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Evidence of Information Asymmetries in the Market for Residential Condominiums

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Abstract Previous research (Rutherford et al. 2005; Levitt and Syverson 2005) identify and quantify agency problems in the brokerage of single-family houses. Real estate agents are found to receive a premium when selling their own houses in comparison to similar client-owned houses. Given the homogeneity of the condominium market in comparison to the single-family house market, we use a large sample of condominium transactions to examine if agency problems exist in the condominium market. Controlling for sample selection and endogeneity bias of the data, we find evidence for a similar price premium for agent-owned condominiums. In contrast to the results for single-family houses in the same geographic market, we find that agent-owned condominiums must stay on the market longer to receive a higher price.

Keywords Real estate agents · Condominium market · Single-family house market

Real estate markets are characterized by imperfect information. Buyers and sellers do not know each other's location or reservation prices. Furthermore, since real estate is a heterogeneous good and households have idiosyncratic tastes, the final transaction price will depend on the characteristics of the buyer and seller at the negotiation table as well as the market conditions.

These uncertainties, coupled with the fact that most people get involved in a real estate transaction on a very infrequent basis, create a market for intermediaries, namely real estate agents, who specialize in facilitating real estate transactions. Real

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estate agents offer professional service to their clients by helping with setting the listing price, marketing the property, offering expert opinion on market conditions, and assisting in the negotiation process.

As part of their fiduciary duties, real estate agents are expected to act in the best interest of their clients and treat their clients' properties the same way they would treat their own properties. However, it is widely argued that the interests of the agent and the seller will diverge under the standard commission structure in the industry. The reason is that the standard commission structure creates positive externalities by giving the agent only a small fraction, typically 5–6%,[1] of any increase in the price, while the seller retaining the remaining 94–95%. Thus, the seller and the agent will have diverging interests because the seller' goal of maximizing price while minimizing marketing time is not entirely compatible with the agent's goal of maximizing net commission revenue while minimizing marketing time (see Anglin and Arnott 1991; Geltner et al. 1991; and Miceli 1991). In particular, the agent may be motivated towards underpricing the client's property for a faster sale. Theoretical models by Williams (1998) and Fisher and Yavas (2006), however, note that competition among agents may completely eliminate the agency problems created by percentage commission structure.

The agency problem under the percentage commission structure has been recently tested by Rutherford et al. (2005) and Levitt and Syverson (2005). Both of these studies contain large data sets of single-family home transactions where a portion of the homes sold were homes that were owned by agents. Thus, these two studies were able to directly test whether agents treated their clients' properties the same way they treated their own properties. Both studies find evidence of agency problems; houses owned by agents sell at a premium.[2] Agents were willing to wait longer to obtain a higher price for their own properties, or they were able to convince their clients to accept a suboptimal price in order to facilitate a faster sale to secure their commission.

Being that Rutherford et al. (2005) and Levitt and Syverson (2005) demonstrated the existence of agency problems in the single-family housing market, it stands to reason that other property markets may exhibit the same phenomenon. In this study, we look at the condominium market. The condominium market has a unique trait in comparison to the single-family home market in that condominiums tend to be more homogeneous than houses. Since agency problems emerge from uncertainty and superior information enjoyed by agents, and since more homogenous assets would involve less uncertainty and reduced superiority of agent's information set, one would expect the agency problem to be smaller in the condominium market than the single-family housing market.

Our results indicate agent-owner selling price premiums of 3.0–7.0% for condominiums. This is comparable to those observed for single-family houses, which range from 4.5 to 7.0% in Rutherford et al. (2005). However, the agents are

[1] In fact, after sharing the commission with his firm and the agent that brings in the buyer, the listing agent receives only about one-fourth of the commission revenue.

[2] The price premium ranges from 3.7 to 4.8% in Levitt and Syverson (2005) and from 4.5 to 7.0% in Rutherford et al. (2005). While agent-owned properties in Levitt and Syverson (2005) stay on the market about 10% (9 days) longer, the difference in Rutherford et al. (2005) is insignificant.

able to obtain a higher price for their condominiums by having to wait 3% longer to sell. This is in contrast to the single-family housing market where they are able to obtain a price premium without having to wait longer to sell (Rutherford et al. 2005). Therefore, agents enjoy a smaller benefit for their informational advantage in the condominium market than they do in the single-family housing market.

The relationship between heterogeneity of the properties and the agency problem has also been addressed by Levitt and Syverson (2005). They construct a Herfindahl index of how heterogeneous the housing stock is on a particular city block.[3] They find that the price gap between agent-owned and non-agent-owned houses is 4.3% on blocks where the houses are most different. This is higher than the price gap in the moderate-heterogeneity blocks (3.9%) and the low-heterogeneity blocks (2.3%). They also report that agents on the more heterogeneous blocks keep their houses on the market for a longer period than non-agents, but this difference disappears for blocks with the most similar houses. The current study differs from Levitt and Syverson (2005) in that our entire data set of more than 20,000 observations involves assets that are more homogenous than single-family houses. Therefore, combined with Rutherford et al. (2005), the current study compares agency problems in two distinct markets in terms of heterogeneity, and avoids the need to estimate the degree of heterogeneity in different blocks of a given market.

