Effects of Real Estate Brokers' Marketing Strategies: Public Open Houses, Broker Open Houses, MLS Virtual Tours, and MLS Photographs

Authors

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Abstract

The existence of the real estate brokerage industry is generally attributed to high transaction costs in real estate markets. Brokers are typically expected to market sellers' properties, assist in contract negotiations, and coordinate the post-contract tasks necessary to close transactions. Presumably, brokers can perform these duties at lower cost than sellers. In addition to cost efficiencies, brokers may also impact market outcomes. Numerous researchers have investigated whether or not the use of brokers as well as various broker actions, broker characteristics, and broker/seller legal relationships affect market outcomes in the form of price and/or, time-on-the-market effects. We extend this line of research by considering price, time-on-market, and probability of sale effects in relation to four specific broker strategies: public open houses, broker open houses, MLS virtual tours, and MLS photographs. The results indicate positive relationships between these strategies and house prices and mixed relationships between these strategies and probability of sale and time-on-market.

The general role of brokers in the housing market is to act as intermediaries between buyers and sellers.[1] Brokers who represent sellers (the brokers of interest in this study) are engaged to market properties, assist in contract negotiations, and perform various post-contract tasks to help finalize or ''close'' transactions with the overall goal of maximizing gross sale proceeds for sellers. To the extent that brokers can perform these tasks at lower cost than sellers, sellers are willing to engage brokers and share the resulting surplus with them. Comparing the brokers' compensation (and any related costs) with the cost of doing these tasks themselves, sellers will choose the lowest cost alternative.

Beyond the cost efficiencies brokers may bring to the market, brokers may also impact market outcomes such as price, time-on-the-market, and probability of sale.

For example, brokers may have greater expertise and/or access to potential buyers than sellers, which typically leads to higher prices, shorter marketing times, and/or increased probability of a successful transaction. The question of whether or not brokers affect market outcomes is a frequent topic of research among housing economists. Early research tends to focus on the impacts on price and time-on-the-market of (a) using a broker versus (b) not using a broker. Later research tends to focus on whether or not various broker characteristics, broker actions, and seller/broker legal relationships affect market outcomes when brokers are used.

The present study contributes to this line of research by considering potential price, time-on-the-market, and probability of sale effects associated with four specific marketing strategies used, to varying degrees, by brokers representing house sellers: public open houses, broker open houses, MLS virtual tours, and MLS photographs. Analysis of 67,297 single-family house transactions recorded in the multiple listing service (MLS) covering Dallas County, Texas, between 2004 and June 2008 indicates that each of these four marketing strategies have positive price effects, but their effects on time-on-the-market and probability of sale are mixed.

The remainder of this paper presents the following: (1) a review of studies on the potential impacts of brokers on price, time-on-the-market, and probability of sale, (2) a discussion of public open houses, broker open houses, MLS virtual tours, and MLS photographs as marketing strategies, (3) a description of the data, (4) a description of the methodology, (5) a discussion of the empirical results, and (6) a summary of the study's contribution to the body of knowledge regarding real estate brokerage.

Studies Related to Brokers and Market Outcomes

Researchers have long questioned whether or not brokers have impacts on market outcomes, such as price and time-on-the-market. Yinger (1981) develops a theoretical model of the brokerage market and concludes that brokers, due to their expertise and access to buyers, can be expected to sell houses more quickly and for higher prices than owners.[2] Jud (1983) extends Yinger's theoretical model and empirically tests its implications in an effort to ascertain whether houses sold with brokers sell for the same prices and with the same speed as those sold without brokers. He finds no significant price effect in his sample data, but he does find that houses sold with brokers sell significantly more quickly. Kamath and Yantek (1982) also conclude that brokers have no significant impact on home prices. On the other hand, Janssen and Jobsen (1980) and Jud and Frew (1986) identify significant price premiums for brokered versus non-brokered house transactions. Zumpano, Elder, and Baryla (1996) and Elder, Zumpano, and Baryla (2000) conclude that the use of brokers has no appreciable, independent influence on house prices. Simon and Violand (2007) provide evidence from 12 French cities indicating that the use of brokers has a positive house price effect. Li and Motiwalla (2009) find no significant price differences between houses sold by

brokers and those sold in for-sale-by-owner transactions in which owners market the houses using the Internet.[3]

Hardin, Johnson, and Wu (2009) report no significant price differences between brokered and non-brokered multifamily property transactions. They attribute this finding to the increased transparency and market participant knowledge in the commercial property market in comparison to the housing market.

Using data from brokered transactions only, numerous studies provide insight into a variety of broker characteristics, actions, and broker/seller legal relationships that may affect observable market outcomes in the form of time-on-the-market and price effects. Some of these studies consider only one of these market outcomes, while others consider both.

Studies that focus primarily on time-on-the-market effects include Haurin (1988), who considers the relationship between time-on-the-market and brokerage firm size and provides evidence that the size of the brokerage firms (number of brokers) is negatively related to time-on-the-market. Larsen and Park (1989) and Sirmans, Turnbull, and Benjamin (1991) also report that larger firms tend to sell houses more quickly than smaller firms. In contrast, Yang and Yavas (1995) also consider this relationship but find no significant impacts on time-on-the-market. Additionally, Jud, Seaks, and Winkler (1996) examine time-on-the-market in relation to several factors, including firm size (measured by number of transactions), broker expertise (proxied by their numbers of in-sample transactions), and whether or not the firm is part of a franchise operation. They find no evidence that particular brokers or firms are able to market a home faster than other brokers or firms. More recently, Hui, Wong, and Wong (2012) consider how overpricing, a decision which brokers are typically involved in with sellers, may impact time-on-the-market. They conclude that overpricing may optimize sellers' returns and that time-on-the-market depends on macroeconomic conditions and alternatives available to buyers in the market.

Studies that focus primarily on price effects include Jud and Winkler (1994), who conclude that neither brokerage firm nor broker characteristics impact house prices. They attribute this finding to the efficiency of information through MLSs. In contrast, Hughes (1995) considers the firm-size relation and reports a significant price premium when the broker is affiliated with a larger firm. Johnson, Springer, and Brockman (2005) examine potential market outcomes related to MLS versus non-MLS marketed transactions (all brokered). They find a significant price premium of over 6% for non-MLS marketed houses.

