Soler, I. P., & Gemar, G. (2018). Hedonic price models with geographically weighted regression: An application to hospitality. *Journal of Destination Marketing & Management*, *9*, 126-137.

Hedonic price models with geographically weighted regression: An application to hospitality

Abstract

The objective of this study was to propose and test a methodology that allow destination managers and hoteliers improve the allocation of resources. For this purpose, this paper analysed the impact of both establishment (e.g. category, size and location) and assessment variables of services included in hotel room prices – using hedonic price regression and geographically weighted regression (GWR). The data were collected in the low season using TripAdvisor and Google Maps for 57 hotels located in Malaga. Analyses showed that spatial correlation creates different patterns of quality-value perceptions within the same city, which is an advance in the knowledge about the hotel location decision–making processes and their implications on destination marketing. These competitive subsystems cannot be detected with the use of ordinary least squares alone. Although the values extracted using a hedonic price model are consistent with the previous literature, the presence of geographic variability in the estimated hedonic model coefficients might be misleading for some hotels. The fitting coefficient of the GWR confirms the need to incorporate GWR into hedonic price models.

Keywords: hedonic price model, geographically weighted regression, hospitality, hotel, tourism

1. Introduction

Location is a key strategic factor for hotels (Yang, Wong & Wang, 2012). Zhang, Zhang, Lu, Cheng and Zhang (2011, p. 1040) write, 'Location is the only generally proved and accepted attribute of lodging products'. In essence, this is the first building block of hotels, based on which they can set up their operations. After selecting their location, hotels appropriate part of the economic rent of their tourism resources already in place. In a related study, Li, Huang and Goh (2015) found that commercial land type and the number of attractions around hotels are significantly related with upmarket hotels in Hong Kong. Hotels and their environments, therefore, have a symbiotic relationship. According to Shoval, McKercher and Birenboim (2011), hotels'

locations have a significant impact on subsequent movements, attracting tourists to less important tourist nodes within the hotels' area of influence.

When establishing hotels, managers also need to consider two other strategic decisions that will be difficult to alter in the future: the hotels' category and size (Urtasun & Gutiérrez, 2006). Other variables can be changed, and, therefore, they constitute a part of hotels' business models. These variables represent the quantity and quality of services provided, which can be altered over the life of a hotel by changing the allocation of resources that the hotel invests in these services or by implementing service or process innovations. These can improve the perceived value of the services provided or reduce the cost of providing these services.

To determine which services are worth developing, hotel managers can analyse each services' impact on overall customer satisfaction using, for example, importance-performance (Martilla & James, 1977) or asymmetric impact-performance analysis (Caber, Albayrak, & Loiacono, 2013). However, for both techniques, surveys must be conducted, and these methods' relationship to profitability is blurred. Another option is to focus on customers' willingness to pay for the facilities and services, which allows hotel managers to compare the implicit prices of each of their hotel's facilities and attributes with their associated cost. Managers can then decide which attributes are worth incorporating, maintaining or becoming the focus of innovation processes. This can be done with hedonic pricing models, whose main strength, according to Fleischer (2012), is that they are based on actual market data. In this way, practitioners can estimate from the available data the implicit prices of characteristics that increase consumer satisfaction (Rigall-I-Torrent et al., 2011).

Because hedonic price models do not need surveys but do provide access to implicit prices – both for the attributes of services and variables of establishment – that can be compared with costs, these models are a quite interesting tool for management and research. Hotels already established in their destination and their current competitors or those hotels that are considering entering the market can access information about customers' propensity to pay for specific destinations and locations and the combination of attributes customers find more interesting. In the same way, the evolution of initiatives carried out by hotels can be understood as their attempt to maximise the value of their hotels' particular characteristics or their clients' willingness to pay for these characteristics.

This paper proposes as a management tool a combination of a hedonic price model with a geographically weighted regression model (GWR), testing both models in a specific destination. However, those interested in using hedonic price models should be aware of a series of problems stem from autocorrelation and heteroscedasticity issues (e.g. Abbott & Klaiber, 2011; Zabel, 2015) or a failure in the use and configuration of panel models (Hua & Yang, 2017). Therefore, to use this tool in decision processes, analyses must take the following considerations into account. First, hedonic research must be carried out in one market at a time, which is extremely difficult to delimit using statistical or econometric tests (Palmquist, 2005). While hedonic research is usually associated with a single market or destination, the question arises of, if location is so important, whether or not an entire destination will behave in the same way because of its specific location and the competition around it. It can also condition the management and marketing strategy of the destination. For example, Zhang et al. (2011) proved that the weighting of establishment variables varies according to the specific location of hotels in the city of Beijing. It is possible, therefore, to assume that, in a city as large as Beijing, different subdestinations or submarkets may exist.

Based on the above consideration, the present research focused on the smaller city of Malaga, located in the south of Spain, which has an area of 395.1 km^2 according to the Instituto de Estadística y Cartografía de Andalucía (2016). In 2015, Malaga had a population of about 569,000 inhabitants (Instituto Nacional de Estadística [INE], 2015). It is also one of the most important tourist destinations in Spain, with total overnight stays for 2015 at 2,246,494, according the INE (2016). Malaga is, thus, a sufficiently important tourism destination and, at the same time, small enough to allow an analysis of spatial differences.

The second consideration is that hedonic price models are sensitive to variations over time (Palmquist, 2005). Although researchers have previously analysed panel data on hotels (e.g. Abrate & Viglia, 2016; Li, Ghose, & Ipeirotis, 2008) or tour operators (e.g. Alegre & Sard, 2015), the models used were mainly static (Abrate & Viglia, 2016). To circumvent this restriction, we could have run the model in two different time periods and allocated the changes in implicit prices to the changes that occurred during the periods. However, if we were to use physical attributes, which are easily imitated by the competition and subject to depreciation, the question remained of how the various aspects that pertain to depreciation, competitors' initiatives and Malaga hotels' management could be isolated.

In contrast to other studies, this study did not seek to analyse the effect of goods and services on hotel room prices. Instead, it used TripAdvisor ratings. First, this approach eliminated the problem of the variety of services that hotels can offer, allowing all services to be measured using standard rating dimensions that reflect clients' satisfaction with, and perception of, those services. Second, while goods and services offered by hotels are subject to depreciation through depletion during the life cycle of these products and, thus, may show differences in customers' perceptions at different times, TripAdvisor scores allow homogenisation over time. We, therefore, believe that this model measures the performance of hotels better because the model is insensitive to time, disregarding changes in services that hotels offer.

