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The Impact of Virtual Marketing Strategies on the Price-TOM Relation

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Abstract

Virtual tours such as pre-recorded videos or self-guided virtual reality (VR) tours represent marketing strategies that agents can use to promote homes for sale. Assuming agents aim at maximizing their net commissions, we expect virtual tours, which require more agent effort and are more costly, to be used for homes that are difficult to show due to being owner- or tenant-occupied. Using 34,359 single-family transactions from multiple US markets, we show that virtual tours impact the sales prices of occupied homes (1) directly (main effect) and (2) indirectly through an interaction with time on market (TOM). However, this impact differs in directionality and size across price segments and occupier type. The use of virtual tours has no effect on the sales prices of vacant homes. Our results suggest that virtual tours are effective strategies to overcome the difficulty of showing homes and moderate the price-TOM relation.

Keywords Residential real estate prices · Agents · Virtual tours · Time on market · Mixed-effects regression

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Background

Residential agents use a variety of promotional tools to increase the exposure of and traffic to a property. Promotional strategies vary in their costs and effort required, ranging from simply adding their own photos and MLS comments over taking professional photos to creating virtual tours.[1] In a competitive market, agents cannot directly pass the costs of more expensive promotional strategies onto sellers in the form of higher commission rates. Rather, agents must hope for higher sales prices leading to higher dollar commissions to compensate them for the higher promotional costs (Benefield, Sirmans & Sirmans, 2019).

Considering that agents prefer to attract buyers with minimal promotional efforts and sell properties with as little marketing expenses as possible to maximize their net commissions (Clauretie & Daneshvary, 2008; Gwin, Ong & Gwin, 2002), we argue that agents use more costly promotional strategies, such as virtual tours, for properties that are more difficult to show due to owner or tenant occupancy. Compared to a vacant property that can be toured at any time, an occupied home limits the frequency and ease with which a home can be visited by prospective buyers and requires agents to spend more time on coordinating viewing appointments between the different parties.

We hypothesize that virtual tours directly and indirectly impact the sales prices of difficult-to-show homes. First, using virtual tours directly affects sales prices as it allows more potential buyers to tour a property remotely, which potentially increases the number of offers received and yields a higher sales price (main effect). Second, the use of virtual tours indirectly affects sales prices by moderating the price-time on market (TOM) relation due to the ability to attract more traffic, either local or out of market, to a home over the life of a listing contract (interaction effect).

Using 34,359 single-family transactions from markets in the Southwest, Pacific Northwest, and Midwest, we show that virtual tours impact sales prices directly and through an interaction with TOM for occupied homes. Virtual tours have no relation with the sales prices of vacant homes, which are easy to show to prospective buyers. However, the pricing effects of virtual tours for occupied homes differ across price segments and occupier type. For homes in the low-price segment, virtual tours allow agents to achieve a sales price premium for occupied homes (main effect). In this segment, virtual marketing strategies moderate the price-TOM relation for tenant-occupied homes, but not owner-occupied homes. In particular, the interaction of TOM and virtual tours is significantly negative, which suggests that the longer a tenant-occupied home with a virtual tour is on the market, the lower is the sales price. This indicates that even virtual tours cannot mitigate the negative pricing effects of tenant occupancy. For homes in the high-price segment, using virtual tours has a negative price relation with the sales prices of occupied homes (main effect).

[1] Based on interviews with residential agents when data was collected, professional photos with a video range from $150 to $350 and a virtual tour adds another $100 to $300. This is in addition to other marketing expenses occurred to an agent such as staging.

However, the longer an owner-occupied home in this price segment is on the market and promoted with a virtual tour (interaction effect), the higher the sales price.

Our study contributes to the literature in several ways. First, we add to the emerging literature on virtual marketing strategies in the context of residential real estate. Previous studies find that the use of virtual tours yields higher sales prices (Yu et al., 2020; Benefield, Sirmans & Sirmans, 2019; Allen et al., 2015); however, they fail to empirically investigate mechanisms by which these promotional strategies help agents achieve higher sales prices. Our study contributes to this literature by providing evidence that virtual tours, directly and indirectly, impact sales prices of difficult-to-show homes.

Secondly, we add to the larger literature on brokerage in residential real estate markets, particularly on marketing strategies employed by agents and their impact on outcomes (e.g., Clauretie & Daneshvary, 2008; Gwin, Ong & Gwin, 2002; Benjamin & Chinloy, 2000). Our findings suggest that employing promotional strategies that are more costly and require more effort is beneficial for agents tasked with promoting difficult-to-show houses. For these properties, using virtual tours yields higher sales prices, which in turn compensates agents for the higher marketing expenses and allows them to maximize their net commission. Last, we contribute to the price-TOM literature (e.g., Benefield, Sirmans & Sirmans, 2019; An et al., 2013; Cheng, Lin & Liu, 2008; Clauretie & Daneshvary, 2008) by providing evidence that virtual tours moderate this relation.

The remainder of this study is structured as follows. Next, we review relevant studies in the residential brokerage literature. Then, we discuss our data and estimation method. Finally, we present our results and a conclusion.

Literature Review

Promotional strategies such as virtual tours, MLS listings, and open houses allow agents to attract potential buyers to properties (pull strategy). This differs from a push strategy, in which agents use personal contacts with potential buyers and agents to increase the traffic to the property (Gwin, Ong & Gwin, 2002).[2] A few studies investigate (1) the impact of different promotional strategies on outcomes such as sales prices and TOM, and (2) the choice of agents between different marketing strategies.

One research stream includes studies investigating the impact of different promotional strategies on outcomes such as sales prices or TOM of single-family homes. These studies find that strategies such as the number of photos, agent remarks in MLS listings, and open houses impact sales prices (e.g., Allen et al., 2015; Benefield, Cain & Johnson, 2011; Haag, Rutherford & Thomson, 2000). Additionally, Zahirovic-Herbert, Waller and Turnbull (2020) show that the number of photos in a listing reduces the probability of a home selling above list price, while the number

[2] For a review of the pull and push strategy in the context of residential brokerage and a review of related studies, see Gwin, Ong and Gwin (2002).

of comments in an MLS listing increases it. Further, using an experiment, Luchtenberg, Seiler and Sun (2019) show that words and picture quality of a listing impact the likelihood with which a potential buyer is interested in touring the property. The authors find that the impact of positive words is greater than the impact of high-quality pictures.