Studies that simultaneously consider both price and time-on-the-market effects include Benjamin and Chinloy (1995), who consider use of electronic lockboxes, a relatively new innovation at the time of their data sample. Their results indicate a positive price effect, but no significant time-on-the-market effect related to the use of this technology. Rutherford, Springer, and Yavas (2005) examine numerous broker-related factors that may impact house prices, including brokers selling their

own houses and the number of other houses those brokers have listed at the time of sale. They report positive price effects for both of these issues. Additionally, they consider the use of public open house and MLS virtual tour marketing strategies as potential determinants of time-on-the-market (but not prices). Their findings indicate that time-on-the-market is positively related to brokers selling their own houses, brokers with fewer than five listings at the time of sale, and the use of open houses. They find a negative relationship between time-on-the-market and the use of MLS virtual tours. Notably, they report that brokers use public open houses and MLS virtual tours more often when selling their own houses than they do when selling their clients' houses. Benefield, Pyles, and Gleason (2011) report that limited service brokerage may also affect marketing outcomes through higher selling prices and less time-on-the-market.

Ford, Rutherford, and Yavas (2005) find that houses marketed simultaneously on the Internet and the MLS exhibit price premiums and longer time-on-the-market. Turnbull and Dombrow (2007) report no significant relationship between various firm and broker characteristics and price or time-on-the-market. Huang and Rutherford (2007) consider market outcomes related to the use of Realtor® and non-Realtor® brokers and report that transactions involving Realtors exhibit higher prices and reduced time-on-the-market.

Benefield, Cain, and Johnson (2011) consider the number of MLS photographs and the impact of that visual information on house prices and time-on-the-market. They report positive price and time-on-the-market effects. Carrillo (2008) also considers whether or not the number of MLS photographs and the use of MLS virtual tours impact price and time-on-the-market. He reports that the number of photographs and the use of MLS virtual tours are positively related to price and negatively related to time-on-the-market.

Johnson, Benefield, and Wiley (2007) consider the probability of a successful transaction as a third important type of market outcome. In addition to price and time-on-the-market, they argue that the probability of successfully selling a property is obviously important to sellers and brokers. Their findings suggest that seller motivation, property attributes for which buyers' and sellers' may have different marginal valuations, and property location significantly affect the outcome of marketing efforts. Benefield and Sirmans (2009), Chang, Dandapani, and Johnson (2010), and Brastow, Johnson, and Waller (forthcoming) also examine issues related to the probability of a successful transaction. None of these studies consider the effects of specific marketing strategies on probability of sale.

From the above review of prior studies, it is clear that the potential impacts of brokers on market outcomes is an unsettled issued worthy of additional research. This study extends the prior research by considering potential price, time-on-the-market, and probability of sale effects related to four specific marketing strategies used by brokers: public open houses, broker open houses, MLS virtual tours, and MLS photographs.

Broker Marketing Strategies

The typical starting point for marketing a seller's property is entering the property's information into the local MLS. This information typically describes the property, its location, any unique conditions of sale, and provides any disclosures that may be required by state-specific laws. Brokers may also engage in other, more active, marketing strategies to promote the property.

One such strategy is to schedule a public open house event during which the general public can enter the property and examine its characteristics. Typically, a broker will advertise a public open house in the MLS, in local periodicals, on signs placed near and on the property, and will be at the property for a few hours on a weekend day to show the property to anyone who arrives. Most brokers do not consider public open house events as an effective method for selling the property on display. Harris (1998) reports survey findings suggesting that 77% of brokers surveyed who hold a public open house do so merely to appease the seller and only 41% of the brokers surveyed believe the technique helps sell the house.

Another strategy that brokers consider to be more effective is scheduling a broker open house. The seller's broker promotes this event to other brokers (perhaps only to brokers within the same firm or to all brokers in the market) to familiarize them with the house and encourage them to show the house to potential buyers. In many markets, broker open houses (sometimes referred to as ''caravans'') are scheduled in sequence on the same day and brokers (and possibly their prospective buyers) travel from one house to another. Harris (1998) reports that 99% of the brokers responding to his survey have used this strategy and that 59% of them believe it is effective in selling houses.

Two additional marketing strategies of interest in this study are MLS virtual tours and MLS photographs. Technology advances have made it inexpensive and simple for brokers to include MLS virtual tours (online videos) and multiple photographs of properties in MLS for public viewing on the Internet. People may access these videos and photographs directly through the broker's website or through numerous other Internet sources. Brokers typically provide only one MLS virtual tour for a property, but most MLSs permit multiple photographs for a property. The ability to ''see'' a property without having to physically visit it is likely to provide valuable information to potential buyers.

Citing Akerlof (1970), Spence (1973), and Rothschild and Stiglitz (1976), Benefield, Cain, and Johnson (2011) argue that increased information about a house is preferred by risk-averse buyers. To the extent that these four marketing strategies provide a more complete information set, potential purchasers will apply a smaller discount than they would apply to a less certain information set, thus resulting in higher prices and reduced marketing time, other things held constant. The research question addressed in this study is whether these specific broker actions (public open houses, broker open houses, MLS virtual tours, and MLS

photographs) impact market outcomes, namely price, time-on-the-market, and probability of sale.

Data

As summarized in Exhibit 1, the data used in this analysis consists of 92,725 single-family house transactions that occurred during January 2004 through June 2008 as indicated in the MLS serving Dallas County, Texas. The sample excludes builder-owned and foreclosure properties. Information for each property includes sale price, sale date, list date, listing broker, various property characteristics, census tract, occupancy status, and indicators for public open houses, broker open houses, MLS virtual tours, and number of MLS photographs. During the sample period, the maximum and minimum permitted numbers of MLS photographs are ten and zero, respectively.

For houses that sold, the average number of MLS photographs used by brokers is 6.22 per property. Brokers used MLS virtual tours in approximately 4% of the sample. Brokers conducted one or more public open houses for approximately 8% of the properties and conducted one or more broker open houses for approximately 16.7% of the properties. The average sale price is $211,649 and the average time-on-the-market is 96 days from the last listing date to the sale date. All analyses reflect time-on-the-market from the last listing in the MLS.[4]

The data used to analyze probability of sale effects are a combination of the transaction sample described above and an additional 25,430 listed, but not sold houses (a total of 92,725 observations). These listings occur during the same time period as the sold houses sample, but expired or were withdrawn from the MLS without a successful transaction. The number of MLS photographs used by this sample is 2.8, with MLS virtual tours used 2.7% of the time, public open houses are used in 8.45 of the sample, and broker open houses occur in 10.4% of the sample. The differences in means *t*-test indicates that list prices are lower for properties not sold and time-on-the-market is extended to 143 days, compared to 96 for properties that transacted. Most other characteristics are statistically different between the two samples.