In the next section of the paper we extend the theoretical model of Rutherford et al. (2005) to study the impact of heterogeneity on the pricing policy of the agent for his own units versus his clients' units. Our model suggests that the price premium will depend on the search technology and how heterogeneity of the asset affects the probability of matching buyers and sellers. "Data" describes the data, "Materials and Methods" discusses the methodology, "Results" presents the results, and "Conclusions"concludes.

The Model

We simplify and extend the theoretical model of Rutherford et al. (2005) to investigate how the degree of asset heterogeneity in a market impacts the price premium for agent-owned properties. As in Rutherford et al. (2005), we assume risk-neutral listing agents who choose both an effort level and a listing price. For simplicity, the seller of the property is assumed to adopt the listing price suggested by his listing agent. The bargaining game is also simplified so that the seller's listing price is a take-it-or-leave-it offer to the buyer (see Rutherford et al. 2005, for the motivation of these assumptions).

A transaction is consummated if the asking price is below the buyer's reservation price. Reservation prices of buyers are distributed uniformly over the interval $[\underline{P}, \overline{P}]$. Let k represent the percentage of the price that the listing agent receives as commission from the seller upon the sale of the property. The listing agent shares this commission with the selling agent by paying the selling agent k_s, $k_s<k$,

[3] They classify houses into 21 different styles, such as ranch, colonial, contemporary, and American four square. Then, they construct the Herfindahl index by summing the squared shares of each housing style in the housing stock on the city block of the sold property.

percentage of the price.[4] The listing agent gets to keep the entire commission if he finds the buyer himself. The total commission rate, k, and the selling agent's share, k_s, are assumed to be determined in the market.

When a listing agent lists his own property, he chooses a price, P^O, and a search effort level, L^O, to maximize his expected profits:

$$\Pi^o(P^o, L^o) = \Psi(L^o) \int_{P^o}^{\overline{P}} (P^o - R) \frac{1}{\overline{P} - \underline{P}} \mathrm{d}P + \Phi \int_{P^o}^{\overline{P}} ((1 - k_s)P^o - R) \frac{1}{\overline{P} - \underline{P}} \mathrm{d}P - C(L^o) \tag{1}$$

where $\psi(L^O)$ is the probability that the listing agent will contact the buyer himself, with $\psi' > 0$ and $\psi'' < 0$, R is the listing agent's reservation price, $P^O - R$ is the agent's surplus as the owner from the sale of the property, Φ, with $0 \leq \Phi + \psi(L^O) \leq 1 \forall L^O$, is the probability that one of the other members of the MLS contacts the buyer, $(1 - k_s)P^O - R$ is the listing agent's surplus as the owner when a selling agent finds the buyer, and $C(L^O)$, with $C' > 0$ and $C'' > 0$, is the search cost function of the listing agent. Assuming a large number of MLS members and the competition among them to sell the property, we take the probability of a sale by another MLS member as given.

The solution is given by the first-order conditions

$$\Psi(L^o)\left[\frac{\overline{P} - 2P^o + R}{\overline{P} - \underline{P}}\right] + \Phi\left[\frac{(1 - k_s)\left(\overline{P} - 2P^o\right) + R}{\overline{P} - \underline{P}}\right] = 0 \tag{2}$$

and

$$\Psi'(L^o)\left[\left(\frac{\overline{P} - P^o}{\overline{P} - \underline{P}}\right)(P^o - R)\right] - C'(L^o) = 0. \tag{3}$$

Next, we consider the case where the listing agent is not the owner of the property. The listing agent receives all of the commission if he finds the buyer, and shares the commission with the selling agent if the selling agent contacts the buyer. The listing agent now chooses a search effort level, L^N, and a price for the client's property, P^N, to maximize his expected profits

$$\Pi^N\left(P^N, L^N\right) = \Psi\left(L^N\right) \int_{P^N}^{\overline{P}} kP^N \frac{1}{\overline{P} - \underline{P}} \mathrm{d}P + \Phi \int_{P^N}^{\overline{P}} (k - k_s)P^N \frac{1}{\overline{P} - \underline{P}} \mathrm{d}P$$

$$- C\left(L^N\right) \tag{4}$$

The first-order conditions are given by

$$\left(\Psi\left(L^N\right)k + \Phi(k - k_s)\right)\left[\frac{\overline{P} - 2P^N}{\overline{P} - \underline{P}}\right] = 0 \tag{5}$$

[4] Each agent may also have to share their portion of the commission revenue with their brokerage firm. Such an extension will not affect the qualitative results of the paper.