A few studies focus on virtual tours as promotional strategies. For example, Benefield, Sirmans and Sirmans (2019) investigate virtual tours as a proxy for agent effort that adds value to sellers by increasing sales prices. Virtual tours, which were an innovation at the time of the study (2006/2007), allow agents to signal that they are cutting-edge regarding new technologies and position themselves in a competitive market by attracting more listings and generating more exposure for properties, transactions, and commissions. The authors find a positive effect of virtual tours on sales prices. Thus, agents can be compensated for the higher costs of using virtual promotional tools by achieving higher dollar commissions from higher transaction prices. The positive relation of virtual tours and sales price identified by Benefield, Sirmans and Sirmans (2019) is in line with the findings of Yu et al. (2020) and Allen et al. (2015). However, results are mixed for the impact of virtual tours on TOM, ranging from negative (Allen et al., 2015) to positive (Yu et al., 2020; Benefield, Sirmans & Sirmans, 2019).

A second research stream includes studies investigating the marketing strategies selected by agents. When helping a homeowner sell a property, agents have two basic strategies they can choose from. First, they can employ a pricing strategy in which they set the listing price below or at market value. Second, they can pursue an exposure strategy in which they set a listing price that exceeds the market value and then increase promotional tools and agent activity to attract more potential buyers to the property. Benjamin and Chinloy (2000) investigate these two strategies and show that agents concentrate their time on sellers with a pricing as opposed to exposure strategy. The advantage for agents is that the pricing strategy requires less marketing efforts and is associated with lower promotional costs to them. On the other hand, the exposure strategy requires agents to use more resources and time in the hope of a higher sales price, which ideally compensates them for the higher promotional costs. The findings of Benjamin and Chinloy (2000) suggest that agents prefer less costly marketing strategies. While promotional strategies to increase the exposure of a home have the potential to achieve a higher transaction price, they may not generate enough additional commission to make up for the higher marketing expenses and effectively reduce the net commission of agents, especially since an exposure strategy likely requires the involvement of a buyer agent.

Gwin, Ong and Gwin (2002) focus on the timing of promotions by agents and seller interests. They argue that agents are likely to prefer delaying costly promotional strategies in the hope that the property sells fast and with little marketing expenses. The preferences of sellers for the timing of promotions are likely to differ based on their holding and showing costs. Sellers with high holding costs, e.g., because they moved out already or put an offer on a new home, potentially with a contingency to secure financing, are more motivated to sell fast and aggressively market the property. Other sellers may have high showing costs, due to the time needed to prepare and be available for showings of the house they still occupy.

While the interests of sellers with high showing costs are more aligned with the agent, i.e., minimal but targeted promotion and spending less in the early periods of the listing contract, sellers with high holding costs are likely to prefer more promotion early on to sell the property fast. Clauretie and Daneshvary (2008) investigate agent strategies in the context of a nearing expiration of a listing contract. At this point in time, agents can either increase their marketing efforts (e.g., use more promotions) or convince the seller to lower the listing price to increase the probability of finding a buyer. The authors find a negative price effect as a listing contract approaches expiration, which suggests that the price-reduction strategy dominates the increased-marketing-effort strategy. Overall, the findings of these previous studies suggest that promotional efforts by agents are driven by their objective to maximize their net commission, i.e., use as little effort and expenses as possible to sell a property. Considering the findings of these previous studies (Clauretie & Daneshvary, 2008; Gwin, Ong & Gwin, 2002; Benjamin & Chinloy, 2000), agents are more likely to employ marketing strategies that require more costs and effort to promote properties that are more difficult to sell. One reason why a property can be difficult to sell is because it is difficult to show.

Previous studies have yielded mixed results for the relation of difficulty-to-show and sales prices of residential property. Gordon, Salter and Johnson (2002) focus on properties that are difficult to show, as proxied by the presence of pets, the need to retrieve a key, and the need to prearrange show times. They find no effect of these variables on sales prices and TOM. On the other hand, Zahirovic-Herbert, Waller and Turnbull (2020) find that the difficulty to show a property, proxied by notice to show, reduces the probability that the sales price exceeds the list price of a home.

We hypothesize that the impact of virtual tours on the sales prices of difficult-to-show homes has two components. The first is the main effect of virtual tours that stems from the ability of more potential buyers being able to tour a property remotely, which then increases the number of offers received and yields a higher sales price. The second is an interaction effect that varies with the time a home has been on the market and reflects the ability of virtual tours to attract more traffic, either local or out of market, over the life of a listing contract. We expect no effect of virtual tours on the sales prices of vacant homes, which are easy to show.

Data and Methodology

We obtain Multiple Listing Service (MLS) data for single-family home transactions from different cities in the Midwest, Southwest, and Pacific Northwest for the period of January to December 2019. We delete all observations without a sales price. We obtain the longitude and latitude for each transaction in our sample and eliminate all duplicate observations. These duplicates commonly have a different TOM or sales price for the same sale date or reflect repeat transactions within a short amount of time, which indicates professional flippers. Our resulting sample covers 34,359 transactions.

In our empirical analysis, we distinguish two types of virtual tours as they differ in technology used and production costs. First, virtual tours can be pre-recorded

videos or slideshows of photos. Second, virtual tours can involve creating self-guided 3D tours of homes that allow an interested buyer to walk through the property without having to be physically present. Hereby, a specialized 360-degree camera is used to capture every angle of a home's interior. The customer-facing software allows a prospective buyer to access the marketing material with virtual reality (VR) content with hardware such as goggles, a mobile phone, tablet, or a desktop/laptop computer. Compared to non-VR tours, VR tours allow potential buyers to interact with the property.