Methodology

The standard hedonic pricing model allows examination of the effects of these marketing strategies on the selling price for single-family residential properties.

$$P_i = X_i\alpha_X + M_i\alpha_M + Z_i\alpha_Z. \quad (1)$$

In Equation (1), the dependent variable P is the natural log of sale price for each observation. X represents a set of variables describing the physical characteristics

Exhibit 1 | Summary Statistics

		Full Sample Sold and Unsold		Sold	Not Sold	*t*-test Mean Difference
Variable	Description	Mean	Std. Dev.	Mean	Mean	
SP	Sale Price (for houses that sold)	—	—	211,649	—	—
LP	List price	213,830	192,408	216,760	206,077	7.54**
TOM	Time-on-the-market (in days)	106.958	77.966	96.208	142.696	−84.03**
PHOTOS	Number of MLS photographs	5.293	3.925	6.223	2.834	130.00**
VIRTUAL TOUR	Dummy indicating MLS virtual tour	0.036	—	0.040	0.027	9.31**
PUBLIC OPEN HOUSE	Dummy indicating open house	0.081	—	0.080	0.084	−2.19*
BROKER OPEN HOUSE	Dummy indicating broker open house	0.150	—	0.167	0.104	23.86**
SQFT	Square feet (100's of square feet)	2,025.519	835.645	2,019.708	2,040.898	−3.44**
AGE	Age (10's of years)	33.554	19.832	33.754	33.025	5.00**
DINAREAS	Number of dining areas	1.525	0.534	1.545	1.473	18.23**
LIVAREAS	Number of living areas	1.716	0.738	1.723	1.697	4.96**
BEDROOMS	Number of bedrooms	3.288	0.692	3.274	3.324	−9.70**
BATHS	Number of baths	2.241	0.749	2.238	2.248	−1.73
POOL	Dummy indicating swimming pool	0.151	—	0.159	0.131	10.68**
FIREPLACES	Number of fireplaces	0.851	0.569	0.859	0.829	7.09**

Exhibit 1 | (continued)

Summary Statistics

		Full Sample Sold and Unsold		Sold	Not Sold	*t*-test Mean Difference
Variable	Description	Mean	Std. Dev.	Mean	Mean	
LARGE LOT	Dummy indicating lot size greater than 0.5 acre	0.120	—	0.110	0.146	−15.04**
TENANT	Dummy indicating tenant occupied	0.026	—	0.021	0.040	−16.60**
VACANT	Dummy indicating vacant property	0.271	—	0.285	0.235	15.52**
MARKUP	(*LP-SP*) / *LP*	6.236	19.266	6.870	4.559	16.32**
ATYPICALITY	Haurin's (1998) atypicality measure (10,000's of dollars)	7.157	13.037	7.486	6.285	12.53**

Notes: Summary statistics for the sample of 92,725 single family residential listings with 67,295 sales and 25,430 not sold. The sample is from Dallas County during the years 2004, 2005, 2006, 2007 and the first 6 months of 2008. For the sold sample, $N = 67{,}295$; for the not sold sample, $N = 25{,}430$.

*Significant difference between the means *t*-test is 5%.

**Significant difference between the means *t*-test is 1%.

of the property. *M* is a set of variables describing marketing strategies, including the number of MLS photographs (*PHOTOS*), participation in a public open house (*PUBLIC OPEN HOUSE*), participation in a broker open house (*BROKER OPEN HOUSE*), and whether the property has a MLS virtual tour available (*VIRTUAL TOUR*). *Z* is a set of variables describing location, estimated residuals for time-on-the-market, occupancy of the property, and year and quarter of sale.

The following model allows examination of the potential effects of marketing strategies on the time-on-the-market for the sample:

$$TOM_i = X_i\alpha_X + M_i\alpha_M + P_i\alpha_Z + W_i\alpha_W. \quad (2)$$

In Equation (2), the dependent variable TOM_i is the natural log of the total number of days between the list and sale dates. *X* represents a set of variables describing the physical characteristics of the property. *M* is the set of variables describing marketing strategies, including the number of MLS photographs (*PHOTOS*), participation in a public open house (*PUBLIC OPEN HOUSE*), participation in a broker open house (*BROKER OPEN HOUSE*), and whether the property has a MLS virtual tour available (*VIRTUAL TOUR*). *P* is a set of variables describing location, estimated residuals from a pricing model, occupancy of the property, and year and quarter of sale. *W* is a set of variables that reflect the relative pricing of the property and the uniqueness of the property. The variable *MARKUP* measures the percentage by which the list price exceeds the sale price. The variable *ATYPICALITY* controls for the uniqueness of each property.[5]

Some researchers have used ordinary least squares (OLS) to estimate the time-on-the-market model, such as the one indicated in Equation (2). This method produces unbiased estimates, but it wastes information. Lancaster (1990) shows that using a semi-log OLS model to estimate the determinants of time-on-the-market is equivalent to throwing away 39% of the data if the true model is exponentially distributed and 43% of the data if a Weibull distribution is more appropriate. The following time-on-the-market model uses a hazard model with a Weibull specification of the baseline hazard function:

$$f(t|X, M, Z, P, W) = \varphi\lambda(X, M, P, W)^{\varphi}t^{\varphi-1} \exp(-(\lambda(X, M, P, W)^{*}t)^{\varphi}), \quad (3)$$

where φ is a duration dependency parameter, λ is a scaling parameter, *t* is time-on-the-market, and other variables are as previously described.

Similar to Johnson, Benefield, and Wiley (2007) and Benefield and Sirmans (2009), the following probit model allows examination of the potential effects of marketing strategies on the probability of sale for houses in the sample:

$$\text{Prob}(SOLD) = \pi(X, M, P, W). \quad (4)$$

In Equation (4), the dependent variable Prob(*SOLD*) is the probability of a successful transaction, and X, M, P, and W are as defined above (excluding the pricing model residuals from P).

Empirical Results

Price Effects

Focusing on the variables of interest, the regression results shown in Exhibit 2 indicate statistically significant positive price effects for all four marketing strategies. The Exhibit presents results for three different specifications of the hedonic price equation (Equation (1)). Model 1 includes *PHOTOS* without a squared term and without a correction for possible endogeneity. Model 2 includes squared terms for *PHOTOS* and inverse Mills ratios (*IMRs*) to correct for possible endogeneity for the variables *PUBLIC OPEN HOUSE*, *BROKER OPEN HOUSE*, and *VIRTUAL TOUR*. The inverse Mills ratios are calculated from a multinomial logistic regression following the work of Dubin and McFadden (1984). Model 3 includes dummy variables for the number of MLS photographs rather than treating the number of MLS photographs as a continuous variable as is done in Models 1 and 2. Model 3 also includes IMRs. All models have robust error terms and control for the year and quarter sold. All models have census tract fixed effects that control for location and other factors common to census tracts. The models also include listing broker fixed effects. The fixed effects for listing broker are included to control for the possibility that brokers have a preference for the number of photographs they post on the MLS.