And

$$\Psi'\left(L^N\right)kP^N\frac{\overline{P}-P^N}{\overline{P}-\underline{P}}-C'\left(L^N\right)=0. \tag{6}$$

It is trivial to replicate the two equilibrium results in Rutherford et al. (2005). One is that the price the agent chooses for his own property will exceed the price that he chooses for his client's property. The other is that the marketing time for a property owned by an agent may be shorter or longer than that of a property not owned by the agent.[5]

There are alternative ways of capturing the difference between the more homogenous condominium market and the more heterogeneous the single-family housing market. One would be to assume a better search technology for the condominium market by increasing the matching probability for any given effort level by the agent. The other is to reduce the uncertainty about buyers' reservation prices. We adopt the second approach here and narrow the support of the uniform distribution of buyer's reservation prices from $\left[\underline{P},\overline{P}\right]$ to $\left[\underline{P}-x,\overline{P}+x\right]$ where x is a constant. A bigger x would represent a market where there is less uncertainty about the final transaction price. Utilizing this simple approach to capture the degree of heterogeneity in the market, we can examine how a change in x impacts the equilibrium price for the agent-owned versus non-agent-owned properties. First, note from Eq. 5 that the price of a non-agent-owned property is independent of the effort level and is given by $P^N=\left(\overline{P}+x\right)/2$ Thus, a unit change in x leads to one-half units of change in the price for the client's property. Applying the same exercise to the pricing of agent-owned properties, and assuming for the moment that the effort level L^O does not change with the price, we can solve Eq. 2 to obtain the price for the agent's property as:

$$P^o=\left[\frac{1}{2(\Psi(L^o)+\Phi(1-k))}\right][\overline{P}(\Psi(L^o)+\Phi(1-k))+R(\Phi-\Psi(L^o)) \\ +x(\Psi(L^o)+\Phi(1-k))] \tag{7}$$

as long as $\frac{\Psi(L^o)+\Phi(1-k)}{\overline{P}-\underline{P}+2x}\neq 0$.

Once again, taking the derivative of P^O with respect to x yields ½. Thus, if a change in the asking price of the agent-owned property has zero or negligible impact on the probability $\Psi(L^O)$, then a mean-preserving spread in the distribution of buyers' reservation prices has the same effect on the price of agent-owned properties as it does on the price of non-agent-owned properties. Therefore, this simple set up predicts that, when the probability of a match by the listing agent is not sensitive to the asking price of the property, the price premium for agent-owned prices is similar

[5] The intuition for the first result is due to the fact that the agent retains a much larger portion of a marginal increase in the selling price if he owns the property than if he does not. The reason for the second result is that, although the agent expends a greater effort to search for a buyer for his own property than for a client's property, this does not necessarily result in a shorter marketing time because the agent sets a higher price for his own property, hence decreasing the probability that a contacted buyer purchases the property.

in the condominium markets to that in the single-family housing markets. As will be seen shortly, this theoretical prediction is in line with our empirical results.

It is clear from Eq. 7 that if a change in the asking price leads to a non-trivial change in the probability $\Psi(L^O)$, then a change in x units will have an impact different than one-half units on the agent-owned properties. However, the impact on the non-agent-owned properties will again be one-half (from Eq. 5). In this case, the price premium for agent-owned properties will change as we move from more heterogeneous houses to more homogeneous condominiums.

Data

The data consist of 21,051 observations of residential condominiums that were for sale between January 1, 1999 and December 31, 2004. The sample was obtained from a large metropolitan Multiple Listing Service (MLS) consisting of several counties in Texas.[6] Of the 21,051 residential condos, 11,551 represent completed transactions with quantifiable selling prices and the remainder were either taken off the market or expired by the end of the study period. Also, of the 11,551 completed transactions, 415 transactions represented listings where the agent was also the owner of the condo. The 498 remaining agent-owned condominiums remained unsold.

The data include physical property characteristics (age, square footage, number of fireplaces, pool), market descriptors (geographic location, calendar information, interest rates) and variables that reflect marketability or possibly investor differences between the properties (vacant, tenant-occupied, builder-owned). Numerical MLS-defined geographic variables are used to control for location differences. The calendar information includes the quarter (Winter, Spring, Summer, and Fall) and year of the listing and either the sale or withdrawal from the market. These variables are intended to capture contemporaneous changes in market conditions.

Other variables include the list price, the selling price, and the days-on-the-market (*DOM*). For properties that are ultimately sold, days-on-the-market (*DOM*) is measured as the number of days from the listing date reported in the MLS to the date a sales contract is executed and the property is removed from the market. The days-on-the market for houses that went off the market without a sale is calculated as the number of days between the listing date and the day the property went off the market.[7] Houses that were both owned and listed by a real estate agent are identified with a binary variable, *Owner Agent Listing*. For this variable, a value of "1" denotes an agent-owned residential condominium. The variables are described in Table 1.

Table 2 shows the descriptive statistics of the data broken out by whether the property was listed by an agent-owner or an agent representing the owner. Slightly

[6] The initial data set had a total of 23,763 observations. Due to missing values for some variables included in the models and extreme values of variables that were considered to be data entry problems, the final data set has 21,051 observations.

[7] The MLS provides no information on whether properties are relisted, thus the calculation of DOM may understate the actual time a house remained on the market. For instance, a property listed with one agent may not sell within the contract time frame. In this case, the seller may relist the property with another agent.