This, nonetheless, presupposes hotels compete under the Red Queen hypothesis. The Red Queen hypothesis is a coevolutionary theory that was introduced by the biologist van Valen (1973), which has since spread beyond the boundaries of that field of study. In a business context, the Red Queen effect can be seen as interdependence between the actions of all competitors in a sector so that the behaviour of one company influences the performance of all actors, which, in turn, conditions the actions of others. As a result, each firm is forced by its competitors to participate in continuous and escalating initiatives and development (Derfus, Maggitti, Grimm & Smith, 2008). If firms stay inactive for too long, they cannot remain competitive against competing firms.

Therefore, if hotel goods and services had been used in this research, the data would have become quickly obsolete, but, by using TripAdvisor ratings, this did not happen. Hotels must innovate to maintain their ratings on TripAdvisor or innovate more than their competitors to increase these scores. If hotels maintain the same services and facilities for too long, these hotels will fall behind their competition and reduce their customers' satisfaction, which will cause a reduction in ratings, entailing a reduction in demand and, thus, prices.

Our model is based on the premise that hotels – as is true of any other kind of company – have limited resources allocated to maximising delivery of customer value. This strategy is, according to several researchers, positively related to increased profitability and improved customer satisfaction and loyalty (e.g. Woodruff [1997] and Slater [1997])**.** This value delivery is accomplished through a series of attributes that configure hotel services. Given limited resources, managers need to base their decisions

about allocating resources on an evaluation of priority given to attributes (Albayrak & Caber, 2015).

Customer value is the result of clients' perceptions. It is the general assessment that each consumer makes using the difference between the utility of the asset received and the value the customer gives in exchange for this asset (Zeithaml, 1988). Matzler, Renzl and Rothenberger (2006) concluded that objective signals about quality do not really reflect the perceptions of customers. They also found that using consumers' perceptions is better than using objective cues, as the former provide better indicators of the impact of service dimensions on perceived price.

The literature on hedonic pricing reveals two kinds of limitations. The first are spatial limitations that concentrate each study in a small region with supposed homogeneity in the influence of variables. That is, few studies have considered possible variations within the same city and the consequences of not taking these variations into account. The second are temporal limitations. In other words, the influence of an attribute on price at a given time does not ensure that this influence is maintained over time. Therefore, the objective of the present study was to use a model that could be applied in different locations and periods to analyse the impact of both establishment (e.g. category, size and location) and assessment variables of services included in all Malaga hotels' room prices. To prevent the influence of seasons and other disruptive variables, the data were collected in the low season during periods without large events. Booking day and booking margin were controlled. Two regression methods were used: hedonic price regression and geographically weighted regression (GWR).

This paper is organised as follows. After this introduction, the literature on determinants of hotel prices is reviewed in section two. In section three, the empirical framework for the analysis of hotel room rates is presented. In section four, empirical analyses are presented. Some implications and conclusions are examined in section five. Finally, limitations and suggestions for further research are presented in section six.

2. Literature review

Many studies in the literature have used hedonic price models to conduct both tourism and hospitality research. Some studies have sought to evaluate the impact of hotel facilities on hotel room prices, for example, identifying characteristics that influence the prices of ski resorts in Austria (Falk, 2008), Bangkok hotels (Agmapisarn,

2014) or Taipei hotels (Chen & Rothschild, 2010). In addition, researchers have focused on the importance of public goods in hotel room prices (Rigall-I-Torrent & Fluvià, 2011). Sánchez-Ollero, García-Pozo and Marchante-Mera (2014) used a hedonic price model to evaluate the impact of environmentally sustainable initiatives implemented by hotels, also in reference to room prices. Many researchers have also applied hedonic pricing models to the environmental sustainability of hotels (e.g. García-Pozo, Sánchez-Ollero, & Marchante-Mera, 2013; Kuminoff, Zhang, & Rudi, 2010; Soler, Gémar, & Sánchez-Ollero, 2016). Other studies have employed hedonic price models to assess, among other aspects, the impact of legal status as a family business hotel (Soler & Gémar, 2016) or a member of a hotel chain (Thrane, 2007) or hotels' attitudes towards innovations (de la Peña, Núñez-Serrano, Turrión, & Velázquez, 2016).

In the literature on hedonic price, the general findings are that star category and location attractiveness help explain price differences (Abrate, Capriello & Fraquelli, 2011). Prices are a function of supply-demand conditions, so seasonality can affect price structure. Monty and Skidmore (2003) confirmed the importance of season, as well as location and accommodation-specific attributes in hotel room rates. Along the same lines, Schamel (2012) found proof that hotel room rates are dependent on whether hotels are booked for weekdays or weekends. For similar reasons, prices can alter due to large events in cities (Herrmann & Herrmann, 2014).

Many studies have focused on the effect of hotels' locations on room prices, such as the importance of a Mediterranean sea view on the pricing of rooms of hotels located in that region (Fleischer, 2012) or the effect of beaches on hotel room prices (Rigall-I-Torrent et al., 2011). Lee and Jang (2011) studied the impact of hotels' proximity to business centres and airports on room prices in United States (U.S.) airport hotels. Alegre, Cladera and Sard (2013) found differences between German and British tourism in the importance of location values in hotel room prices. Saló, Garriga, Rigall-I-Torrent, Vila and Fluvià (2014) found that the effects on price of some characteristics related to location differ for hotels and second houses along the Costa Brava, Spain. Bull (1998), in particular, conducted a thorough analysis of the importance of location.

Numerous studies have proven the existence of a positive relationship between hotel category and hotel room prices. For example, Israeli (2002) found evidence for this relationship using a hedonic price model in Israeli hotels. Schamel (2012) also concluded that hotel category is the most important variable in determining hotel room price variability. In addition, the cited author revealed the importance of booking

margin in determining prices and the need to differentiate between weekday and weekend prices. Table 1 presents an overview of recent literature on hedonic studies and the ways in which general and site-specific attributes have been analysed and operationalised.