For each transaction in our sample, we review MLS information to assess whether a listing had a video tour or other form of non-VR virtual tour or a VR tour. We then derive a binary variable for each type of virtual tours, i.e., *NVR* for a non-VR virtual tour and *VR* for a virtual reality tour. We also control for the number of photos in a listing, which has been found to impact a home's sales price (e.g., Allen et al., 2015; Benefield, Cain & Johnson, 2011), by including the log of the number of photos (*logPics*). Please note, Zillow research suggests that 22–27 photos are the ideal number of photos for a single-family home listing.[3]

We use the days on market information from the MLS datasets to create our *TOM* variable. Previous empirical and theoretical studies on the price-TOM relation for residential properties have yielded mixed results, ranging from a positive relation (e.g., An et al., 2013; Cheng, Lin and Liu, 2008) to negative one (e.g., Benefield, Sirmans & Sirmans, 2019; Clauretie & Daneshvary, 2008). One explanation for these ambiguous findings is how TOM is calculated and the practice of agents to relist a property after a price cut as opposed to changing the price in an existing listing (Benefield & Hardin, 2015). One shortcoming of our dataset is that we do not have the information to calculate different TOM metrics, as suggested by Benefield and Hardin (2015). However, because we delete duplicate transactions based on longitude and latitude, we control for potential biases of TOM from property relistings in our dataset.

We employ an instrumental variable approach to account for the endogeneity of TOM and sales price, which follows the same principle as the two-stage least squares (2SLS) approach employed in previous housing studies (e.g., An et al., 2013; Hansz & Hayunga, 2012). Our instrumental variable approach allows us to create interactions to be included in our model. We regress *TOM* onto physical characteristics of a property using month-fixed effects and retain the fitted values as $\hat{TOM}$. Then we derive the respective interaction effects of *TOM* and our virtual tour variables (*NVR* and *VR*), $\hat{TOM}$*xNVR* and $\hat{TOM}$*xVR*.

We control for several variables that impact single-family home prices such as age (*Age*) and its quadratic term (*Agesq*), the log of the property's square footage (*logSF*), number of bedrooms (*Beds*) and bathrooms (*Baths*), log of the lot size (*loglot*), number of fireplaces (*Fireplaces*), and garages (*Garages*). To account for seasonality effects, we include binary variables for each month except January.

Previous studies have shown that the size of the brokerage firm involved in a transaction has an impact on price and TOM (e.g., Benefield, Sirmans & Sirmans,

[3] https://www.zillow.com/sellers-guide/real-estate-photography-tips/

Table 1 Descriptive statistics

	Mean	Median	St. Dev	Min	Max
logSP	12.69	12.66	0.57	8.01	15.95
logPics	3.16	3.33	0.75	0	4.60
NVR	0.45	0	0.50	0	1
VR	0.04	0	0.19	0	1
TÔM	36.20	25.87	12.88	−4.86	113.76
Age	35.37	25	29.18	0	173
logSF	7.56	7.57	0.41	5.98	9.80
Beds	3.40	3	0.83	1	9
Baths	2.62	3	0.96	1	11
loglot	−1.63	−1.66	0.73	−6.91	5.04
Fireplaces	0.69	1	0.70	0	9
Garages	1.87	2	0.93	0	14
LargeBroker	0.83	1	0.37	0	1

This table presents the descriptive statistics for a dataset of 34,359 single-family home transactions from the Midwest, Northwest, and Southwest for 2019. logSP is the log of sales price. logPics is the log of the number of pictures in the listing for a transaction while NVR and VR are binary variables coded 1 if the listing contained a virtual tour or virtual reality feature respectively. TÔM is the fitted value of the regression of time on market (TOM) on home characteristics. Age is the age of home at the time of sale. logSF is the log of the square footage of a home. Beds and Baths are the number of bedrooms and bathrooms respectively in a home. Loglot is the log of the lot size (in acres). Fireplaces and garages are the number of fireplaces and garage spaces for a transaction. LargeBroker is coded 1 if the brokerage firm had above average transactions in 2019

2019; Turnbull & Waller, 2018). Benefield, Sirmans and Sirmans (2019) find that agent size matters for using virtual tours as promotional strategy and its impact on TOM and price. Consequently, we create a variable *LargeBroker*, which is coded 1 if the brokerage firm associated with a transaction in the MLS dataset had more than the average amount of transactions based on all firms in our sample.

Last, previous studies emphasize the importance of distinguishing price segments in empirical investigations into housing markets (e.g., Seo, Holmes & Lee, 2021; Clauretie & Daneshvary, 2008). Following Benefield, Sirmans and Sirmans (2019) and Clauretie and Daneshvary (2008), we separate our sample into high and low-price sub-samples based the median price in the respective geographical market a property sold in.

Our descriptive statistics are presented in Table 1. Overall, 45.19% of transactions had a non-VR virtual tour (*NVR*) and 3.88% had a VR tour (*VR*). However, the frequency of virtual tours varies by price segment. Irrespective of type of virtual tour, the mean share of transactions with virtual tours is significantly higher (at the 1% level, unequal variances assumed) for homes in the high-price segment than the low-price segment. This is in line with Benefield, Sirmans and Sirmans

(2019), who show that the use of virtual tours is more common for properties in the high-price segment. In particular, 48.05% of high-price transactions had a non-VR virtual tour and 4.77% had a VR tour compared to 42.34% (*NVR*) and 2.99% (*VR*) for low-price transactions. Across markets, the share of homes sold with non-VR tours ranges from 3.03% (Midwest) to 12.47% (Pacific Northwest) to 90.32% (Southwest) and with VR tours from 2.02% (Southwest) to 2.78% (Midwest) to 6.35% (Pacific Northwest).

Our dataset has multiple sources of random variability that impact the independence of observations. These spatial effects can exist at different levels (hierarchies) such as the overall market, city within the market, and zip-code. Multilevel modelling allows to control for spatial correlation and heterogeneity (Djurdjevic, Eugster & Haase, 2008). To account for these effects, we use a multilevel mixed-effects generalized linear regression, which has fixed and random effects. Fixed effects are estimated directly, i.e., are represented by coefficients on independent variables, while random effects are reflected by variances for the different levels (market, city, and zip-code). Mixed-effects models have been employed in previous studies investigating real estate markets (e.g., DeFranco et al., 2022; Chasco & Le Gallo, 2013; Riley, 2012; Shin, Saginor & Van Zandt, 2011; Djurdjevic, Eugster & Haase, 2008; Isakson, 2004).