Table 1 Definition of variables used in the time-on-the-market hazard models, the selling price regression models, and the Probit models for condos

Variable	Description
Selling price	selling price of the condo, expressed as log(sp) in the regression models
List price	listed price on the Multiple Listing Service (MLS)
Size	number of square feet divided by 100
Age	year of sale minus year built divided by ten
Owner agent listing	dummy variable indicating a listing by an owner–agent
Pool	dummy variable indicating the presence of a pool
Fireplace	number of fireplaces
Tenant-occupied	dummy variable indicating a rental property occupied by a tenant
Vacant	dummy variable indicating a vacant property
Builder-owned	dummy variable indicating a builder-owned condo
Market competition	number of active agents in a MLS defined area divided by the total number of sides in the same MLS defined area, multiplied by 100
Degree of overpricing (DOP)	residual from a list price equation (actual list price minus predicted list price)
Interest rate change	change in the level of annual percentage mortgage rates calculated as the difference in the weekly interest rate at the time of listing to the weekly interest rate either when the property sold or went off the market
Open house	dummy variable indicating the use of an open house in marketing the property
Tour house	dummy variable indicating the house was included in a tour of homes
Listing agent limited experience	dummy variable indicating the listing agent has less than 3 years of experience
Listing agent experienced	dummy variable indicating the listing agent has 5 or more years of experience
Listing agent broker	dummy variable indicating the listing agent holds a brokers license
Internet	dummy variable indicating the listing was marketed on the internet
Large firm	dummy variable indicating the listing agent is associated with a larger firm (top 20th percentile) based on number of agents working for the same sponsoring broker
Time-on-the-market (DOM)	calculated number of days from list date until date sold, went off the market, or the end of the sample period, expressed as log(time) in the duration model
Sold property	dummy variable indicating the property sold

more than 4% (4.3%) of the full sample consists of agent-owned listings.[8] A comparison of the two sub-samples shows that 17 of the 21 variables displayed are statistically different at either a 1 or 5% level of significance. The comparison of sub-samples shows that agent-owned properties both list and sell at a lower price, are smaller and older, more likely to be occupied by a tenant, more likely to be vacant, and sell more quickly than other listings. Also, the owner-agent is likely to be less experienced, more likely to be a broker and more likely working for a small brokerage firm.

We can compare the statistics to those for single-family homes in the same market by looking at Rutherford et al. (2005). In contrast to owner-agent condominiums, the univariate statistics for agent-owned single-family houses indicate homes list and sell at a higher price, are larger, and sell slightly faster than their non-agent owned peers. Thus, some apparent differences exist between the agent-owned single-family

[8] This compares to 3.2% of the sample of single-family homes being owner-agent listings in Rutherford et al. (2005) study of the same geographic market.

Table 2 Descriptive statistics for the full sample and subsamples of residential condos for owner agent listings and non-owner agent listings on the Multiple Listing Service in several Texas counties during 1999–2004

Summary statistics and univariate tests of key variables								
	Full sample		Not an owner agent listing		Owner agent listing		*T*-statistics	Wilcoxon rank sum test
Variable	Mean	Median	Mean	Median	Mean	Median		
Selling price	117,492	85,000	118,016	85,000	103,414	79,500	2.46[a]	2.21[a]
List price	142,786	92,000	144,161	92,900	112,469	75,000	5.78[b]	9.26[b]
Size	12.067	10.660	12.107	10.690	11.199	10.260	5.01[b]	5.82[b]
Age	2.246	2.000	2.239	2.000	2.392	2.100	−3.40[b]	−5.90[b]
Owner agent listing	0.043	0.000	–	–	1.000	1.000	–	–
Pool	0.418	0.000	0.412	0.000	0.549	1.000	−8.26[b]	−8.25[b]
Fireplace	0.742	1.000	0.741	1.000	0.749	1.000	−0.43	−0.81
Tenant-occupied	0.097	0.000	0.094	0.000	0.152	0.000	−5.83[b]	−5.83[b]
Vacant	0.434	0.000	0.429	0.000	0.549	1.000	−7.23[b]	−7.22[b]
Builder-owned	0.062	0.000	0.062	0.000	0.051	0.000	1.31	1.31
Market competition	41.964	37.720	40.880	37.527	42.828	41.676	−4.41[b]	−5.69[b]
Degree of overpricing (DOP)	0.000	0.001	0.000	0.001	0.000	0.001	0.00	0.28
Interest rate change	−0.056	−0.050	−0.055	−0.050	−0.087	−0.060	2.41[a]	2.56[a]
Open house	0.030	0.000	0.030	0.000	0.033	0.000	−0.57	−0.57
Tour house	0.129	0.000	0.130	0.000	0.105	0.000	2.16[a]	2.16[a]
Listing agent limited experience	0.078	0.000	0.077	0.000	0.111	0.000	−3.71[b]	−3.71[b]
Listing agent experienced	0.818	1.000	0.819	1.000	0.789	1.000	2.36[a]	2.36[a]
Listing agent broker	0.341	0.000	0.335	0.000	0.479	0.000	−8.99[b]	−8.96[b]
Internet	0.938	1.000	0.939	1.000	0.910	1.000	3.59[b]	3.58[b]
Large firm	0.342	0.000	0.349	1.000	0.186	0.000	10.17[b]	10.15[b]
Time-on-the-market (days)	117.392	91.000	117.687	91.000	110.873	89.000	1.99[a]	1.42
Sold property	0.549	1.000	0.553	1.000	0.455	0.000	5.85[b]	5.85[b]
Sample size	21,051		20,138		913			
Sample size for the selling price variable above	11,551		11,136		415			