The estimated coefficient on the *PHOTOS* variable in Model 1 suggests larger effects than those reported by Carrillo (2008), but smaller effects than those reported by Benefield, Johnson, and Cain (2011). Carrillo estimates a positive price effect of 0.15% for an additional MLS photograph, while Benefield, Johnson, and Cain (2011) estimate a 1.2% positive price effect for an additional MLS photograph. In comparison, the results shown in Exhibit 2 for Model 1 indicate positive price effects of 0.78% for this sample or $9,944 for the average of six MLS photographs and an average priced house.

Model 2 includes both *PHOTOS* and the quadratic of *PHOTOS*, or *PHOTOS SQUARED*, to account for potential nonlinearity in the price/photograph relationship.[6] The coefficient on the variable *PHOTOS* is not statistically significant, but the coefficient on the quadratic term is positive and significant. This suggests increasing price effects for additional MLS photographs, with the total price effect of approximately 3.5% when evaluated at the average number of

Exhibit 2 | Log of Sale Price Regression Results With and Without Endogeneity Correction

Variables	Model without Endogenity Correction		Model with Endogenity Correction		Model with Dummy Variables for Number of Photos and Endogenity Correction	
CONSTANT	7.371**	131.84	6.931**	81.78	6.950**	82.08
PHOTOS	0.008**	24.45	−0.003**	−2.64		
PHOTOS SQUARED			0.001**	10.74		
VIRTUAL TOUR	0.041**	8.76	0.039**	8.59	0.039**	8.58
PUBLIC OPEN HOUSE	0.017**	4.88	0.021**	6.22	0.021**	6.21
BROKER OPEN HOUSE	0.036**	9.58	0.033**	9.27	0.033**	9.20
lnSQFT	0.686**	86.96	0.729**	76.67	0.729**	76.74
AGE	−0.088**	−27.77	−0.092**	−28.59	−0.092**	−28.60
AGE SQUARED	0.010**	22.81	0.010**	23.14	0.010**	23.16
DINAREAS	0.005*	2.52	−0.006**	−2.77	−0.006**	−2.77
LIVAREAS	−0.011**	−6.99	−0.011**	−7.11	−0.011**	−7.15
BEDROOMS	−0.022**	−12.66	−0.024**	−11.45	−0.024**	−11.48
BATHS	0.071**	32.42	0.061**	26.52	0.061**	26.51
POOL	0.079**	35.20	0.080**	36.07	0.080**	36.11
FIREPLACES	0.034**	16.78	0.025**	12.42	0.025**	12.41
LARGE LOT	0.065**	19.33	0.069**	18.92	0.069**	18.90
TENANT	−0.064**	−11.23	−0.082**	−12.72	−0.082**	−12.75
VACANT	−0.040**	−19.71	−0.026**	−7.67	−0.026**	−7.68
PHOTOS_0					−0.026**	−6.10
PHOTOS_1					−0.018**	−5.07
PHOTOS_2					−0.022**	−4.15
PHOTOS_3					−0.015*	−2.52
PHOTOS_4					−0.017**	−3.73
PHOTOS_5					−0.006	−1.53
PHOTOS_7					0.007*	2.23
PHOTOS_8					0.017**	5.33
PHOTOS_9					0.032**	9.32
PHOTOS_10					0.052**	17.86
RlnTOM	−0.000**	−4.32	−0.000**	−3.88	−0.000**	−4.22
MILLS VIRTUAL TOUR			0.009**	12.27	0.009**	12.24
MILLS PUBLIC OPEN HOUSE			−0.031**	−15.12	−0.031**	−15.12
MILLS BROKER OPEN HOUSE			0.013**	6.49	0.013**	6.48

Exhibit 2 | (continued)
Log of Sale Price Regression Results With and Without Endogeneity Correction

Variables	Model without Endogenity Correction	Model with Endogenity Correction	Model with Dummy Variables for Number of Photos and Endogenity Correction
Sale Year / Quarter dummies	yes	yes	yes
Census tract fixed effects	yes	yes	yes
Listing agent effects	yes	yes	yes
Robust errors / estimation	yes	yes	yes
Model	Panel	Panel	Panel
R^2	0.846	0.852	0.852

This table shows the log of sale price regression results with and without endogeneity correction for virtual tours, public open houses, and broker open houses. All models are estimated with robust standard errors and control or sale year and quarter, census tract location, and listing agent fixed effects. The number of observations is 67,295.
*$p < .1$
**$p < .05$
***$p < .01$

MLS photographs for the average priced house in the sample. Exhibit 3 shows the price effects of the number of MLS photographs calculated using the coefficients from each of the models for the average priced house in the sample. At the average number of MLS photographs for the sample (6.22) and an average price of $211,649, the impact of those six photographs is $7,417 or approximately 0.56% or $1,200 per photograph.

The estimated coefficients for the variable *VIRTUAL TOUR* are positive and significant in all model specifications reported in Exhibit 2, suggesting a positive price effect of approximately 4.0%. These results compare to 2.1% found by Carrillo (2008). The coefficients are also positive and significant in all models for the variable *PUBLIC OPEN HOUSE*. The coefficients suggest a positive price effect ranging from 1.7% to 2.1%. This suggests that public open houses are worthwhile for the seller even if brokers in general do not believe they are that beneficial. Assuming a price of $200,000 and 3% commission for the listing broker, holding a public open house only generates an extra $120 of compensation to the broker, while the seller benefits by approximately $4,000. Finally, the coefficients on the variable *BROKER OPEN HOUSE* are also positive and significant in all models, suggesting a positive price effect ranging from 3.3% to 3.6%.

Exhibit 3 | Estimated Value of Number of Photographs Based on the Average Sales Price

	Estimated Value		
Photographs	1st Sale Price Model	2nd Sale Price Model	3rd Sale Price Model
0	$0	−$568	−$5,455
1	$1,657	−$156	−$3,833
2	$3,315	$256	−$4,675
3	$4,972	$668	−$3,147
4	$6,629	$1,081	−$3,572
5	$8,286	$1,493	−$1,239
6	$9,944	$1,905	—
7	$11,601	$2,317	$1,537
8	$13,258	$2,729	$3,717
9	$14,915	$3,141	$6,774
10	$16,573	$3,553	$11,194

Notes: Estimated value of number of photographs based on the average sales price using coefficients from the sale price models for the first two models and the value of photographs relative to the mean number of photographs in the third model.