We use random effects at market, city, and zip-code level to estimate our model shown in Eq. 1. Standard errors are clustered at market level.

$$logSP_i = \alpha + X_i\beta + Z_i u_i + \varepsilon_i \tag{1}$$

Where *logSP* is the sales price of a single-family home. X is a matrix of our independent variables of interest (*NVR, VR*, $T\hat{O}M$, and the respective interaction effects) and control variables for property i. Z is a matrix for the random effects u for the three groups (market, city, and zip code) while ε_i represents the residuals.

Results

Table 2 presents the results for our baseline model without the interaction effects of $T\hat{O}M$ and the virtual tour variables. While the use of a non-VR tour (*NVR*) has no relation with sales prices, the coefficient on *VR* is significantly positive for the full sample. This suggests that the use of a VR-virtual tour yields a premium to sales prices. This is in line with previous studies that find virtual tours to positively impact sales prices of single-family homes (Yu et al., 2020; Benefield, Sirmans & Sirmans, 2019; Allen et al., 2015). Furthermore, the more photos a listing has, the higher is the sales price, which is in line with previous studies (Allen et al., 2015; Benefield, Cain & Johnson, 2011).

However, if we separate the sample by price segment, it becomes apparent that the results for *logPics* for the full sample are driven by homes in the low-price segment while the results for *VR* are driven by the high-price segment. These results are in line with the expectation that agents select promotional strategies that allow them to maximize their net commission. Compared to more expensive homes, more

Table 2 Multilevel mixed-effects results – baseline model

	Full sample		Low price		High price	
	Coef.	SE	Coef.	SE	Coef.	SE
logPics	**0.04*** **	**0.02**	**0.07*** **	**0.02**	0.01	0.01
NVR	−0.02	0.02	−0.02	0.01	−0.01	0.03
VR	**0.03*** **	**0.004**	0.01	0.01	**0.03*** **	**0.01**
TÔM	**−0.002*** **	**0.001**	**−0.002** **	**0.001**	**−0.001*** **	**0.0004**
Age	**−0.01*** **	**0.001**	−0.001	0.001	**−0.01*** **	**0.001**
Agesq	**0.00003*** **	**0.00001**	0.00	0.00	**0.0001*** **	**0.00001**
logSF	**0.46*** **	**0.04**	**0.32*** **	**0.05**	**0.49*** **	**0.02**
Beds	−0.01	0.01	**0.01*** **	**0.003**	−0.03	0.02
Baths	**0.07*** **	**0.01**	0.03	0.02	**0.07*** **	**0.02**
loglot	**0.15*** **	**0.04**	**0.05***	**0.03**	**0.15*** **	**0.05**
Fireplaces	**0.04*** **	**0.01**	0.0002	0.01	**0.05*** **	**0.01**
Garages	**0.05*** **	**0.01**	**0.05*** **	**0.01**	**0.04*** **	**0.01**
LargeBroker	**0.01***	0.007	0.01	0.01	0.01	0.004
Fixed Effects	Month					
Random Effects	Market, City and Zipcode					
Number of obs	34,359		17,187		17,172	
No of Groups (Avg. Obs per Group)						
Market	3 (11,453.0)		3 (5729.0)		3 (5724.0)	
City	194 (177.1)		178 (96.6)		111 (154.7)	
Zipcode	386 (89.0)		337 (51.0)		272 (63.1)	
Estimate (Robust SE)						
Market var.(cons)	0.38 (0.18)		0.28 (0.14)		0.22 (0.11)	
City var.(cons)	0.27 (0.01)		0.29 (0.01)		0.02 (0.01)	
Zipcode var.(cons)	0.02 (0.01)		0.01 (0.01)		0.02 (0.01)	
var(Residual)	0.03 (0.01)		0.03 (0.01)		0.02 (0.001)	

This table presents the results of a multilevel mixed-effects linear regression for a sample of 34,359 single-family transactions in the Midwest, Northwest, and Southwest in 2019. Variable definitions are in Table 1. *Low (high) price transactions have sales prices below (above) the median sales price in their respective market. Market-clustered standard errors are used*

*'***', '**' and '*' denote significance at the 1%, 5% and 10% level respectively*

costly promotional strategies for homes in the low-price segment are less likely to allow agents to recover the additional expenses. The coefficient on *TÔM* across all price segments suggests a negative price-TOM relationship in line with Benefield, Sirmans and Sirmans (2019) and Clauretie and Daneshvary (2008). The coefficients on control variables are in line with expectations.

Next, we estimate our model in Eq. 1 with the interaction effects of *TÔM* and *NVR* and *VR* respectively (*TOMˆxNVR* and *TOMˆxVR*) and report our results separated by price segment in Table 3. For the low-price segment, the coefficient on *VR* is significantly positive while the coefficient on *TOMˆxVR* is significantly negative. This suggests a sales price premium of 7.25% for homes promoted with

Table 3 Multilevel mixed-effects results – model with interaction effects

	Low price		High price	
	Coef.	SE	Coef.	SE
logPics	**0.07*** **	**0.02**	0.01	0.01
VT	0.002	0.01	**−0.10** **	**0.04**
VR	**0.07** **	**0.03**	**−0.12***	**0.07**
TÔM	−0.03	0.002	**−0.004*** **	**0.001**
TOMˆxNVR	−0.001	0.001	**0.002** **	**0.001**
TOMˆxVR	**−0.002** **	**0.001**	**0.003*** **	**0.001**
Age	−0.002	0.001	**−0.01*** **	**0.001**
Agesq	0.00	0.00001	**0.0001*** **	**0.00001**
logSF	**0.34*** **	**0.06**	**0.52*** **	**0.02**
Beds	**0.01** **	**0.004**	**−0.03***	**0.02**
Baths	0.04	0.03	**0.07*** **	**0.01**
loglot	**0.05***	**0.03**	**0.15*** **	**0.05**
Fireplaces	−0.003	0.01	**0.05*** **	**0.01**
Garages	**0.05*** **	**0.01**	**0.04*** **	**0.01**
LargeBroker	0.01	0.01	**0.01***	**0.004**
Fixed Effects	Month			
Random Effects	Market, City and Zipcode			
Number of obs	17,187		17,172	
No of Groups (Avg. Obs per Group)				
Market	3 (5729.0)		3 (5724)	
City	178 (96.6)		111 (154.7)	
Zipcode	337 (51.0)		272 (63.1)	
Estimate (Robust SE)				
Market var.(cons)	0.28 (0.14)		0.22 (0.11)	
City var.(cons)	0.29 (0.01)		0.02 (0.01)	
Zipcode var.(cons)	0.01 (0.005)		0.02 (0.01)	
var(Residual)	0.03 (0.01)		0.02 (0.001)	

