^1_{5,\,L} - \hat{\beta}^1_{6,\,L}\right], \tag{26}$$

which assists in the determination that there is no transaction at the end of period 1. Similar arguments obtain for (18) and (19). The results are reported in Table 4.

The numbers exhibit stability across years, with the probability that a given house will sell within a month of listing being 0.5148. Moreover, few houses are withdrawn from the market through discouragement, less than $\frac{1}{2}$%, and a large proportion of the houses are listed but never sold. The

TABLE 4
Withdrawal from Housing Listing

Event	1967–1969	1970–1972	1973–1975
1. Transaction (sale) occurring in-period 1	0.5148	0.5156	0.5184
2. Withdrawal at end of period 0 and listing continued in period 1	0.4852	0.4844	0.4816
3. No transaction at end of period 1	0.4779	0.4699	0.4761
4. Withdrawal at end of period 0	0.0039	0.0092	0.0030
5. Listing continued in period 1	0.4813	0.4752	0.4786

Note. All results are derived for a house with a seller who was an owner–occupant and was represented by a large real estate firm. The prospective buyer was also represented by a large firm.

sample data show similar trends. Of the 476 houses in the sample, only 3 were withdrawn before 4 weeks, and over half sold in the first month. In fact, 152, or almost one-third, were sold within 1 week of duration.

6. CONCLUDING REMARKS

We have proposed a model which computes, on the basis of observable house and household characteristics, whether a given house will sell. The model examines the behavior of list prices, and finds them relatively "firm" for houses over the given period. A more comprehensive analysis can be undertaken. Specifically, repeat surveys of households during a listing period will provide information of a more direct and detailed nature of the willingness to accept an offer.

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