Table 1. An overview of recent empirical studies

Authors	Area	Sample	Data Collection Period	Dependent Variables	Independent Variables	
					General Attributes	Site Specific Attributes
(Israeli, 2002)	Israel	Hotels (215)	March 1999–March 2001	Room price	Stars, brand, corporate affiliation, number of room and season	Physical location
(Monty & Skidmore, 2003)	Southeast Wisconsin	Bed & breakfast hotels (15)	Fall 2000	Willingness to pay	Room facilities and room size	Distance from the nearest city centre
(Aguiló, Alegre & Sard, 2003)	Balearic	Hotels (693)	2000	Room price	Stars, number of rooms, beds per room, number of floors, agreements between chains and tour operators, type of board, tour operator, amenities and services	Physical location, urban or natural proximity, playground proximity, distance to city centre, distance to beach, room with sea view and product and area concentration degree
(Thrane, 2007)	Oslo	Hotels (74)	March 2005	Weekday rates for a single person for a one-night stay in a single or a double room	Chain, size, amenities and facilities	Distance to Oslo Central Station
(Falk, 2008)	Austria	Ski resorts (84)	Winter season 2005/2006	Price of an adult one-day and six-day lift tickets	Ski quality values	Physical location
(Li et al., 2008)	U.S.	Hotels (9463)	September 2007	Room price	Stars, number of reviews, customers' review count, number of rooms, size of room, hotel amenities, popularity rank, number of reviews and reviews rating	Physical locations, number of restaurants, city annual crime rate and city population
(Kuminoff et al., 2010)	Virginia	Hotels (223)	Summer 2008	Room rate	Stars, amenities and services	Physical locations
(Andersson, 2010)	Singapore	Hotels (69)	1 January 2006 to 1 March 2007	Room rate	Star, facilities, architectural interest and online customer ratings	Dummy location (Orchard Road yes/no) and accessibility to city centre
(Chen & Rothschild, 2010)	Taipei	Hotels (73)	July 2007	Room rate	Stars, chain, room size and hotel facilities	Dummy location (centre yes/no)
(Rigall-I-Torrent et al., 2011)	Costa Brava	Coastal hotels (197)	May–October 2002	Price of double room (half board) during seven days	Stars, hotel facilities, quality certification and month	Beach quality values and jurisdiction values

(Lee & Jang, 2011)	U.S. cities with a central business district (CBD) size of less than one square mile and airports located more than five miles away from the CBD	Airport hotels (106)	First quarter 2008	Average weekday rate for standard or equivalent room	Amenities and services, chain and lodging per diem index	Distance to airports and to CBDs and travel time index
(Rigall-I-Torrent & Fluvià, 2011)	Catalonia	Coastal hotels (279)	May–October 2000 (two observations per month)	Price of double room (full board)	Stars, room services, hotel facilities and time of the year	Physical location, room location, beach location, jurisdiction values and number of hotel rooms in jurisdiction
(Abrate et al., 2011)	Turin Piedmont Region	Hotels (145)	2007	Peak and off-peak price	Amenities and services, total number of room, stars, chain, guidebook and quality certification	Presence in a business/leisure district and distance from railway stations
(Zhang et al., 2011)	Beijing	Hotels (228)	2005	Average hotel prices	Hotel size, stars and age	Distance between hotels and nearest scenic spots and nearest transport hubs
(Fleischer, 2012)	Mediterranean Region	Hotels (589)	Price for 24 October 2011 (high season) and 5 January 2011 (low season)	Room price in high and low seasons	Type of room, number of persons per room, amenities and services	Room view values and physical location
(Schamel, 2012)	Bolzano (10 km vicinity of Bolzano)	Hotels	Between late August and mid-November 2010	Room price total, single weekday and double weekend (two-night stays in Bolzano)	Stars, online rating and amenities and services	Distance from city centre (km)
(Alegre et al., 2013)	Majorca Island	Tour operators travel brochures (11 German and nine British)	Summer 2008	Price for German and British tour operators	Stars, chain, number of rooms and floors, quality certification, amenities and services	Physical location, distances (centre, beach and airport), beach, quality values, sea view and hotel rooms' ratio in the jurisdiction
(García-Pozo et al., 2013)	Andalusia	Hotels (216)	20–26 July 2009	Mean daily price for double room with breakfast	Stars, chain, survey of managers about environmental involvement, number of quality certification, number of environmental certifications, amenities and services	Physical location
(Saló et al., 2014)	Costa Brava	Hotels (182) and second homes (1002)	May to October 2004	Average price per month (based on seven-day package) for hotels and second home rental (based on seven-day package) taking into account the average price per month	For hotels: number of rooms, stars and hotel facilities For second homes: home attributes and intermediary For both: season	For hotels: room location For second homes: sea view For both: physical location, distance to the beach and jurisdiction facilities

(Agmapi-sarn, 2014)	Bangkok	Hotels (141)	Two measurements within high season (October and November 2012) and low season (July and August 2013)	Room rate on weekends, on weekends in high season and low season	Hotel age, number of rooms, room size, chain and hotel facilities	Distances (city centre and Bangkok Mass Transit System)
(Sánchez-Ollero el al., 2014)	Andalusia	Hotels (232)	20–26 July 2009	Mean daily price for double room with breakfast	Environmentally sustainable measures initiatives, quality and environmental quality certification, stars and amenities and services	Physical location
(Herrmann & Herrmann, 2014)	Munich (less than 10 km from Theresien-wiese)	Hotels	16 September to 7 October 2012 (measured on 16 September); 1–14 October (measured on 1 October); and Oktoberfest (22 September–7 October)	Mean price	Number of rooms available in the city, booking day, booking margin, stars and online rating values	Distance between hotels and location of Oktoberfest
(Soler & Gémar, 2016)	Malaga	Hotels (57)	Offseason 2014	Room rate	Stars, number of rooms, booking day, booking margin, service rating and family business hotel	Distance between hotels and city centre
(Soler et al., 2016)	Madrid and Barcelona	Hotels (329 in Madrid and 348 in Barcelona)	Third week of July 2015	Room rate	Stars, chain, service rating and green values according TripAdvisor tags	Location rating
(de la Peña et al., 2016)	Cuba	Hotels (176)	December 2010	Room rate	Stars, size, chain, type of room, core target, brand, online rating, amenities and services	Physical location
(Abrate & Viglia, 2016)	Historical centre of Milan	Hotels (57)	October 2012	Standard catalogue prices and real prices	Stars, number of rooms, size of rooms, online reputation, booking margin, day of the week, amenities and services	Number of close competitors and number of other competitors

Source: Authors

According to Schamel (2012), a third limitation of hedonic models is the assumption of perfect information, but the use of meta-booking engines now allows researchers to assume that consumers have access to an extremely detailed presentation of hotels' attributes in particular markets. The growth of tourism websites and online booking tools and the importance of metasearch engines in the tourism sector has resulted in a fall in information costs. This has meant that an increasing number of studies have used information from these websites as sources of information. The number of these studies using hedonic model regression also has increased. For example, Li et al. (2008) used data from TripAdvisor's website, such as customer reviews count and popularity rank, in their hedonic research focused on U.S. hotels. Andersson (2010) collected data from customer reviews from HotelTravel.com to test a

hedonic model for Singapore's hotel market. Fleischer (2012) also used Booking.com, and Schamel (2012) accessed trivago.com's data, among other similar studies (see Table 1 above).

Based on the literature review for the present research, we concluded that many variables have been used in different hedonic studies. In addition, these have been adapted to fit the specific objectives pursued. We also found that all hedonic research has used some kind of site attribute measurement system that reflects the importance of this type of variable. Although these are not used in all studies, many have included hotel category and size measured by number of rooms. With regard to the latter variable, Chung and Kalnins (2001) found that small hotels can take advantage of positive externalities more easily than large hotels can, especially when small hotels are surrounded by larger hotels. This finding could lead to expectations of lower prices in small hotels.