Excluding condos with missing variables or data with obvious data entry problems, the final sample includes 21,051 condos, of which 913 are properties listed by an owner agent. Univariate test statistics for the difference in characteristics between listed by an owner agent and not listed by an owner agent are presented. The *t*-statistics are calculated to test the null: mean(not listed by an owner agent)-mean(listed by an owner agent) = 0, with the assumption that the two subsamples are random and independently selected and the sampled population is approximately normal. The nonparametric Wilcoxon statistic is to test whether the owner agent listings and the non-owner agent listings have identical distributions, with the assumption that the two samples are random and independent

Statistics with significance at the 1% level are denoted with a[b] and the 5% level are denoted with a[a]

houses and agent-owned attached housing. They also share similarities. Similar to the statistics for condominiums, agent-owned single-family homes are older, more likely to be occupied by a tenant, and more likely to be vacant. Also, the agent selling his own single-family house is more likely to be a broker and more likely working for a small brokerage firm.

Materials and Methods

First, we estimate a model to predict the expected list price for a house described by $\boldsymbol{X}$ under market conditions described by $\boldsymbol{M}$. The list price ($\boldsymbol{LP}$) model is:

$$\ln(\mathrm{LP}) = X\alpha_X + M\alpha_M + \in_i \tag{8}$$

The model is estimated by generalized least squares (GLS) because specification testing indicated the presence of heteroskedasticity,. The residual of this model is used to estimate the degree of overpricing, *DOP*, calculated as ln(*LP*)−E(ln(*LP*); X, M). *DOP* is the percentage deviation from the expected list price for a condo described by $\boldsymbol{X}$ and $\boldsymbol{M}$ and is expected to influence the time-on-the-market, DOM.

Next, we specify several selling price models for condominiums. The generic selling price model is:

$$\ln(\mathrm{SP}_i) = \beta_0 + \beta_1 \mathrm{Owner\ Agent\ Listing} + \Sigma\beta_i X_i + \Sigma\beta_j M_j + \Sigma\beta_k S_k + \in_i \tag{9}$$

with $\boldsymbol{X}_i$ a vector of property characteristics, $\boldsymbol{M}_{\mathrm{j}}$ a vector of market and investor characteristics, and $\boldsymbol{S}_{\mathrm{k}}$ a vector of geographic and calendar variables where the season variables relate to the season of the sale. The first specified model is a straight-forward Ordinary Least Squares (OLS) model. The second model corrects for sample selection bias arising from incomplete data on the condos that remained unsold.[9] While the previous model corrects for possible sample selection bias based on whether or not the property was sold, the issue of self-selection or endogeneity of *Owner Agent Listing* is unresolved. The third selling price model corrects for both selectivity and endogeneity.

Generally, sample selection bias occurs when a dependent variable is only observed for a restricted, non-random sample. In this study, we observe a selling price only if the condominium is actually sold. For housing studies and many other applications, the Heckman model (Heckman 1978) is appropriate when one suspects sample selection bias.[10] Compared to Model 1, the selectivity corrected price model (Model 2) includes an additional variable, the Inverse Mills Ratio (*IMR*), and is a two-stage model. First, we estimate a Probit model (see Table 3, Model 1) to predict the probability of a house being sold. In the second stage, the *IMR* from the Probit model is included as a regressor in the selling price model. The dependent variable in the Probit model is the variable *Sold Property*. The independent variables are those included in the selling price model plus excess time-on-the-market (the residual from a log linear time-on-the-market model) and a variable measuring interest rate changes. Also, the calendar variables relate to the date of the listing, not the date of the sale.

We attempt to correct for the possible endogeneity of *Owner Agent Listing* by estimating a second Probit model (see Model 2, Table 3) where the dependent variable is *Owner Agent Listing* and the independent variables are similar to the Probit model for *Sold Property,* with the addition of *Internet* and *Large Firm*. We

[9] This model adapts from the labor economics literature for wage equations where one has information on the characteristics of the individual but no wage data for those individuals not employed. For our model, we have housing characteristics for all of the sampled condominiums, but no selling price for the 9,500 properties that did not sell during the sample period.

[10] The Heckman selection model corrects for selectivity bias by adjusting the conditional error terms using the Inverse Mills Ratio so that the conditional error terms will have zero means.

Table 3 The results below are for two binary dependent variable Probit models

Independent variable	Model 1: Probit model for solid versus not solid	Model 2: Probit model for owner agent listing
Constant	0.99	−1.21
	(6.69)[a]	−(3.89)[a]
Size	−0.03	0.01
	−(13.30)[a]	(1.50)
Age	−0.00	0.05
	−(0.02)	(2.55)[b]
Owner agent listing	−0.23	–
	−(5.16)[a]	
Tenant-Occupied	−0.17	0.25
	−(5.13)[a]	(3.13)[a]
Vacant	0.01	0.24
	(0.58)	(4.84)[a]
Builder-occupied	−0.11	−0.47
	−(2.54)[b]	−(2.64)[a]
Market competition	0.01	0.00
	−(2.80)[a]	(0.69)
Degree of overpricing (DOP)	–	0.00
		(2.38)[b]
Interest rate change	0.41	–
	(15.68)[a]	
Open house	−0.11	0.01
	−(2.06)[b]	(0.06)
Tour house	0.17	0.22
	(5.52)[a]	(3.03)[a]
Listing agent limited experience	0.02	0.18
	(0.48)	(1.68)
Listing agent experienced	0.14	−0.14
	(4.55)[a]	−(1.75)
Listing agent broker	0.27	0.25
	(12.72)[a]	(4.68)[a]
Internet		−0.29
		−(3.42)
Large firm	0.62	−0.15
	(29.69)[a]	−(2.78)[a]
Residual from a time-on-the market log linear model	−0.003	−0.00
	−(21.61)[a]	−(0.11)
Number of houses sold	11,551	11,551
Log likelihood	−12,852	−1,639
Wald Chi^2 (model)	2,772	259
Pseudo R^2	0.11	0.08