Time-on-the-Market Effects

Exhibit 4 shows results from estimating equation (2) with five different specifications of the time-on-the-market model. In Model 1, the coefficient on the variable *PHOTOS* is positive 3.6% or four days when evaluated at the average time-on-the-market of 96 days. This is approximately 21 days for a property with the average number of photographs listed.

Models 2 and 3 include the quadratic variable *PHOTOS SQUARED*, which necessitates the joint interpretation of the effects of the number of MLS photographs and its square at a specified value for the number of MLS photographs. In each of these models, the coefficients on the variable *PHOTOS* are positive and significant, while the coefficients on the square of this variable are negative and significant. The negative coefficients on the squared terms suggest diminishing quadratic effects similar to those reported by Benefield, Cain, and Johnson (2011).

The opposite signs on the coefficients for the variables *PHOTOS* and *PHOTOS SQUARED* indicate that additional MLS photographs increase the time-on-the-market up to some number of MLS photographs, then decrease time-on-the-market for additional MLS photographs. Following Wooldridge (2009), the ''turning point'' in the function of the time-on-the-market/number of photographs relation

Exhibit 4 | Time-on-the-Market Regression Results With and Without Endogeneity Correction

Variables	Model 1 without Endogeneity Correction		Model 2 with Endogeneity Correction		Duration Model 3 with Endogeneity Correction		Model 4 with Endogeneity Correction		Duration Model 5 with Endogeneity Correction	
CONSTANT	3.193**	22.20	3.232**	17.66	1.101**	33.34	3.567**	19.66	1.138**	34.49
PHOTOS	0.035**	29.26	0.118**	29.87	0.013**	16.20				
PHOTOS SQUARED			−0.008**	−24.20	−0.001**	−12.92				
VIRTUAL TOUR	−0.024	−1.63	−0.023	−1.59	−0.011**	−3.80	−0.024	−1.64	−0.011**	−3.71
PUBLIC OPEN HOUSE	0.204**	19.57	0.201**	19.47	0.029**	14.95	0.201**	19.61	0.029**	14.90
BROKER OPEN HOUSE	0.166**	15.24	0.165**	15.19	0.010**	4.52	0.159**	14.95	0.010**	4.46
lnSQFT	0.074**	3.59	0.049*	2.11	0.035**	7.72	0.058*	2.52	0.035**	7.87
AGE	−0.006	−0.90	−0.023**	−3.07	0.001	0.95	−0.022**	−2.93	0.002	1.04
AGE SQUARED	0.001	0.93	0.002*	2.40	0	0.25	0.002*	2.28	0	0.20
DINAREAS	−0.022**	−3.59	−0.023**	−3.39	−0.003*	−2.19	−0.023**	−3.43	−0.003*	−2.20
LIVAREAS	0.009	1.85	0.011*	2.31	0.003*	2.53	0.010*	2.01	0.002*	2.39
BEDROOMS	0.020**	3.66	0.030**	5.06	0.001	0.65	0.028**	4.71	0	0.30
BATHS	0.005	0.76	0.009	1.32	0.003	1.95	0.009	1.37	0.003*	2.10
POOL	−0.033**	−4.59	−0.026**	−3.62	−0.006**	−3.82	−0.026**	−3.66	−0.006**	−3.85
FIREPLACES	−0.018**	−2.97	−0.022**	−3.60	−0.004**	−3.10	−0.022**	−3.66	−0.004**	−3.32
LARGE LOT	−0.020*	−2.14	−0.006	−0.60	−0.003	−1.50	−0.007	−0.76	−0.003	−1.36
TENANT	0.101**	5.00	0.135**	6.26	0.026**	5.46	0.128**	5.97	0.026**	5.36
VACANT	0.031**	4.81	0.058**	6.32	0.003	1.81	0.057**	6.33	0.002	1.56
MARKUP	0.037**	67.84	0.035**	47.13	0.007**	52.37	0.035**	47.18	0.007**	51.51
ATYPICALITY	0.002**	5.15	0.002**	5.51	0.000**	6.16	0.002**	5.39	0.000**	6.13
PHOTOS_0							−0.592**	−30.80	−0.065**	−17.50
PHOTOS_1							−0.154**	−13.70	−0.015**	−6.19
PHOTOS_2							−0.077**	−4.25	−0.005	−1.23

Exhibit 4 | (continued)

Time-on-the-Market Regression Results With and Without Endogeneity Correction

Variables	Model 1 without Endogeneity Correction		Model 2 with Endogeneity Correction		Duration Model 3 with Endogeneity Correction		Model 4 with Endogeneity Correction		Duration Model 5 with Endogeneity Correction	
PHOTOS_3							−0.041*	−2.16	−0.003	−0.72
PHOTOS_4							−0.018	−1.15	0.002	0.70
PHOTOS_5							−0.007	−0.50	−0.001	−0.38
PHOTOS_7							0.009	0.72	0.002	0.75
PHOTOS_8							0.010	0.87	0.003	1.10
PHOTOS_9							0.019	1.63	0.002	0.91
PHOTOS_10							0.007	0.74	0.001	0.68
MILLS VIRTUAL TOUR			−0.008*	−2.24	−0.002**	−5.51	−0.008*	−2.24	−0.002**	−5.15
MILLS PUBLIC OPEN HOUSE			−0.004	−0.87	0.001	1.04	−0.004	−0.96	0.001	0.98
MILLS BROKER OPEN HOUSE			0.026**	5.83	−0.003**	−6.88	0.025**	5.67	−0.003**	−7.03
List year / quarter dummies	yes		yes		yes		yes		yes	
Census tract fixed effects	yes		yes		yes		yes		yes	
Listing agent effects	yes		yes		yes		yes		yes	
Robust Errors / Estimation	yes		yes		yes / mle		yes		yes / mle	
Model	Panel		Panel		Weibull		Panel		Weibull	
R^2	0.228		0.24				0.251			

Time-on-the-market regression results with & without endogeneity correction for *PHOTOS*, *VIRTUAL TOUR*, *PUBLIC OPEN HOUSE*, and *BROKER OPEN HOUSE*. The first two models are estimated with OLS and the duration models are estimated by MLE. The number of observations 67,295. In Model 3, the log pseudo likelihood is 33,272 and the Wald Chi^2 is 10,194; for model 5, Model 3, the log pseudo likelihood is 33,449 and the Wald Chi^2 is 10,321.