However, hedonic price research has produced varied results in this area. For example, Israeli (2002) and de la Peña et al. (2016) found a positive relationship between size and price, whilst others, including Saló et al. (2014) and Soler and Gémar (2016), found the opposite to be true. In contrast, the relationship found by Agmapisarn (2014) was null. The effect of size on prices, therefore, raises questions. It could be that its influence depends on the destination studied, or it may depend on the type of tourist, as shown by Alegre et al. (2013)'s results of a positive relationship between size and price for German tourists and a negative relationship for British tourists. However, Aguiló et al. (2003) found both relationships were null. In addition, hedonic research has also tended to control for seasonality, either including its measurement with a dummy variable or narrowing the investigation to a period that does not entail changes.

3. Empirical framework

3.1 Data

Different types of data were compiled for the present analysis. First, room price data for hotels in Malaga were collected using TripAdvisor. Those hotels not located in Malaga were excluded, leaving a total of 57 hotels (i.e. all hotels located in the municipality of Malaga). The data collection period was between 8 October and 19 November 2014, thereby eliminating the influence of high-season conditions. Prices were collected for Wednesdays and Saturdays in order to control the difference between

weekday booking and weekend booking. Booking margin also was controlled. For searches on both Wednesday and Saturday, prices were captured for the same search day – in other words, booking margin equalled zero – and for the following three Wednesdays and Saturdays.

In total, 2,328 prices were collected, but, in order to minimise uncontrolled effects (e.g. conferences or football matches), the median prices of hotels for each booking margin were used, leaving 862 values for the regression. Based on Rosen (1974) and Schamel's (2012) work, among other studies, we chose to employ a log-linear model. Thus, prices were converted using natural logarithms. As recommended by Zhang et al. (2011), hotel room numbers were used to represent hotel size.

In addition, clients' reviews in TripAdvisor were collected. These ratings ranged from one ('terrible') to five ('excellent') and evaluated each hotel by location, sleep quality, room, service, value and cleanliness. In addition, each hotel's position on TripAdvisor's list was measured.

TripAdvisor ratings have been used in previous studies to represent the level of customer satisfaction with the quantity and quality of goods and services offered by hotels. One score is the location rating. This location rating is subjective, unlike other location variables such as geographic distances or coordinates, which are clearly objective variables. In this case, location ratings reflect customers' perception of hotels' locations. Bulchand-Gidumal, Melián-González and González (2013) found three destination variables that explain client satisfaction with hotels: the local population's qualifications, productivity of the service sector and environmental quality. Thus, it is possible that hotels that are distant from a city centre and situated in natural areas can have excellent location ratings because these hotels capitalise on the high quality of their environments.

Next, the distances of each hotel to three key locations were collected using Google Maps. These locations are the city centre (i.e. Calle Marqués de Larios), the train station (i.e. Estación María Zambrano) and the Malaga airport. Using the same source, projected coordinates and postal codes for each hotel were collected. All variables are compiled in the following table.

Table 2. Variables and their brief descriptions

Source	Variable	Description	Mean	Standard Deviation

TripAdvisor	**LNMEDIANPRICE**	Ln form of median price	4.2360	0.4172
	RANKING	Hotel's position on TripAdvisor's list	-	-
	LNROOM	Ln form of rooms	3.9273	0.8982
	STARS	Star rating	3.0640	0.9959
	SLEEPQ	Rating for sleep quality	3.9230	0.3449
	ROOMS	Rating for room	3.8990	0.4149
	SERVICE	Rating for service	3.9750	0.3760
	VALUE	Rating for value	3.9920	0.3264
	LOCATION	Rating for location	4.1740	0.5071
	CLEANLINESS	Rating for cleanliness	4.2130	0.2984
	BDAY	Booking day (Wednesday=0; Saturday=1)	0.4900	0.5000
	BMARGIN	The difference in days between the search day and the booking day	12.4640	7.9377
Google Maps	**KMCENTRE1**	Ln form of driving distance in kms to the city centre	0.9214	0.9863
	KMCENTRE2	Ln form of walking distance in kms to the city centre	0.3090	1.1414
	MINCENTRE1	Ln form of driving distance in minutes to the city centre	1.9159	0.9308
	MINCENTRE2	Ln form of walking distance in minutes to the city centre	2.7628	1.2321
	KMTRAIN1	Ln form of driving distance in kms to the train station	0.9863	0.7566
	KMTRAIN2	Ln form of walking distance in kms to the train station	0.6642	0.8909
	MINTRAIN1	Ln form of driving distance in minutes to the train station	2.1443	0.5263
	MINTRAIN2	Ln form of walking distance in minutes to the train station	3.1549	0.9038
	KMAIR1	Ln form of driving distance in kms to the airport	2.3221	0.4436
	KMAIR2	Ln form of walking distance in kms to the airport	2.2592	0.2637
	MINAIR1	Ln form of driving distance in minutes to the airport	2.6121	0.3632
	MINAIR2	Ln form of walking distance in minutes to the airport	4.7580	0.2804
	X	Projected coordinate for the x axis	-	-
	Y	Projected coordinate for the y axis	-	-
	AREA	Hotel postal code	-	-

Source: Authors

3.2 Principal component analysis (PCA)

Some researchers have suggested that multicollinearity can be a fourth problem in hedonic research (Schamel, 2012). In general, to avoid this issue, either attributes have been reduced or combined into groups (Aguiló et al., 2003; Andersson, 2010). In the present study, we sought to form groups with the least loss of information possible. To this end, PCA was used to obtain uncorrelated variables through regressions. These new variables were used in subsequent analyses. For the rating and list position number in TripAdvisor, two factors were found (i.e. TRIP1 and TRIP2), and, for all natural logarithms of distance, three factors were obtained (i.e. DISTANCE1, DISTANCE2 and DISTANCE3). In both cases, only the components with eigenvalues higher than one were selected. Details for the matrix of component values extracted using PCA of

TripAdvisor ratings and Google Maps distances are shown in Tables 3 and 4, respectively. In these tables, marks have been added to facilitate their interpretation.

Table 3. Components matrix for TripAdvisor ratings

	Components	
	1	2
RANKING	-0.855***	0.356
LOCATION	0.417	-0.875***
SLEEPQ	0.854***	0.121
ROOMS	0.884***	0.119
SERVICE	0.872***	0.057
VALUE	0.714**	0.289
CLEANLINESS	0.840***	0.244

Note * Absolute value higher than 0.6; ** Absolute value higher than 0.7; *** Absolute value higher than 0.8; **** Absolute value higher than 0.9

Source: Authors

In this way, it was possible to synthesise all these variables into a few values that reflect different but complementary strategies. Therefore, in the assessment dimension, the first factor covers the strategy of a good location in search results on TripAdvisor. Hotel position on TripAdvisor's list (i.e. the variable RANKING) has a negative sign, with particular emphasis on quality rating versus location rating – the latter having a weight half of the other factors' rating weights. On the other hand, the second factor gives greater importance to location ratings, although it has a negative sign. In this factor, other variables have almost no importance.