For the first model, the dependent variable equals one for a sold condo and zero for an unsold condo. From this Probit model the inverse Mills ratio is calculated and included in selling price models 2 and 3 in Table 4 to correct for possible sample selection bias of sold versus unsold properties. For the second model, the dependent variable equals one if the condo is listed by an owner agent and zero for condos not listed by an owner agent. The inverse Mills ratio calculated using the results from this Probit model is included in a selling price model 3 in Table 4 to correct for the possible endogeneity of an *Owner Agent Listing*

All models include quarterly dummy variables (not reported for brevity) to control for potential serial effects and all regressions include dummy variables for Multiple Listing Service specified areas (not reported for brevity) to control for location. The estimates of the coefficients are presented in the table, with *t*-statistics reported in parentheses using heteroskedasticity-robust Huebner/White standard errors

Statistics with significance at the 1% level are denoted with a[a] and at the 5% level are denoted with a[b]

then estimate a selling price model correcting for both selectivity and endogeneity by including both of the IMRs created from the Probit models.

Finally, we specify a time-on-the-market (DOM) model with DOM being a function of the property characteristics, market conditions, market competition, the residuals from the list price model (DOP), and ownership. To estimate DOM, we use a Weibull failure time (hazard) model:[11]

$$f(t|X, M, Z, \text{Owner Agent Listing}) = \varphi\lambda(X, M, Z, \text{Owner Agent Listing})^{\varphi} t^{\varphi-1} \, exp\left(-(\lambda(X, M, Z, \text{Owner Agent Listing})^{*} t)^{\varphi}\right) \tag{10}$$

where φ is a duration dependency parameter, λ is a scaling parameter, t is DOM, Z represents market competition, DOP, effort level, and experience and other variables as previously described. We use a proportional hazards specification to explain the contribution of the independent variables where

$$\lambda(X, M, Z, \text{Owner Agent Listing}) = exp\left(-X\beta_X - M\beta_M + g(\text{Owner Agent Listing})\right) \tag{11}$$

for some function g(.).

We modify this likelihood in two ways. First, we assume that unmeasured heterogeneity in the hazard function can be described by a Gamma distribution with mean 1 and variance θ. Second, the observed DOM is the minimum of two random variables: the time-to-sale and the time-to-withdrawal. Whether a seller is observed selling the house or withdrawing from the market depends on which event occurs first. The fact that a seller can withdraw without selling introduces "censoring" into the duration data which shortens the average DOM and can be misleading. The variable, *Sold Property*, indicates whether a property was sold (*Sold Property* = 1) or withdrawn. For the condos which were withdrawn from the market at time t, the probability that the time-to-sale exceeds t is

$$1 - F(t|X, M, Z, \text{Owner Agent Listing}) = exp\left(-(\lambda(X, M, Z, \text{Owner Agent Listing})^{*} t)^{\varphi}\right). \tag{12}$$

The maximum likelihood estimates of β, φ and θ correct for this random and frequent censoring (for further discussion, see Lancaster 1990).

Results

The results for the two Probit models (see Table 3), while having the primary purpose of generating Inverse Mill's Ratios (IMRs) for the selection models, are still

[11] Using a semi-log OLS model to estimate the determinants of DOM is equivalent to throwing away nearly 40% of the data if the true model is exponentially distributed and even a higher percent if a Weibull distribution is more appropriate (see Lancaster (1990, ch 8.8)).

useful for gaining insight both to the marketability of condominiums (Model 1) and to the owner–agent phenomenon (Model 2).

The first Probit model considers whether a condominium sells or remains unsold at the end of the study period. The results suggest that the probability of a condominium being sold is higher when a broker, a larger brokerage firm, or a more experienced agent lists the property. The probability of a property selling decreases with the size of the property, for tenant-occupied properties, if the property is owned by the builder, and with increased market competition. The difficulty of sale for tenant-occupied properties is well confirmed in the literature and in practice. The Inverse Mill's Ratio (IMR_1) calculated from model one is included in the both of the selection models and is used to correct for selection bias.

The second Probit model examines the probability that a listed property is owned by the listing agent. This model gives insight as to the type of condominium that real estate agents are likely to buy and some information on what type of agents are most likely to be selling the condominiums they own.[12] The probability of an agent-owned listing increases with properties that are older, tenant-occupied, or vacant, and if the listing agent is a broker. Thus, by this analysis, experienced agents (brokers) are more likely to buy properties that are harder to sell or that are in need of some attention. The probability of an agent-owned listing decreases if the listing agent works for a large firm. The Inverse Mill's Ratio (IMR_2) calculated from the second model is included in the selection model to control for both selection bias and endogeneity bias.