*$p < .1$

**$p < .05$

***$p < .01$

Exhibit 5 | Estimated Number of Days on the Market for the Number of Photographs

Photographs	Model 1 No Square Term	Model 2 Squared Term Included	Duration Model 3 Squared Term Included	Model 4 Dummy Variables	Duration Model 5 Dummy Variables
0	0	12	1	−44	−7
1	4	10	1	−14	−2
2	7	9	1	−7	−1
3	11	7	1	−5	0
4	14	5	1	−2	0
5	18	4	0	−1	0
6	21	2	0	—	—
7	25	1	0	2	0
8	28	−1	0	1	0
9	32	−2	0	2	0
10	35	−4	0	1	0

Notes: Estimated number of days on the market for the number of photographs relative to the average time-on-the-market using coefficients from the five models in Exhibit 4.

in this sample occurs at approximately five to seven MLS photographs in the applicable models.[7] Evaluating the models with the quadratic term at the average number of MLS photographs (six) from the sample suggests a positive time-on-the-market effect for additional MLS photographs ranging from two additional days for the regression model to zero additional days for the duration model. The time-on-the-market model with dummy variables (Model 4) indicates that zero to five photographs are associated with a reduction in number of days to sell, with additional MLS photographs having no significant effect on time-on-the-market. Exhibit 5 shows the estimated days on the market for the number of photographs for each model. Without a quadratic term, with the average number of photographs, 21 extra days are implied. When the square term is included, the implication is two extra days. The results for duration model with dummy variables (Model 5) suggest that the number of MLS photographs does not materially impact the time-on-the-market.

The coefficients on the variable *VIRTUAL TOUR* are negative and statistically significant in the two duration models (Models 3 and 5) in Exhibit 5. The magnitude of the time-on-the-market effect is approximately −1.0 in these models. The regression models results indicate coefficients of less than −1%, but these are insignificant at the 10% level in the three models. Thus, the average effect of *VIRTUAL TOUR* on time-on-the-market is a potential reduction of one day.

The results also indicate that the variable *PUBLIC OPEN HOUSE* is positively related to time-on-the-market in all specifications of the model in Exhibit 5. The largest coefficient on this variable (26%) appears in all the regression models, while the coefficient is only 3.4% in both of the hazard models. This result shows that the variable *PUBLIC OPEN HOUSE* is associated with increased time-on-the-market ranging from 3.26 to 25 days depending on which model (hazard or OLS) is most appropriate. The choice between models is a discussion that has not been settled, but, following Lancaster (1990), the smaller coefficient is most representative of a priori expectations. Again, this result is consistent with the results reported by Rutherford, Springer, and Yavas (2005) regarding the relation between public open houses and time-on-the-market.

Lastly, the results in Exhibit 5 show that the variable *BROKER OPEN HOUSE* has a significant relationship with time-on-the-market in the models with the coefficients ranging from 1.4% to 20.8%. These percentages translate to an increase in time-on-the-market of 1 to 20 days, again depending on the model selected.

Combined Price and Time-on-the-Market Effects

When considered in combination, the price effect of the four marketing strategies for the average priced property ($211,649) with the average number of MLS photographs (6.22) is a price increase of 10.2%, or $21,600 (based on the results from Model 2, Exhibit 2). Similarly, the combined time-on-the-market effect for a property with the average time-on-the-market for the sample (96 days) evaluated at the average number of MLS photographs for the sample is a time-on-the-market increase of 3.8%, or 3.7 days (based on the results from the duration Model 3, Exhibit 4).

Probability of Sale Effects

Exhibit 6 shows results from estimating equation (4), the probability of sale model.[8] Using 92,725 listings, of which 67,295 sold and 25,430 did not sell, the marginal effects of the four marketing strategies indicates that virtual tours and broker open houses significantly increase the probability of a successful transaction by 4.7% and 4.6%, respectively, while public open houses decrease the probability of sale by 6.1%. The number of MLS photographs is also significantly related to the probability of sale. Houses listed with five or fewer MLS photographs are less likely to sell and houses listed with eight or more MLS photographs are more likely to sell. The logit model results tell a similar story consistent with the probit marginal effects results. The marginal effects for probit and logit models, in columns (2) and (7), respectively, are essentially the same. The odds ratio from the logit in column (5) requires a different interpretation. For example, a virtual tour has a 0.047 marginal effect from the probit model and a 0.046 marginal effect from the logit model. Given this is a dummy variable, the

Exhibit 6 | Probit Model 1 and Logit Model 2 where the Dependent Variable is Whether the Property is Sold or Not

	Model 1			Model 2			
	Probit	Marginal Effects	*t*-Stat.	Logit	Odds Ratio	*t*-Stat.	Logit[a]
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CONSTANT	4.218**			7.217**		16.81	
VIRTUAL TOUR	0.161**	0.047**	4.79	0.267**	1.306**	4.54	0.046
PUBLIC OPEN HOUSE	−0.188**	−0.061**	−8.27	−0.337**	0.714**	−8.62	−0.058
BROKER OPEN HOUSE	0.155**	0.046**	6.34	0.277**	1.320**	6.47	0.048
lnSQFT	−0.463**	−0.143**	−12.69	−0.782**	0.457**	−12.38	−0.135
AGE	0.077**	0.024**	6.88	0.132**	1.141**	6.80	0.023
AGE SQUARED	−0.010**	−0.003**	−7.10	−0.017**	0.984**	−6.99	−0.003
DINAREAS	0.130**	0.040**	10.28	0.226**	1.253**	10.25	0.039
LIVAREAS	0.012	0.004	1.21	0.021	1.022	1.22	0.004
BEDROOMS	0.004	0.001	0.39	0.009	1.009	0.46	0.002
BATHS	−0.014	−0.004	−1.02	−0.029	0.972	−1.23	−0.005
POOL	0.034*	0.010*	2.16	0.051	1.053	1.89	0.009
FIREPLACES	0.029*	0.009*	2.45	0.050*	1.051*	2.42	0.009
LARGE LOT	−0.125**	−0.040**	−6.82	−0.223**	0.800**	−7.03	−0.038
TENANT	−0.143**	−0.046**	−4.55	−0.230**	0.795**	−4.25	−0.040
VACANT	0.290**	0.085**	14.08	0.513**	1.669**	14.00	0.088
MARKUP	0.000	0.000	1.21	0.001	1.001	1.67	0.000
ATYPICALITY	0.004**	0.001**	4.72	0.007**	1.007**	4.62	0.001
PHOTOS_0	−0.665**	−0.237**	−21.15	−1.182**	0.307**	−21.19	−0.203
PHOTOS_1	−1.203**	−0.411**	−39.84	−2.081**	0.125**	−38.04	−0.358