Table 4. Components matrix for Google Maps distances

	Components		
	1	2	3
KMCENTRE1	0.829***	-0.101	0.505
KMCENTRE2	0.892***	0.066	0.205
MINCENTRE1	0.723**	-0.094	0.626*
MINCENTRE2	0.900****	0.046	0.341
KMTRAIN1	0.852***	0.373	-0.312
KMTRAIN2	0.813***	0.428	-0.352
MINTRAIN1	0.735**	0.569	-0.265

MINTRAIN2	0.814***	0.421	-0.355
KMAIR1	-0.372	0.890***	0.138
KMAIR2	-0.345	0.867***	0.197
MINAIR1	-0.517	0.756**	0.211
MINAIR2	-0.417	0.851***	0.229

Note * Absolute value higher than 0.6; ** Absolute value higher than 0.7; * Absolute value higher than 0.8; **** Absolute value higher than 0.9**

Source: Authors

In the location dimension, the first factor gives almost equal importance to distance to the city centre and distance to the train station, while distance to the airport is negative. The second factor prioritises the importance of distance to the airport, while the third factor mainly weights distance to the city centre.

3.3 Hedonic prices

Using the model of hedonic price developed by Rosen (1974), implicit prices can be derived for attributes that constitute goods or services. This model assumes that a perfectly competitive market exists with no significant transaction costs or information costs (Falk, 2008). Although researchers often seek to combine data over time – either to measure a change in the environment or to increase the number of usable observations – this is only possible if the contribution of the characteristic to the value is relatively stable over the entire period in question (Palmquist, 2005). Therefore, most hedonic studies use cross-sectional models.

Hotel room prices are a function of the bundle of attributes that make up services, customer scores for these attributes and the cost of these services. The general specification for the hedonic price equation is given as:

$$(1) \qquad P_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + u_i$$

This model is regarded as a global ordinary least squares (OLS) regression model, where P_i is the room price, α is the constant, X_{ki} is the hotel room attributes or characteristics and β_k is their associated coefficients.

According to Wooldridge (2009), it is better to use a natural logarithm model for greater explanatory power. Therefore, we employed a log-linear model rather than a

linear specification, as did Agmapisarn (2014) and Schamel (2012), among other authors in tourism and hospitality research. The specification applied to the hedonic price equation is given as:

$$(2) \qquad Ln\ P_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + u_i$$

To check for and control multicollinearity, variance inflation factors (VIFs) were calculated. Similarly to Chen and Rothschild (2010), Sánchez-Ollero et al., (2014), Schamel (2012) and Soler et al., (2016) among others, VIFs were checked, using as a reference the critical values suggested by Kennedy (2008) and Kutner, Nachtsheim and Neter (2004).

3.4 GWR

GWR is a multivariate regression method that has become increasingly popular in economic geography. Modelling with hedonic and GWR has been used to measure the determinants of house prices in different places, such as Austria (Helbich, Brunauer, Vaz & Nijkamp, 2014), China (Hanink, Cromley & Ebenstein, 2012), Paris (Nappi-Choulet & Maury, 2011) and London (Lu, Charlton, Harris & Fotheringham, 2014).

In this regression, data samples were weighted based on their specific proximity, producing a bundle of regression parameters for each observation. Thus, this model allows a better analysis of economic phenomenon by accounting for spatial effect (i.e. local dependence and spatial heterogeneity) (Koschinsky & Lozano-Gracia, 2012; Zhang et al., 2011).

GWR is a non-stationary technique that models spatially varying relationships. Compared with basic (global) regressions, coefficients in GWR are functions of spatial location (Fotheringham, Brunsdon & Charlton, 2003; Fotheringham, Charlton & Brunsdon, 1998). This resulted in a general formation of the basic GWR model for this study as:

$$(3) \qquad P(g) = \beta_0(g) + \beta_1(g)X + \varepsilon$$

where *g* is a coordinate vector, which indicates that there is a separate set of parameters for each of the *g* observations.

When GWR is used, the parameters can be estimated by solving:

$$(4) \qquad \hat{\beta}_i(g) = (X'W_gX)^{-1}X'W_gy$$

where X is the matrix of the independent variables with a column of ones for the intercept, y is the dependent variable vector and $\hat{\beta}_g$ is the regression coefficient. In addition, W_g is the diagonal matrix denoting the geographical weighting of each observed data for regression point g.

This weight matrix can be calculated with a kernel function based on the proximities between regression point i and the N data points around it. For this study, an adaptive bi-square kernel was used. It was defined as:

$$(5) \qquad Adaptive\ bi-square: w_{ij} = \begin{cases} (1 - d_{ij}^2/\theta_{i(k)})^2, d_{ij} < \theta \\ 0, \qquad\qquad\qquad d_{ij} > \theta \end{cases}$$

in which i is the regression point index, j is the locational index, wij is the weight value of observation at location j for estimating the coefficient at location i and dij is the Euclidean distance between i and j. In addition, $\theta_{i(k)}$ is an adaptive bandwidth size defined as the k^{th} nearest neighbour distance.

The optimal bandwidth can be found by minimising the cross validation statistics, which only account for model prediction accuracy or Akaike's information criterion (AIC). The latter accounts for model parsimony (i.e. a trade-off between prediction accuracy and complexity) (Hurvich, Simonoff & Tsai, 1998).

The criteria used for selecting the optimal bandwidth is the corrected AIC (AIC_c), as established by Lu et al. (2014) and Zhang et al. (2011). This is a corrected version of AIC, which, unlike basic AIC, is a function of sample size (Hurvich et al., 1998). The next step is selecting the model with the lowest AIC_c score, given as:

$$(6) \qquad AIC_c = 2n\ln(\hat{\sigma}) + n\ln(2\pi) + n\left\{\frac{n+tr(S)}{n-2-tr(S)}\right\}$$

Here n is the sample size, $\hat{\sigma}$ is the estimated standard deviation of the error term and $tr(S)$ is the trace of the hat matrix S. The hat matrix enables us to calculate the estimated values of $\hat{y}$ from the observed value in y (Hoaglin & Welsch, 1978).

4. Empirical analysis

In this section, the empirical findings are described. This study analysed how hotel room prices are affected by both establishment variables and assessment variables of services provided by hotels, using two models: a hedonic price model and a GWR model.