This table presents the results of a multilevel mixed-effects linear regression for a sample of 34,359 single-family transactions in the Midwest, Northwest, and Southwest in 2019. Variable definitions are in Table 1. *Low (high) price transactions have sales prices below (above) the median sales price in their respective market. TOMˆxNVR and TOMˆxVR are the interaction effects of the respective variables. Market-clustered standard errors are used*

*'***', '**' and '*' denote significance at the 1%, 5% and 10% level respectively*

VR-virtual tours but a discount of 0.2% for each additional day a home is on the market. To illustrate our results: For a low-price home that has been on the market for 10 days, the overall pricing effect of using a VR-virtual tour is a premium of 5.3% while for a home with a TOM of 60 days, the overall effect is a discount of 4.8%. Thus, the use of VR tours is beneficial in the early days of a listing for

homes in this price segment, but VR tours as a promotional tool lose their effectiveness the longer a property is on the market.

One explanation for our findings is that while the use of VR tours can help attract more traffic to a difficult-to-show home, which is captured by the positive coefficient on *VR*, they fail to mitigate the negative effects of a longer TOM on sales prices due to certain types of occupiers such as tenants, as captured by the negative coefficient on $TO\hat{M}xVR$. We further investigate this explanation in the remainder of the study. The insignificant coefficient on $T\hat{O}M$ suggests that the interaction effect captures the negative price-TOM relation. The positive relation of number of photos and sales prices for homes in the low-price segment is in line with Table 2.

For the high-price segment, the coefficients on *NVR* and *VR* are significantly negative while the coefficients on the interaction effects ($TO\hat{M}xNVR$ and $TO\hat{M}xVR$) are significantly positive. This suggests a sales price discount for homes being promoted using any type of virtual tour, but a premium for any additional day such a home is on the market. For illustration purposes, for a home in this price segment that has been on the market for 10 days, the overall pricing effect of using a VR-virtual tour is a discount of 9.8% while for a home with a TOM of 60 days, the overall effect is a premium of 5.3%. If a non-VR virtual tour is used the overall effect for 10 days is a discount of 8.5% and for 60 days is a premium of 1.5%.

One explanation for the negative relation of the main effects (*VR* and *NVR*) with sales price is that agents are more likely to use these promotional strategies for homes in the high-price segment that require more time to find a buyer as the pool of potential buyers is relatively small. Thus, the use of a virtual tour signals the difficulty to sell a property in this price segment. However, the longer these homes are on the market and if they are promoted using virtual tours, the higher is the chance to find suitable buyers, for example, from outside the respective geographical market, and receive offers. This explains the positive coefficients on the interaction effects ($TO\hat{M}xNVR$ and $TO\hat{M}xVR$). The number of pictures (*logPics*) in a listing has no effect on sales prices. One explanation for this finding is that for higher priced homes, the number of photos used in a listing is relatively standardized among agents.

Overall, our results in Table 3 suggest that the use of virtual tours by agents moderates the price-TOM relation. However, the pricing effects of virtual tours differ across price segments and emphasizes the importance of distinguishing home price segments in empirical investigations. Our results provide evidence that the effect of virtual tours on sales prices identified in previous studies (Yu et al., 2020; Benefield, Sirmans & Sirmans, 2019; Allen et al., 2015) has different components – one is fixed (main effect) and the other varies with TOM (interaction effect).

We hypothesize that agents use promotional strategies that require more effort and are more costly, such as virtual tours, for single-family homes that are difficult-to-show. As a result, we separate our sample into properties that were vacant and occupied, either by owners or tenants, at the point of sale. Please note, information on the occupancy of a property is not available for all transactions in our dataset, which reduces our sample size. We then estimate our model in Eq. 1 and report the results in Table 4.

Table 4 Multilevel mixed-effects results – separated by price and occupancy

	Low price				High price			
	Occupied		Vacant		Occupied		Vacant	
	Coef.	**SE**	**Coef.**	**SE**	**Coef.**	**SE**	**Coef.**	**SE**
logPics	**0.06*****	**0.02**	**0.08****	**0.03**	0.01	0.01	0.01	0.01
VT	−0.01	0.01	0.01	0.03	**−0.11*****	**0.03**	−0.08	0.06
VR	**0.06*****	**0.02**	0.05	0.04	−0.10	0.07	−0.15	0.09
$T\hat{O}M$	−0.002	0.002	**−0.01*****	**0.002**	**−0.01*****	**0.001**	0.003	0.002
$TOM\hat{x}NVR$	−0.001	0.001	−0.001	0.001	**0.002*****	**0.001**	0.001	0.002
$TOM\hat{x}VR$	**−0.002****	**0.001**	−0.002	0.001	**0.003****	**0.001**	**0.004*****	**0.002**
Age	−0.001	0.001	−0.002	0.002	**−0.01*****	**0.001**	**−0.01*****	**0.002**
Agesq	0.00	0.00	0.00	0.00	**0.0001*****	**<0.0001**	**0.0001*****	**0.00002**
logSF	**0.33*****	**0.05**	**0.39*****	**0.05**	**0.56*****	**0.02**	**0.37*****	**0.04**
Beds	**0.01*****	**0.03**	0.004	0.01	−0.03	0.02	**−0.02***	**0.01**
Baths	0.03	0.02	**0.05***	**0.03**	**0.08*****	**0.02**	**0.04*****	**0.01**
loglot	0.05	0.03	**0.06****	**0.03**	**0.14*****	**0.04**	**0.17*****	**0.05**
Fireplaces	0.001	0.01	−0.01	0.01	**0.05*****	**0.01**	**0.05*****	**0.01**
Garages	**0.05*****	**0.01**	**0.04*****	**0.01**	**0.04*****	**0.01**	**0.04*****	**0.01**
LargeBroker	0.001	0.003	0.02	0.01	0.003	0.002	**0.01***	**0.005**
Fixed Effects	Month							
Random Effects	Market, City and Zipcode							
Number of obs	8570		8616		10,784		6388	
No of Groups (Avg. Obs per Group)								
Market	3 (2856.7)		3 (2872.0)		3 (3594.7)		3 (2129.3)	
City	142 (60.4)		137 (62.9)		104 (103.7)		63 (101.4)	
Zipcode	283 (30.3)		279 (30.9)		255 (42.3)		199 (32.1)	
Estimate (Robust SE)								
Market var. (cons)	0.24 (0.13)		0.31 (0.15)		0.22 (0.11)		0.21 (0.11)	
City var. (cons)	0.08 (0.01)		0.37 (0.02)		0.02 (0.01)		0.02 (0.01)	
Zipcode var. (cons)	0.01 (0.005)		0.01 (0.006)		0.02 (0.01)		0.02 (0.01)	
var(Residual)	0.02 (0.01)		0.03 (0.02)		0.02 (0.001)		0.02 (0.002)	