Exhibit 6 | (continued)

Probit Model 1 and Logit Model 2 where the Dependent Variable is Whether the Property is Sold or Not

	Model 1			Model 2			
	Probit	Marginal Effects	*t*-Stat.	Logit	Odds Ratio	*t*-Stat.	Logit[a]
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PHOTOS_2	−0.361**	−0.124**	−8.26	−0.672**	0.510**	−8.50	−0.116
PHOTOS_3	−0.226**	−0.075**	−4.56	−0.424**	0.654**	−4.79	−0.073
PHOTOS_4	−0.153**	−0.049**	−3.68	−0.284**	0.753**	−3.75	−0.049
PHOTOS_5	−0.119**	−0.038**	−3.38	−0.228**	0.797**	−3.52	−0.039
PHOTOS_7	0.039	0.012	1.20	0.071	1.074	1.20	0.012
PHOTOS_8	0.113**	0.034**	3.61	0.207**	1.229**	3.58	0.036
PHOTOS_9	0.190**	0.055**	5.89	0.338**	1.402**	5.65	0.058
PHOTOS_10	0.364**	0.105**	13.72	0.669**	1.952**	13.56	0.115
List year / quarter dummies	yes			yes			
Location fixed effects	yes			yes			
Robust errors / estimation	yes			yes			
Pseudo R^2	22.94			23.56			

Notes: Probit Model 1 and logit Model 2 where the dependent variable is whether the property is sold or not with one for sold and zero for not sold. The model includes list quarter dummy variables (not reported for brevity) and dummy variables for MLS areas (not reported for brevity) to control for location. The estimates of the coefficients, marginal effects, and odds ratio are presented in the table, with *t*-statistics reported using heteroscedasticity-robust standard errors. There are 92,725 observations. The log–pseudo likelihood for Model 1 is −41,977; the log–pseudo likelihood for Model 2 is −.41,636.

[a]Changes in predicted probabilities for sold.

*Significant at the 5% level.

**Significant at the 1% level.

results indicate that a house for sale with a MLS virtual tour has a 4.7% higher probability of selling, relative to a house without a virtual tour. For the odds ratio, 1.306, it indicates that for a house with a MLS virtual tour, the odds of selling are 1.306 times larger than the odds of a house without a MLS virtual tour. The results for both models show that houses with virtual tours are more likely to sell.

Discussion and Issues

The results indicate that marketing tools impact the probability of completing a sale, the price, and time-on-the-market. Given these results, why do we see only limited use of these tools? Overall, listings with six or more photos are associated with an increase in price, no increase in time-on-the-market, and a higher probability of completing a sale. Listings with MLS virtual tours have higher prices, experience lower time-on-the-market, and are more likely to sell. Listings with broker open houses sell at higher prices and are more likely to sell, but take longer to sell. Listings with public open houses also sell at higher prices, but are less likely to sell and take longer to sell.

One possible answer to the question, ''Why do we see only limited use of these tools?'' is that brokers may be unaware of the benefits of these strategies.[9] However, regressing the mean number of uses of each marketing strategy variable by broker on the number of listings by broker as shown in Exhibit 7 indicates that brokers with more listings use more MLS photographs and broker open houses than brokers with fewer listings, but the use of public open houses and virtual tours are not related to broker activity level in the market. Thus, it appears that more active brokers are indeed aware of the benefits of additional MLS photographs and broker open houses and use these strategies more often than less active brokers.

Another possible answer is that the effort to use the marketing tools does not justify the returns to the brokers. For example, agents typically indicate that public open houses have no impact on price. Our results, however, indicate a 2% price premium for the seller holding the probability of sale and marketing time constant. Brokers would typically only receive, at most, 3% of this 2%. In a hypothetical case of a house selling for $102,000 using a public open house versus $100,000 for a house not using a public open house, the broker only receives 0.03*$2,000 or $60. We doubt that $60 is reasonable compensation to motivate more brokers to hold public open houses. In general, each of the marketing tools has low payoffs for the broker relative to the dollar payoff for the seller and sometimes are associated with a longer time-on-the-market required to obtain a commission. This suggests that better informed sellers could obtain higher prices if they insisted the broker use all marketing tools at his/her disposal but that typical listing contracts may not adequately incentivize brokers to employ these strategies for all listings. Unfortunately, the data set employed in this study does not contain sufficient information about listing contracts to formally test this issue.

Exhibit 7 | Results from Regressing the Mean Number of Uses of Each Marketing Strategy by Broker on the Number of Listings by Broker

	Public Open House		Broker Open House		MLS Photographs		Virtual Tour	
Variables	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.
CONSTANT	0.0749	24.64	0.0792	23.49	4.1619	92.4	0.0257	14.31
Number of listings per broker	0.0000	0.20	0.0003**	2.04	0.0006**	2.46	0.000	0.57
R^2	0.00%		0.09%		0.13%		0.01%	
F-Stat.	0.0394		4.1763*		6.0286*		0.3296	

Notes: This table shows results from regressing the mean number of uses of each marketing strategy by broker on the number of listings by broker. The sample contains 4,720 brokers.
*Significant at the 5% level.
**Significant at the 1% level.

Exhibit 8 | Difference in Means Test Results

	Public Open House		Broker Open House		MLS Photographs		Virtual Tour	
	75% Lower Price Percentile	25% Higher Price Percentile	75% Lower Price Percentile	25% Higher Price Percentile	75% Lower Price Percentile	25% Higher Price Percentile	75% Lower Price Percentile	25% Higher Price Percentile
Panel A: Sale Prices (16,780 observations in 25% percentile and 50,516 observations in lower price 75% percentile)								
Mean	0.1610	0.0530	0.4481	0.0735	5.8754	7.2683	0.0847	0.0248
Std. Dev.	0.3678	0.2239	0.4973	0.0261	3.7582	3.4012	0.2785	0.1555
Difference (high-low)	0.1081		0.3746		1.9329		0.0600	
t-Stat.	45.41**		133.33**		42.57**		34.76**	
Panel B: List Prices (23,134 observations in 25% percentile and 69,592 observations in lower price 75% percentile)								
Mean	0.0518	0.1694	0.0606	0.4179	4.9500	6.3271	0.02193	0.0792
Std. Dev. Deviation	0.2216	0.3751	0.3568	0.4932	3.8921	3.8417	0.1464	0.2701
Difference (high-low)	0.1176		0.3573		1.3773		0.0573	
t-Stat.	57.77**		155.56**		46.78**		40.77**	

Notes: This table shows the difference in means test results between sale price (≥$239,000) and high list price (≥$239,500) top 25% percentile against lower sale and list price 75% percentiles, respectively, for each marketing strategy.