To test for the existence of an agent-owner premium in the condominium market, we ran several selling price models. The results for these models are shown in Table 4. The first model is an OLS regression that does not correct for any potential selection or endogeneity biases introduced by the data. The second model is the Heckman selection model which corrects for possible sample selection bias based on the probability of sale. The third model not only corrects for the selection bias, but also corrects for any endogeneity bias associated with the *Owner Agent Listing* variable.

As shown in Table 4, the results for an OLS regression of condominium prices (Model 1) indicate an insignificant coefficient for the variable of interest, *Owner Agent Listing*. The results for the other variables are mostly as expected. Condominiums sell for higher prices when they are larger, builder-owned (new condos) and include a fireplace. Discounts to the selling price are evident for properties that are older, and either vacant or occupied by a tenant. Market competition, measured by the agent activity in the MLS area, has a negative impact on the selling prices of condominiums. It is worth noting that three of the variables with a negative influence on the selling prices of condominiums are the same variables associated with a higher probability of an agent being the owner of the property.

The results for the selling price model (Model 2) with a correction for sample selection bias (using Heckman's selection model) show that the coefficient for

[12] We cannot deduce why the agents buy the properties. More information on holding periods and whether the condominium is a homestead would serve this purpose, but the necessary data are not readily available.

Table 4 Regression models of condominium prices estimated with a sample of 11,551 residential condominiums sold through the Multiple Listing Service (MLS) in several Texas counties from 1999 to 2004

Independent variable	Model 1 OLS	Model 2 selectivity corrected	Model 3 selectivity and endogeneity corrected
Constant	10.53	10.53	10.40
	(236.84)[a]	(235.65)[a]	(239.17)[a]
Size	0.09	0.09	0.10
	(44.67)[a]	(44.48)[a]	(43.89)[a]
Age	−0.07	−0.07	−0.06
	−(14.13)[a]	−(14.31)[a]	−(11.65)[a]
Owner agent listing	0.024	0.03	0.07
	(1.70)	(2.28)[b]	(4.61)[a]
Pool	0.01	0.01	0.01
	(1.76)	(2.17)[b]	(2.13)[b]
Fireplace	0.03	0.03	0.04
	(3.94)[a]	(3.82)[a]	(6.38)[a]
Tenant-occupied	−0.16	−0.15	−0.14
	−(15.71)[a]	−(14.72)[a]	−(17.77)[a]
Vacant	−0.09	−0.09	−0.09
	−(14.55)[a]	−(14.18)[a]	−(17.73)[a]
Builder-owned	0.25	0.25	0.29
	(15.67)[a]	(15.72)[a]	(19.89)[a]
Market competition	−0.01	−0.007	−0.01
	−(15.46)[a]	−(15.30)	−(21.21)[a]
Adjusted R^2	0.81		0.87
F	765		1,028
Log likelihood		−14,954	
Wald Chi^2 (model)		32,292	
Inverse Mills Ratio (IMR_1) from a Probit model for sold versus not sold to correct for possible sample selection bias		−0.06	−0.16
		−(3.36)[a]	−(40.54)[a]
IMR_2 from a Probit model for agent-owned houses versus client-owned house to correct for possible endogeneity of *Owner–agent Listing*			−0.20
			−(17.76)[a]

Model 1 is an OLS regression. Model 2 corrects for possible sample selection bias based on the probability of sale using Heckman's selection model. Model 3 corrects for both sample selection bias and for possible endogeneity of *Owner Agent Listing.* The results from the two Probit models in Table 3 are used to estimate the inverse Mills ratios (IMRs). The probit for sold properties and the resulting IMR_1 is based on Model 1 in Table 3. The probit for *Owner Agent Listing* and the resulting IMR_2 is based on Model 2 in Table 3. IMR_1 is included in Model 2 below. Both IMRs are included in Model 2 below
The dependent variable is the log of the selling price. All regressions include quarterly dummy variables (not reported for brevity) to control for potential serial effects and all regressions include dummy variables for Multiple Listing Service specified areas (not reported for brevity) to control for location. The estimates of the coefficients are presented in the table, with *t*-statistics reported in parentheses using heteroskedasticity-robust Huebner/White standard errors
Statistics with significance at the 1% level are denoted with a [a] and at the 5% level are denoted with a [b]

Owner Agent Listing is positive and significant with a magnitude of 3.3%. This result suggests that agent-owned properties sell at a premium of over 3% in comparison to non-agent owned properties. Also, given that the coefficient for *Owner Agent Listing* from the uncorrected model is not significant, the correction

for sample selection bias is important. Indeed, the coefficient for IMR_1 is significant, indicating that selection bias is present. The other variables show results much as expected and similar to those of Model 1, the uncorrected model.

Finally, in the model corrected for both selectivity and endogeneity, the coefficient for *Owner Agent Listing* is again significant and positive, suggesting a seven percent premium associated with condominiums listed and sold by an agent-owner. The other variables show results much as expected and similar to Model 1. The coefficients for IMR_1 and IMR_2 are both significant, indicating that both sample selection bias and endogeneity bias are present in the data.