This table presents the results of a multilevel mixed-effects linear regression for a sample of 34,359 single-family transactions in the Midwest, Northwest, and Southwest in 2019, separated by whether the property was occupied or vacant at the time of sale. Variable definitions are in Table 1. *Low (high) price transactions have sales prices below (above) the median sales price in their respective market. $TOM\hat{x}NVR$ and $TOM\hat{x}VR$ are the interaction effects of the respective variables. Market-clustered standard errors are used*

*'***', '** and '* denote significance at the 1%, 5% and 10% level respectively*

Our results support the hypothesis that the impact of virtual tours on sales prices differs between difficult-to-show properties, as proxied by an occupier at the time of sale, and vacant properties. For vacant homes in the low and high-price category,

the use of virtual strategies has no impact on sales prices. The exception is $\hat{TOM}xVR$ for high-price vacant homes, which is significantly positive. Considering that the coefficient on $\hat{TOM}$ for vacant high-price homes is positive but insignificant, one explanation for this finding is that the interaction effect ($\hat{TOM}xVR$) captures the positive price-TOM relation for these types of homes. Being in the high-price segment implies a smaller pool of potential buyers, and a longer marketing time in combination with a VR tour is likely to help the seller attract more offers and achieve a higher sales price in line with the argument of previous studies finding a positive price-TOM relation (An et al., 2013; Cheng, Lin & Liu, 2008). On the other hand, the results for occupied homes in either price segment are in line with Table 3. Please note, the negative coefficient on *VR* for the high-price segment is significant at the 10% level in Table 3 but is insignificant in Table 4.

Overall, our results in Table 4 suggest that the direct and indirect effects of virtual tours on sales prices primarily exist for difficult-to-show homes due to occupancy. This is in line with our hypothesis that agents employ more costly and higher effort promotional strategies such as virtual tours to add value for sellers of these types of homes. For these properties, the use of virtual tours allows increasing the number of potential buyers touring the property, without having to set up multiple appointments with current occupants. The larger number of individuals being able to tour the property remotely in turn increases the probability of receiving more offers and achieving a higher sales price, which then leads to a higher dollar commission and justifies the higher promotional costs of virtual tours for agents.

Last, we investigate whether our results vary by type of occupants. Single-family homes can either be occupied by the owner or tenants.[4] While an owner-occupier merely affects the difficulty to show a property (e.g., due to scheduling and availability reasons), tenants also impact the appeal of a property to buyers. Compared to owner-occupied homes, single-family homes purchased by investors and rented out to tenants commonly have a lower quality (Allen et al., 2018). Furthermore, the pool of potential homebuyers interested in having tenants is smaller. Tenants also require more effort from agents regarding scheduling and preparing the property for viewing. Last, uncooperative tenants may refuse to tidy up or leave the property for a showing to potential buyers, which negatively impacts the ability to show a property. To assess the impact of different types of occupiers on our results, we separate our sample in homes occupied by owners and tenants and present our results in Table 5.

The results for homes in the low-price segment suggest that our findings in Table 4 are driven by tenant occupancy. For owner-occupied homes, only the coefficient on *VR* is significant. Thus, owner-occupied homes in the low-price segment marketed with VR tours yield a sales price premium of 5.13%. This suggests that VR tours can help agents overcome the difficulty to show a home. Our result for owner-occupied homes in the low-price segment is in line with results of previous

[4] Please note, the MLS dataset does not provide any information on whether a property has an accessory dwelling unit (ADU), which can be rented out. We can only distinguish whether the single-family home itself is owner- or tenant-occupied.

Table 5 Multilevel mixed-effects results – separated by price and occupant type

	Low price				High price			
	Owner occupied		Tenant occupied		Owner occupied		Tenant occupied	
	Coef.	**SE**	**Coef.**	**SE**	**Coef.**	**SE**	**Coef.**	**SE**
logPics	**0.05*** **	**0.01**	**0.06*** **	**0.02**	0.004	0.01	0.02	0.02
VT	−0.01	0.01	0.03	0.04	**−0.12*** **	**0.03**	**−0.04*** **	**0.01**
VR	**0.05** **	**0.02**	**0.26*** **	**0.03**	**−0.12***	**0.06**	0.01	0.09
TÔM	−0.003	0.002	**0.01*** **	**0.001**	**−0.01*** **	**0.001**	**−0.02*** **	**0.001**
TOM̂xNVR	−0.0001	0.001	**−0.003***	**0.002**	**0.003*** **	**0.001**	**0.001***	**0.0006**
TOM̂xVR	−0.001	0.001	**−0.01*** **	**0.001**	**0.003*** **	**0.001**	−0.001	0.003
Age	−0.001	0.001	**−0.003***	**0.001**	**−0.01*** **	**0.001**	**−0.01*** **	**0.001**
Agesq	0.00	0.00	0.00	0.00001	**0.0001*** **	**<0.0001**	**0.0001*** **	**0.00001**
logSF	**0.32*** **	**0.06**	**0.19*** **	**0.03**	**0.56*** **	**0.01**	**0.66*** **	**0.05**
Beds	**0.01***	**0.01**	**0.01** **	**0.003**	−0.03	0.02	**−0.06*** **	**0.02**
Baths	0.03	0.02	**−0.05*** **	0.02	**0.08*** **	**0.02**	**0.12*** **	**0.01**
loglot	0.04	0.03	**0.08*** **	**0.03**	**0.14*** **	**0.04**	**0.12** **	**0.05**
Fireplaces	0.001	0.01	0.02	0.02	**0.05*** **	**0.01**	0.03	0.03
Garages	**0.05*** **	**0.01**	**0.06*** **	**0.003**	**0.04*** **	**0.01**	**0.05** **	**0.02**
LargeBroker	0.002	0.003	0.01	0.02	−0.001	0.001	0.02	0.01
Fixed Effects	Month							
Random Effects	Market, City and Zipcode							
Number of obs	7660		782		10,353		259	
No of Groups (Avg. Obs per Group)								
Market	3 (2553.3)		3 (260.7)		3 (3451.0)		3 (86.3)	
City	140 (54.7)		32 (24.4)		103 (100.5)		15 (17.3)	
Zipcode	281 (27.3)		135 (5.8)		253 (40.9)		83 (3.1)	
Estimate (Robust SE)								
Market var. (cons)	0.23 (0.12)		0.27 (0.14)		0.22 (0.11)		0.17 (0.10)	
City var. (cons)	0.08 (0.01)		0.14 (0.01)		0.01 (0.01)		0.01 (0.01)	
Zipcode var. (cons)	0.01 (0.004)		0.02 (0.01)		0.02 (0.01)		0.01 (0.01)	
var(Residual)	0.02 (0.01)		0.02 (0.01)		0.02 (0.001)		0.02 (0.005)	