*Significant at the 5% level.

**Significant at the 1% level.

A third possible answer, closely related to the answer immediately above, is that brokers more often employ these marketing strategies for high-end properties (higher priced properties) for which the broker payoffs are higher, taking into consideration any price effect, probability of sale effect, or time-on-the-market effect. Simple difference in means test results shown in Exhibit 8 for the top sale price (and list price) quartile versus lower quartiles sale prices (and list prices) indicate that broker open houses, additional MLS photographs, and public open houses are more likely to be observed for higher value properties, but that virtual tours are equally likely in each of these value quartiles. Thus, as the marginal benefit to the broker moves toward the marginal cost, we see additional use of the marketing tools. In the example above, we estimated a $60 increase per $100,000 increase in the sales price for a public open house. This would suggest $300 for a $500,000 house. It is reasonable that a broker could have a staff member or rookie agent conduct the public open house with a possible positive return to the broker if they can pay less than the $300 to conduct the public open house. In such a case, the incentives of the broker and seller would be aligned with both benefiting from the marketing tools.

These results support the hypothesis that brokers are aware of the benefits and that as the benefits increase with price, we find that brokers are more likely to use the marketing tools as the benefits exceeds the costs. We also observe, in the data, due either to market competition or the seller's and/or broker's awareness of the benefits, an increasing usage of these marketing tools over time.

Conclusion

The impact of real estate brokers on market outcomes is an unsettled issue, both theoretically and empirically. The underlying question in this study is whether brokers, through their actions, expertise, access to buyers, etc., can impact the price at which a property is sold, the time it takes to sell that property, and/or the probability that the property does sell. Previous attempts to answer this question have considered a lengthy list of factors including, but not limited to, brokered versus non-brokered sales, brokerage firm size, franchise affiliation, MLS versus non-MLS marketing, use of electronic lockboxes, the legal relationship between broker and seller, Internet advertising, the number of MLS photographs used, the use of public open houses, and the use of MLS virtual tours. This study contributes to the body of knowledge regarding real estate brokerage by considering potential market outcomes resulting from the use of four specific strategies that brokers use to varying degrees to market their clients' properties. Three of these marketing strategies have been previously considered by various researchers (public open houses, MLS photographs, and MLS virtual tours), but the remaining strategy (broker open houses) has not been previously scrutinized, nor has the effect of public open houses on selling price been specifically considered in prior empirical studies. No prior research has considered the relationship between these marketing strategies and the probability of a successful transaction.

Analysis of data from 67,295 sales of single-family houses collected from the MLS that serves Dallas County, Texas, leads to the following general conclusions. First, all four of the marketing strategies considered here have positive relationships with house prices. Second, two of the strategies (MLS photographs and public open house) have positive relationships with time-on-the-market, although the positive effect of additional MLS photographs begins to decrease at approximately six MLS photographs. Third, two of the strategies (MLS virtual tours and broker open house) have a negative relationship with time-on-the-market. When considered together for the average property in the sample, the magnitude of the price increase associated with using these four strategies appears to overwhelm the relatively small increase in time-on-the-market. Finally, virtual tours, broker open houses, and eight or more photographs increase the probability of a successful sale, but public open houses decrease the probability of sale. Overall, these results indicate that these real estate broker marketing strategies result in substantial price and probability of sale effects, but less substantial time-on-the-market effects.

Given these findings, the obvious question arises ''Why do all sellers/brokers not use these marketing strategies in every transaction effort?'' Perhaps the answer is that brokers follow a wealth maximization strategy that may result in an agency problem with sellers. The costs of some of these strategies to the broker are relatively high compared to the returns to the broker with most of the benefits going to the seller. Our expectation is that as information regarding the benefits of these marketing tools to the seller becomes available, and in some cases the cost to brokers decrease, more sellers will insist on using these marketing tools.

Endnotes

[1] The term ''broker'' is used throughout this manuscript in its general form without regard to license status.

[2] Yinger (1981) and many of the other studies discussed here also addresses other topics that are beyond this scope of this analysis, including the nature and efficiency of the market for brokerage services, broker compensation methods, and potential principal/agent problems in the brokerage industry. Benjamin, Jud, and Sirmans (2000) and Zietz and Sirmans (2011) provide excellent reviews of research addressing these and other related issues.

[3] Richardson and Zumpano (2012) consider how increased Internet usage has impacted house buyer search efficiency and conclude that the Internet may slow the market clearing process, thus increasing seller holding costs.

[4] The sale data sample includes properties with expired listings but does not include properties that are withdrawn from the market prior to sale or expiration of the listing agreement. As discussed by Rutherford, Springer, and Yavas (2005), this data limitation may introduce censoring for the time-on-the-market variable, which may misleadingly reduce the average time-on-the-market. This data limitation is common to many of the studies discussed above that examine only ''sold'' houses.

[5] Following Haurin (1988), this measure is the sum of the product of the implicit price of each feature and the absolute value of the deviation of that feature, across all features of the property.

[6] Carrillo (2008) does not include a quadratic term. Benefield, Cain, and Johnson (2011) do include such a term, but find it to be insignificant.

[7] Wooldridge (2009, pp. 192–96) demonstrates that in an estimated equation $y = \beta_1 x + \beta_2 x^2$ where β_1 and β_2 have the same sign, the effect of a change in x on the logged dependent variable y is simply $\beta_1 + 2\beta_2$. If, however, β_1 and β_2 have opposite signs, their combined effect on logged y reverses sign at some value of x. This turning point is always achieved at the value of x that is equal to the absolute value of the ratio of $\beta_1/(2\beta_2)$.

[8] Logit results are consistent with probit results discussed in the text. The logit odds ratios results tell a similar story consistent with the probit marginal effects results. Interpretation is different with the odds ratio. For example, a virtual tour has a 0.047 marginal effect and since this is a dummy variable, indicates that a house with a virtual tour has a 4.7% higher probability of selling, relative to a house without a MLS virtual tour. For the odds ratio, 1.036, it indicates that for a house with a MLS virtual tour, the odds of selling are 1.306 times larger than the odds of a house without a MLS virtual tour.

[9] We would like to thank Ko Wang for suggesting rationale and tests for the use of the marketing tools.

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