4.1 Hedonic prices

Table 5. Hedonic price model estimates for room price

Model	Parameter							
	Coefficient		Standard Coefficient					
	Beta	Standard Error	Beta	t	Sig.	%	€–Value	VIF Value
(Constant)	3.683***	0.051		72.662	0.000			
LNROOM	-0.034*	0.013	-0.073	-2.553	0.011		-2.18	1.947
STARS	0.242***	0.012	0.578	20.275	0.000		15.49	1.951
BDAY	0.157***	0.017	0.188	9.216	0.000	17%	11.75	1.002
BMARGIN	-0.011***	0.001	-0.203	-9.948	0.000		-0.70	1.001
DISTANCE1	-0.052***	0.012	-0.123	-4.488	0.000		-3.33	1.799
DISTANCE2	-0.012	0.011	-0.028	-1.108	0.268		-0.77	1.505
DISTANCE3	-0.031**	0.009	-0.075	-3.305	0.001		-1.98	1.230
TRIP1	0.070***	0.010	0.167	7.030	0.000		4.48	1.349
TRIP2	-0.054***	0.013	-0.130	-4.300	0.000		-3.46	2.198
d	1.502^{δ}							
$\bar{R}^2$	0.641							
F	171.621***							

Dependent variable: LNPMEDIANPRICE

Note: *Statistical significance at the 95% level; **statistical significance at the 99% level; ***statistical significance at the 99.9% level; δ values are independent[*]; d = Durbin-Watson coefficient; $\bar{R}^2$ = corrected coefficient of determination; F = F-value

Source: Authors

All the independent variables are significantly correlated with hotel room prices, except DISTANCE2, the variable that prioritises distance to the airport. Therefore, a nearby airport strategy is not significant in terms of variations in price. However, the first factor, which gives more importance to distance to the city centre and distance to the train station, is statistically significant. In addition, this factor has an important weight in the standardised coefficients and negative signs, as does the variable DISTANCE3, which prioritises distance to the city centre (positively).

The results of the analysis using standardised coefficients also suggest that hotel category is the most important variable in the configuration of hotel room prices, followed by booking margin and booking day.

The next variables, which also made use of standardised coefficients, are TRIP1, with a positive sign, and TRIP2, with a negative sign. The negative sign of the TRIP2

[*] The Durbin-Watson statistic, which should be between 1.5 and 2.5, indicates the values are independent (Kianpishen, Mustaffa, See & Keikhosrokiani, 2011).

coefficient may be due to the negative sign of the location rating coefficient in this factor. DISTANCE1, DISTANCE3 and LNROOM come last, each with negative sign coefficients.

The model fulfils the basic requirements for use. It has an adjusted coefficient of determination $\bar{R}^2$ of 0.641. Table 5 was the result report of hedonic price model analysis.

4.2 GWR

The geographical variability for each varying coefficient was tested. All variables, except booking day, suggested that spatial variability existed, so it made sense to use GWR.

The GWR model used in this study first required an OLS model. Therefore, the latter model was tested on the former model, adding information on projected coordinates and areas.

The $\overline{R}^2$ of GWR increased to 0.813.† As previously explained, the coefficients show a range of values. The coefficient of determination R^2 varies between 0.422 and 0.968, but the lower quartile with the GWR model is already higher than the value of the OLS. Figure 1 shows the R^2 spatial distribution. For the coefficients of independent variables, there is also a range of values. In this range, for all variables, the zero value is included. This means that the OLS model can be misleading for some hotels.

† This is a pseudo-adjusted coefficient of determination, calculated as the squared correlation coefficient between the observed and predicted values for all regressions.

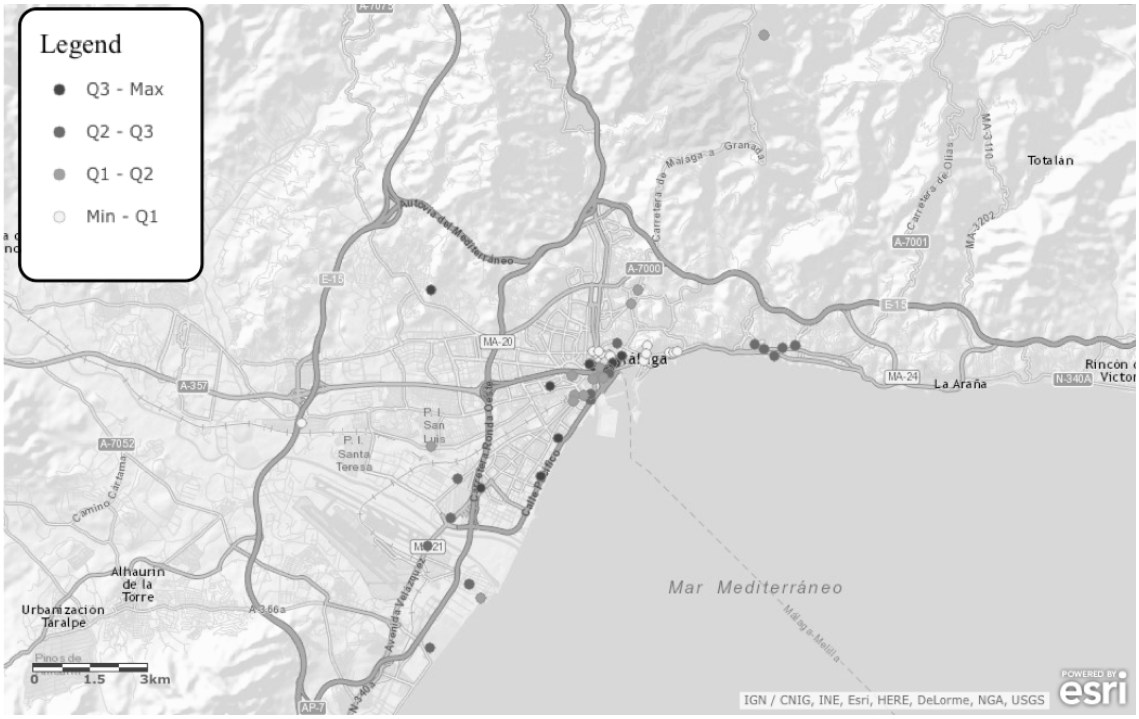

Figure 1. Spatial distribution of R^2 values in the municipality of Malaga

Source: Map generated using the ArcGIS Geographical Information Systems computer software programme

For the interquartile range values, a positive or negative trend appears in some of the coefficients – the constant, stars, booking day and booking margin – while others in this range even include zero. For an overview, in this model, two measures of central tendency – mean and median – need to be observed. In this way, the general trend of these coefficients and the degree of asymmetry in either direction can be observed. Table 6 provides the results of the GWR analysis.