This table presents the results of a multilevel mixed-effects linear regression for a sample of 34,359 single-family transactions in the Midwest, Northwest, and Southwest in 2019, separated by whether the property was owner or tenant-occupied the time of sale. Variable definitions are in Table 1. *Low (high) price transactions have sales prices below (above) the median sales price in their respective market. TOM̂xNVRand TOM̂xVRare the interaction effects of the respective variables. Market-clustered standard errors are used*

*'***', '**' and '*' denote significance at the 1%, 5% and 10% level respectively*

studies investing the impact of virtual tours on sales prices (Yu et al., 2020; Benefield, Sirmans & Sirmans, 2019; Allen et al., 2015).

However, for tenant-occupied homes in the low-price segment, the effect of virtual tours on sales prices is in line with Table 4. In addition to the significant results

for the main and interaction effect of *VR*, the coefficient on the interaction effect for non-VR virtual tours ($TOM\hat{x}NVR$) is significantly negative, albeit only at the 10% level. Our results suggest that while virtual tours can help overcome the challenges of difficult-to-show homes (*VR*) in the low-price segment, they are not effective in fully alleviating the negative pricing effects of tenants the longer a home is on the market ($TOM\hat{x}NVR$ and $TOM\hat{x}VR$).

Our results in Table 5 suggest that the findings for high-price homes in Tables 3 and 4 are driven by owner-occupied homes. Compared to high-price properties that are not marketed with a virtual tour, the use of any type of virtual tour increases sales prices, the longer owner-occupied homes are on the market. For tenant-occupied homes in the high-price segment, only non-VR virtual tours have an impact on sales prices. Please note that tenants are less common in the high-price segment, and our tenant-occupied sample size is relatively small (259). For this sub-sample, the main effect (*NVR*) has a significantly negative relation with sales price, while the interaction effect ($TOM\hat{x}NVR$) has a positive relation, albeit only significant at the 10% level. One explanation for the fact that only non-VR (*NVR*) tours have an impact on sales prices for tenant-occupied homes in this segment is that agents know of the limited appeal of investment properties to high-price buyers and the resulting limited potential to achieve a higher sales price using virtual promotional strategies. As a result, this reduced price-potential compared to owner-occupied homes leads agents to use the cheaper virtual tour alternative to maximize their net commission.

Conclusion

Virtual tours represent tools for agents to promote homes, increase the traffic to a property, and attract more potential buyers. However, virtual tours require more effort and have higher costs than other promotional strategies such as photos and MLS comments. We hypothesize that agents focused on maximizing their net commissions are more likely to choose virtual tours for difficult-to-show properties, due to owner- or tenant occupancy, as they allow them to increase sales prices.

We use 34,359 single-family transactions from three geographical US markets and a multilevel mixed-effects regression to empirically investigate the impact of virtual tours on sales prices. Hereby, we distinguish the direct effect of using virtual tours on sales prices from an interaction effect of virtual tours with TOM. In line with our expectations, we find that virtual tours impact sales prices directly and through an interaction with TOM for difficult-to-show homes due to occupancy. However, the impact of virtual tours on sales prices differs by price segment and occupant type.

For homes in the low-price segment, the use of virtual tours allows agents to achieve a premium for occupied homes but is less effective in overcoming the negative pricing effects of a longer TOM of homes occupied by tenants. For occupied homes in the high-price segment, the use of virtual tours has a negative relation with sales prices. However, the longer an owner-occupied home with a virtual tour in this price segment is on the market, the higher is the sales price. Overall, our results

suggest that virtual tours are effective strategies to overcome the difficulty to show homes and moderate the price-TOM relation.

Our findings have practical implications for residential agents in that they suggest virtual tours to be effective promotional tools for difficult-to-show properties that allow agents to increase sales prices and hence their commissions. Agents can use our findings to optimize their pricing and promotional strategies.

We consider our findings a starting point for further investigations into virtual marketing strategies in the context of residential real estate markets. Future studies can investigate how the use and pricing effects of virtual tours have changed during and after the COVID-19 pandemic compared to the pre-COVID period investigated in this study. Additional investigations can also focus on virtual tours in the context of different housing market phases. Li and Yavas (2015) show that the value agents add for sellers varies across cold and hot markets. Complementing this earlier and our study, future studies may investigate the impact of virtual and other marketing strategies on the price-TOM relationship in hot and cold housing markets.

A limitation of our study is that our MLS data does not provide insights into when virtual tours became available for listings. Future studies with appropriate datasets may investigate whether virtual tours are used at different phases of a listing contract, and how this impacts the price-TOM relation. Future studies could also focus on other aspects of difficult-to-sell homes. While we focus on the difficult-to-show aspect, these studies may investigate the impact of virtual marketing tools on the price-TOM relation in the context of other home characteristics that make properties difficult to sell.