Based on the results of the selling price models that correct for sample selection and endogeneity, we observe a selling price premium of between 3 and 7% for condominiums that are listed by their owner, a real estate agent. This premium to the owner–agent is present when the factors that seemingly influence agent-ownership of condominiums are controlled for in the model, with all three demonstrating a negative impact on selling price. Thus, in the absence of information on whether the agent resides in the condo, the results suggest that, based on pricing evidence, the condos more likely to be owned by agents are less desirable in the marketplace. However, the bottom line is that after controlling for the differences between properties the results suggest that agent-owners receive a price premium. That is, they sell similar properties owned by their clients for less. The existence of a statistically significant and positive coefficient for *Agent Owner Listing* provides direct evidence of an agency problem in residential condominium brokerage resulting from information asymmetries.

The observed agent-owner selling price premiums of 3.0–7.0% are comparable to those observed for single-family houses, which range from 4.5 to 7.0% in Rutherford et al. (2005) and were approximately 3.5% in Levitt and Syverson (2005). The evidence from the results neither firmly supports nor refutes the contention that a more homogeneous market, in this case the condominium market, will reduce the observed premiums. The similarity of results can be explained, at least partly, by the potential of offsetting influences resulting from differences in investment preferences for agents when buying single-family homes in comparison to buying condos. In the Probit models in Rutherford et al. (2005), the probability of an agent-owned single-family house increases for vacant and builder-owned houses, and decreases for tenant-occupied and older houses. Except for vacant properties, these factors all have the opposite effect in the Probit models for condos.

A Weibull failure time model corrected for censoring is used to assess the time-on-the-market effects of agent-owned listings. The results for this model are shown in Table 5. The coefficient for *Owner Agent Listing* is significant and positive suggesting that agent-owned houses stay on the market longer than client-owned houses. The model also shows that marketing time decreases for older condos, condos with fireplaces, and condos listed with either a broker (rather than sales agent) or a large firm. Marketing time is shown to increase with the size of the condo, the presence of a pool, if the condo is either tenant-occupied or vacant, if a builder owns the condo, with overpricing and when open houses are used in the marketing of the property.

When the results for *Owner Agent Listing* in the hazard model are compared to the premium observed for agent-owned properties in the selling price models, there

Table 5 Parametric estimation of an accelerated failure time Weibull duration model corrected for censoring based on the full sample over the 1999 to 2004 study period, where 11,551 of 21,051 condo listings eventually sold

Independent variable	Duration model
Constant	1.39
	(43.48)[a]
Size	0.01
	(20.59)[a]
Age	−0.01
	−(4.62)[a]
Owner agent listing	0.03
	(2.84)[a]
Pool	0.03
	(7.47)[a]
Fireplace	−0.03
	−(7.48)[a]
Tenant-occupied	0.06
	(8.96)[a]
Vacant	0.01
	(2.53)[b]
Builder-owned	0.09
	(8.93)[a]
Market competition	0.00
	(2.80)[a]
Degree of overpricing (DOP)	0.001
	(2.80)[a]
Interest rate change	−0.14
	−(24.07)[a]
Open house	0.03
	(2.27)[b]
Tour house	−0.02
	−(3.07)[a]
Listing agent limited experience	0.02
	(1.55)
Listing agent experienced	−0.01
	−(1.09)
Listing agent broker	−0.04
	−(9.10)[a]
Large firm	−0.09
	−(21.35)[a]
Number of observations	21,051
# Sold obs	11,551
# UnSold obs	9,500
Log likelihood	−8,537
Wald Chi^2 (model)	3,559
ρ	4.74
AIC	582

The dependent variable is log of time on the market (DOM). All regressions include quarterly dummy variables (not reported for brevity) to control for potential serial effects and all regressions include dummy variables for Multiple Listing Service specified areas (not reported for brevity) to control for location. The ML estimates of the coefficients are presented in the table, with t-statistics reported in parentheses using heteroskedasticity-robust Huebner/White standard errors

Statistics with significance at the 1% level are denoted with a[a] and at the 5% level are denoted with a[b]

is evidence that the premium is earned while keeping the property on the market for a slightly longer time. The puzzling question is "Why don't the agents market their clients' properties for a bit longer to receive the same premium and directly benefit the client?" There are several possible explanations. Perhaps the clients are jumping at sub-optimal offers to avoid losing the sale. However, the same argument can be made that an agency problems exists and the agents encourage their clients to accept the suboptimal offers and demonstrate more patience when selling their own properties. For an agent selling a client-owned property, the payoff to extending the time on the market could be as low as 1.5% of the increase in selling price minus any additional costs incurred. For this limited payoff, the agent also risks the possibility of a lesser or more belated commission. For an agent selling his own property, the payoff to extending the time on the market is the entire increase to the selling price minus additional expenses incurred during the extended marketing time. Thus, the agent faces different incentives according to whose property he is selling.

Conclusions

Previous research (Rutherford et al. 2005; Levitt and Syverson 2005) has shown that real estate agents receive a 3–7% premium when selling their own houses in comparison to selling similar houses owned by clients. In this study, we find evidence in the condominium market for a similar price premium as observed for single-family houses. We also find that agent-owned condominiums must stay on the market longer to receive the higher price. The results showing the similarity of the owner–agent premiums in the two markets may be affected by the apparent differences in property preferences of agents between condominiums and single-family houses.

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