Table 6. GWR analysis estimates for room price

Variable	Min	Lower Quartile	Median	OLS	Upper Quartile	Max	Mean
R2	0.422	0.758	0.863	0.641	0.900	0.968	0.815
Intercept	-10.063	1.794	3.573	3.683	4.612	7.622	2.560
LNROOM	-1.536	-0.261	-0.063	-0.034	0.052	0.352	-0.140
STARS	-0.318	0.153	0.284	0.242	0.409	6.291	0.565
BDAY	-0.016	0.043	0.061	0.157	0.130	0.233	0.084
BMARGIN	-0.124	-0.114	-0.094	-0.011	-0.067	0.001	-0.088
DISTANCE1	-17.521	-3.923	0.143	-0.052	2.278	5.245	-0.900
DISTANCE2	-6.714	-1.901	-0.256	-0.012	1.203	17.035	-0.279

DISTANCE3	-4.242	-0.028	0.879	-0.031	2.173	9.397	1.534
TRIP1	-4.129	-0.107	0.044	0.070	0.234	1.939	-0.058
TRIP2	-6.039	-0.358	-0.138	-0.054	0.001	0.439	-0.551

Source: Authors

5. Implications and conclusions

The hedonic model applied has the advantage of allowing a comparison of different periods despite alterations in services or complementary products associated with hotel rooms. Moreover, this model makes it possible to compare results for different markets or destinations. The hedonic price model used has a corrected coefficient of determination $\bar{R}^2$ of 0.641. Nonetheless, data loss occurred because of the use of PCA, which was needed to convert a set of observations of possibly correlated variables into a set of linearly uncorrelated values.

The GWR model further improves the accuracy of the hedonic price model by accounting for spatial effects. In those regions where the GWR's results fit less well than the hedonic model did, some determinants of price may have remained hidden (Zhang et al., 2011). A possible explanation is that these hotels' degree of exposure to online reviews could be lower, and they may attract customers through other communication channels, such as their own websites, tour operators or tourist catalogues. Another possibility is that competition with other types of accommodation besides hotels, in these specific cases, modifies the hotels' patterns. A further explanation is a specific condition of hotels' location, such as pedestrian zones and proximity to museums and restaurants, could have been lost in the modelling process.

The main contribution of this paper is to confirm spatial changes in the impact of quality assessment variables, showing that, within these variables, there are competitive subsystems that cannot be detected with the use of OLS alone. Notably, Helbich, Brunauer, Hagenauer and Leitner (2013) previously asserted that these submarkets always need to be considered in the Austrian housing market. The present study's findings also are in line with Balaguer and Pernías (2013), who showed the importance of spatial factors in hotel price dispersion, especially in urban hotels. However, our study went further and showed that spatial correlation creates different patterns of

quality value perceptions within the same city, which is an advance in the knowledge about the hotel location decision–making processes and their implications.

These findings have important implications for researchers and managers. For other hedonic price research, GWR may not be necessary, but in hotel and tourism studies in which location is a key factor, it is essential to include GWR in any hedonic price model. Although hedonic price models are able to explain overall market performance, they are inadequate if there is spatial autocorrelation in the sample. The role of spatial autocorrelation has been confirmed in this study for the small city of Malaga, as well as how this spatial autocorrelation can change the impact of service quality perceptions on hotel room price. This impact can create confusion about hotels in terms of differential values of competition within a given city. Therefore, hedonic models must be combined with GWR models for more accurate estimates. In addition, GWR models allow to identify different submarkets and thereby they may help to destination managers in the challenge that, as declared Volgger and Pechlaner (2014), supposes making a consistent tourism product from a fragmented supply.

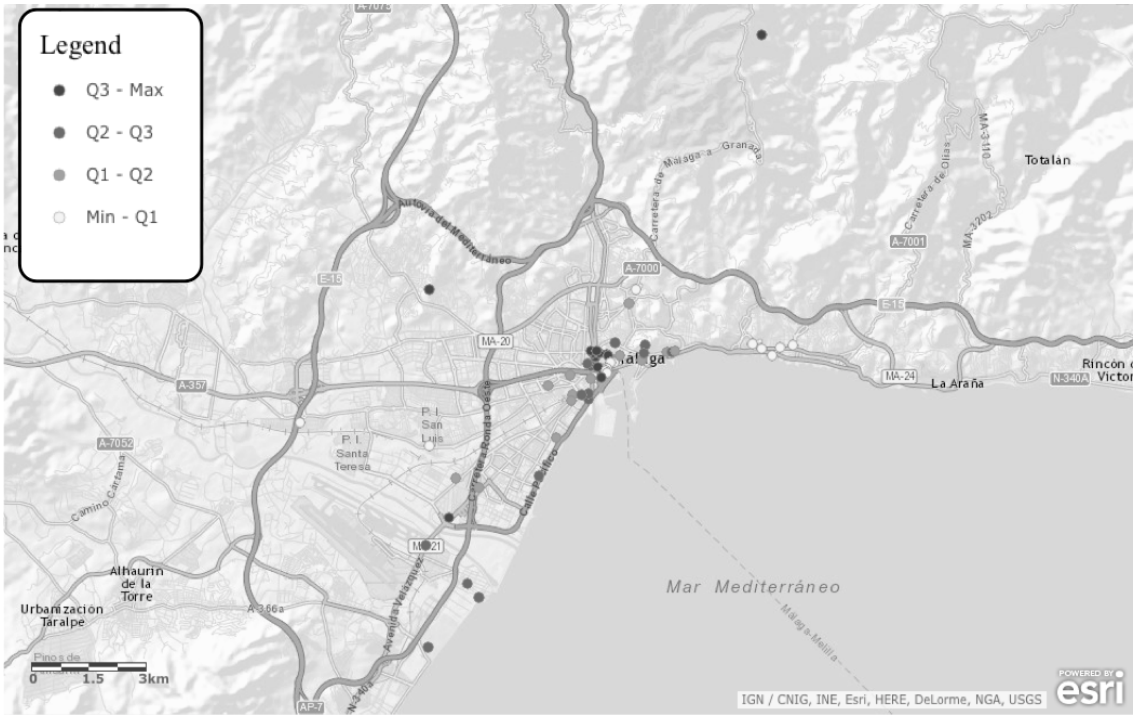

Figure 2. Spatial distribution of TRIP1 values in the municipality of Malaga

Source: Map generated using the ArcGIS Geographical Information Systems computer software programme

Figure 2 provides a graphic and intuitive vision of how to read the results of GWR in the case of the variable TRIP1, showing the parameter fluctuation on the competitive subsystem of GWR versus the fixed parameter of the OLS. The first submarket, with a quality rating between the minimum and quartile one could represent hotels whose location attracts especially price-sensitive customers. In this case, these hotels need to use their resources for innovation and management improvements that allow them to reduce costs. The second and the third submarkets could represent those hotels that are located in second-tier locations and that compete against top-tier location hotels with equal quality values. This location disadvantage forces prices below those of competitors, so the relationship between quality rating and price is lower than for upper-grade hotels, creating a submarket with the variable TRIP1 between quartile three and the maximum.