References

Allen, M.T., Cadena, A., Rutherford, J., & Rutherford, R.C. (2015). Effects of real estate brokers' marketing strategies: Public open houses, broker open houses, MLS virtual tours, and MLS photographs. *Journal of Real Estate Research*, 37(3), 343–369. https://doi.org/10.1080/10835547.2015.12091422

Allen, M.T., Rutherford, J., Rutherford, R., & Yavas, A. (2018). Impact of investors in the distressed housing markets. *Journal of Real Estate Finance and Economics*, 56:622–652. https://doi.org/10.1007/s11146-017-9609-0

An, Z., Cheng, P., Lin, Z., & Liu, Y. (2013). How do market conditions impact price-TOM relationship? Evidence from real estate owned (REO) sales. *Journal of Housing Economics*, 22:250–263. https://doi.org/10.1016/j.jhe.2013.07.003

Benefield, J.D., & Hardin, W.G. (2015). Does time-on-market measurement matter? *Journal of Real Estate Finance and Economics*, 50:52–73. https://doi.org/10.1007/s11146-013-9450-z

Benefield, J.D., Cain, C.L., & Johnson, K.H. (2011). On the relationship between property price, time-on-market, and photo depictions in a multiple listing service. *Journal of Real Estate Finance and Economics*, 43:401–422. https://doi.org/10.1007/s11146-009-9219-6

Benefield, J.D., Sirmans, C.S., & Sirmans, G.S. (2019). Observable agent effort and limits to innovation in residential real estate. *Journal of Real Estate Research*, 41(1), 1–36. https://doi.org/10.1080/10835547.2019.12091517

Benjamin, J.D., & Chinloy, P.T. (2000). Pricing, exposure and residential listing strategies. *Journal of Real Estate Research*, 20(1/2), 61–74. https://doi.org/10.1080/10835547.2000.12091026

Chasco, C., & Le Gallo, J. (2013). The impact of objective and subjective measures of air quality and noise on house prices: A multilevel approach for downtown Madrid. *Economic Geography*, 89(2), 127–148. https://doi.org/10.1111/j.1944-8287.2012.01172.x

Cheng, P., Lin, Z., & Liu, Y. (2008). A model of time-on-market and real estate price under sequential search with recall. *Real Estate Economics*, 36(4), 813–843. https://doi.org/10.1111/j.1540-6229.2008.00231.x

Clauretie, T.M., & Daneshvary, N. (2008). Principal-agent conflict and broker effort near listing contract expiration: The case of residential properties. *Journal of Real Estate Finance and Economics*, 37:147–161. https://doi.org/10.1007/S11146-007-9045-7

DeFranco, A., Koh, Y., Prem, P., & Love, Benjamin (2022). Inclusion of condominium units in luxury hotels as a diversification strategy: Property performance perspective. *Cornell Hospitality Quarterly*, 63(1), 108–118. https://doi.org/10.1177/19389655211050398

Djurdjevic, D., Eugster, C., & Haase, R. (2008). Estimation of hedonic models using a multilevel approach: An application for the Swiss Rental Market. *Swiss Journal of Economics and Statistics*, 144:679–701. https://doi.org/10.1007/BF03399271

Gordon, B., Salter, S.P., & Johnson, K.H. (2002). Difficult to show properties and utility maximizing brokers. *Journal of Real Estate Research*, 23(1/2), 111–127. https://doi.org/10.1080/10835547.2002.12091071

Gwin, C.R., Ong, S.-E., & Gwin, C.F. (2002). Seller versus broker: Timing of promotion. *Journal of Real Estate Research*, 24(1), 27–45. https://doi.org/10.1080/10835547.2002.12091085

Haag, J., Rutherford, R., & Thomson, T. (2000). Real estate agent remarks: Help or hype? *Journal of Real Estate Research*, 20(1/2), 205–216. https://doi.org/10.1080/10835547.2000.12091024

Hansz, J.A., & Hayunga, D.K. (2012). Club good influence on residential transaction prices. *Journal of Real Estate Research*, 34(4), 549–576. https://doi.org/10.1080/10835547.2012.12091343

Isakson, H. (2004). Analysis of the effects of large lot zoning. *Journal of Real Estate Research*, 26(4), 397–416. https://doi.org/10.1080/10835547.2004.12091144

Li, Y., & Yavas, A. (2015). Residential brokerage in hot and cold markets. *Journal of Real Estate Finance and Economics*, 51:1–21. https://doi.org/10.1007/s11146-014-9472-1

Luchtenberg, K.F., Seiler, M.J., & Sun, H. (2019). Listing agent signals: Does a picture paint a thousand words? *Journal of Real Estate Finance and Economics*, 59:617–648. https://doi.org/10.1007/s11146-018-9674-z

Riley, S.F. (2012). Land use regulations and the returns to low-income homeownership. *Annals of Regional Science*, 49:745–766. https://doi.org/10.1007/s00168-011-0450-8

Seo, Y., Holmes, C., & Lee, S.H. (2021). Examining the cash-only price discount and the driving forces of cash-only transactions in the housing market. *Journal of Real Estate Finance and Economics*, forthcoming. https://doi.org/10.1007/s11146-020-09807-z

Shin, W.-J., Saginor, J., & Van Zandt, S. (2011). Evaluating subdivision characteristics on single-family housing value using hierarchical linear modeling. *Journal of Real Estate Research*, 33(3), 317–348. https://doi.org/10.1080/10835547.2011.12091310

Turnbull, G.K., & Waller, B.D. (2018). (What) do top performing real estate agents deliver for their clients? *Journal of Housing Economics*, 41:142–152. https://doi.org/10.1016/j.jhe.2018.06.005

Yu, W., Ma, Z., Pant, G., & Hu, J. (2020). The effect of virtual tours on house price and time on market. *Journal of Real Estate Literature*, 28(2), 133–149. https://doi.org/10.1080/09277544.2021.1876433

Zahirovic-Herbert, V., Waller, B.D., & Turnbull, G.K. (2020). Properties that sell at or above listing price: Strategic pricing, better broker or just dumb luck? *Journal of Real Estate Finance and Economics*, 60:53–76. https://doi.org/10.1007/s11146-019-09714-y