This method also has possible applications for management since it facilitates comparisons between hotels, even comparing their evolution over time. Furthermore, hotel managers can identify their competitive submarket and detect potential competitors. Therefore, this method can be used to identify improvements over competitors, and it does not require a large deployment of resources. In addition, this paper provides a measurement of the impact of different variables on hotel room prices for the municipality of Malaga, based on two methods.

The results of the hedonic price model used are consistent with previous research in the literature. In this model, all variables – except for the factor related to distance to the airport (i.e. DISTANCE2) – have a significant impact on the price of hotel rooms in Malaga. Of all the attributes, the most important in determining the price of hotel rooms in Malaga is hotel category. According the results of most hedonic research in this field, hotel star category is the most important factor shaping the prices of hotel room, (e.g. Israeli, 2002; Schamel, 2012).

However, Abrate and Viglia (2016) found proof that hotel category has become less important as a result of the benefits of good online reputations for hotels in Milan's historic centre. In addition, Torres, Adler and Behnke (2014) suggest that star category may be obsolete as a good quality measure, although, at least in Malaga, this category is still a good indicator of quality for customers. De la Peña et al.'s (2016) results for Cuban hotels show that the importance of star category in hotel room prices is conditioned by other attributes.

Regardless of these findings, star category is the only variable under the control of hotels whose values are positive between quartiles one and three in the present GWR model. Therefore, the results confirm that, as a general rule, hotel category has a positive influence on hotel room prices.

The next in importance, according the results for the hedonic price model, are the control variables booking day and booking margin, which confirms the need to control both variables in any further research. For these variables, the GWR model shows a stable trend, positive for booking day and negative for booking margin. Nevertheless, in the GWR model, the values vary depending on the hotel.

The variable TRIP1, which covers all TripAdvisor hotel quality ratings, is the fourth in importance – and the second variable under the control of hotels – for the hedonic price model, which highlights the importance of customer-generated feedback in hotel prices. This result could be in line with the increasing importance of online reputation found by Abrate and Viglia (2016), mentioned previously, or the relationship found by Ye, Law and Gu (2009) between online consumer reviews of business performance and room sales of hotels in China. This variable has been used as an example of how to read GWR results, as seen in Figure 5.

In addition, the TripAdvisor location rating collected specifically through the variable TRIP2 has an extremely important role in pricing. It is more important than any individual objective location variable, making the TripAdvisor location rating the most important assessment for hotels and further reinforcing the importance of online user ratings. The results of the GWR model show a wide range of values for both TRIP1 and TRIP2. This is related to spatial changes in the impact of the quality assessment variables mentioned above, which could not be detected using the hedonic price model alone.

Furthermore, the results of the hedonic price model show that the distance of hotels to the city centre and train station significantly reduces hotel room prices. The standard coefficient of the variable DISTANCE1 is quite close to that of TRIP2. However, this may be due to the size of Malaga and its transport network. This could make these variables less relevant and the perceived quality of location more relevant than these are in other destinations.

Finally, it is important to highlight the negative sign of hotel size in our model, which is in line with other studies (e.g. Saló et al., 2014; Soler & Gémar, 2016; Zhang et al., 2011) and which may be due to three reasons. The first may be that hotel size

allows economies of scale that enable hotels to reduce costs, which is then reflected in prices. Nevertheless, this should also be reflected in the practical totality of the present research's results, something that did not happen. The second reason may be that, in low season, hotels may have difficulty keeping certain occupancy rates, forcing hotels to drop the price of rooms to increase occupancy rates and reduce fixed costs per unit.

The third reason may be the preference of customers for smaller, exclusive hotels, making size a negative feature in prices. Hotel size is an inconsistency in the GWR model, as was also observed in Zhang et al.'s (2011) study, proving that the impact of hotel size on price depends on the destination's conditions. This could explain the disparity of results (i.e. positive, negative or null significance) found in the other hedonic research. Depending on the predominant pattern in the city under study, the results could be inclined to favour either sign. The GWR model highlighted this variability within the destination in question, which reinforces the need to combine this model with hedonic price models.

6. Limitations and further research

This paper has some limitations that must be considered. First, it is important to note that the values obtained in this work, although consistent with the findings in the literature, cannot be generalised to other settings, and they are only applicable to the municipality of Malaga. However, the conclusion about the importance of using the GWR method in hedonic research can be generalised.

Second, based on the literature that shows many variables that can affect prices, it is possible to create a model with more variables. For example, objective quality, occupancy rates or demographic variables could lead to a better adjustment. However, by using these variables, researchers lose the dynamic possibilities that the model used in this study offers, and these additional variables would involve an increase in the costs of gathering data. Furthermore, the present study presents a similar level of adjustment to that of most of the literature reviewed.

In this sense, given that quality patterns differ in the city under study at any given point in time, these patterns could change in each area so that these differ in another season and one area may be favoured over others. For example, beach areas' perceived value may improve, and urban areas' occupancy rates may decrease in high season. Based on this finding, future research needs to be conducted in different seasons

and focus on possible pattern changes within city destinations. It would also be interesting to check for variations over time in spatial patterns using a geographically and temporally weighted regression model (Huang, Wu, & Batty, 2010), which would expand the present approach from only considering spatial dimensions to including time dimensions. This would allow the GWR model to take into account the instability of time. Researchers could, thereby, take advantage of the benefits of using panel data, such as those employed by Abrate and Viglia (2016), and, at the same time, maintain the GWR model's advantages.

In addition, it is possible that there is endogeneity between customer ratings and prices. This may mean that lower prices would permit better assessments. This was not observed in this study. However, the presence of two forces may be assumed, the first in a positive relationship between prices and ratings as approximations of quality and the second in a negative relationship between these two aspects (i.e. lower prices with higher valuations). Based on the results obtained by Ye et al. (2009), which showed a relationship between online consumer reviews of business performance and the growth of room sales of hotels in China, it is possible to assume that the dominant force is the positive relationship between rating and prices. The other relationship may be considered residual or a discount within the first pattern.

Another limitation is the short lifetime of the GWR model, although progress is currently being made in its theoretical development. For example, in the present study, Euclidean distance was used in the GWR model, but Lu et al. (2014) questioned the use of Euclidean distance in the kernel function and replaced this with a non-Euclidean distance. Therefore, we believe that further research on this methodology is necessary. In addition, given the results of the present study, the use of this methodology in economic research needs to become more widespread. More specifically, we believe there is a need to generalise the implementation of the GWR model as a necessary component of hedonic price research.

As more researchers combine hedonic price and GWR in their models, a common pattern for competitive subsystems in different cities may be found, a pattern until now hidden by the exclusive use of OLS. It might also be interesting in further research to determine what actions have the greatest impact on changing hotels' competitive position – depending on the competitive subsystem in which hotels are located – or to connect these competitive subsystems with hotel revenue management.

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