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The Value of Going Green in the Hotel Industry: Evidence from Beijing

Li Zhang,* Jing Wu,** Hongyu Liu*** and Xiaoling Zhang****

Based on several unique datasets in Beijing, this article investigates the value of going green in the hotel industry by combining the traditional hedonic pricing model with the state-of-the-art content analysis of online reviews. The results indicate that the rate of complaints about the indoor environmental quality of green hotels is roughly 19% lower than that for nongreen hotels. Hedonic regression analysis concludes that green hotels enjoy a significant room rate premium of 6.5% without reducing occupancy rates, mainly due to improved indoor environmental quality. Recognizing the presence of such cobenefits is likely to induce hoteliers to embrace green practices.

Introduction

Hotels and associated services have substantial negative impacts on the natural environment due to their massive resource consumption, carbon dioxide emission and waste generation during construction, operation and maintenance (Kasim 2004, Bohdanowicz 2005, Chan, Wong and Lo 2009, Manomaivibool 2015). As the green momentum of energy savings and emissions reduction grows globally, the hospitality industry has a key role to play. This has led to the emergence of "green" hotels, defined as hotels adopting green design and ecofriendly operations such as saving energy and water, purchasing ecofriendly goods and reducing the release of pollutants (Lee *et al.* 2010, Han *et al.* 2011, Barber 2014).

However, the conventional wisdom from the business sector suggests that any contribution to resource conservation and environmental protection might erode financial performance. Thus, companies do not voluntarily embrace standards that invite them to internalize environmental costs and risks that

*Hang Lung Center for Real Estate and Department of Construction Management, Tsinghua University, Beijing 100084, China or zhang-li13@mails.tsinghua.edu.cn.
**Hang Lung Center for Real Estate and Department of Construction Management, Tsinghua University, Beijing 100084, China or ireswujing@tsinghua.edu.cn.
***Hang Lung Center for Real Estate and Department of Construction Management, Tsinghua University, Beijing 100084, China or liuhy@tsinghua.edu.cn.
****Department of Public Policy, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong SAR or xiaoling.zhang@cityu.edu.hk.

remain externalities to their competitors (Erdogan and Baris 2007, Zhang *et al.* 2015, Shen, Zhang and Long 2017). Although extensive studies about office and housing markets have proved that price premium plays a pivotal role in attracting investment in green offices and residential properties by providing economic returns to offset green incremental costs (Eichholtz, Kok and Quigley 2010, Brounen and Kok 2011, Fuerst and McAllister 2011a, b, Freybote, Sun and Yang 2015, Zhang, Liu and Wu 2016, Holtermans and Kok 2017), evidence on the profitability of green hotels is still tenuous (Butler 2008, Kang *et al.* 2012).

What is more, the promotion of green practices in hotels is generally considered to face greater challenges than that in office and housing markets. Although hoteliers can enjoy financial benefits from reducing energy, water and waste costs, they still worry that the financial performance of green hotels may erode if resource savings, recycling or other green activities lead to discomfort or inconvenience to their customers, as tourists always pay great attention to the comfort level of their recreational experience (Kasim 2004, Butler 2008). In addition, from a financial perspective, there is a split-incentive problem for hotel customers, as they are not charged for electricity and water, and thus have no incentive to conserve resources or pay extra for resource conservation (Lee *et al.* 2010, Barber 2014, Kahn and Liu 2015).

To strengthen customer acceptance of green hotels, it is crucial to investigate the potential incentives for their green demand. As hotel customers cannot obtain benefits from energy savings, their demand for green hotels depends on environmental responsibility and/or improvement in living comfort (Dastrup *et al.* 2012, De Silva and Pownall 2014, Hu, Geertman and Hooimeijer 2014, Kahn and Kok 2014, Zhang *et al.* 2017). Most studies attribute hotel customers' ecofriendly decisions to their environmental consciousness (Han, Hsu and Lee 2009, Kim and Han 2010, Han *et al.* 2011, Kang *et al.* 2012). However, as these studies adopt a contingent valuation method, the respondents' answers may differ from their actual choices (Kasim 2004, Han, Hsu and Lee 2009). It is necessary to take into account consumers' actual payment for green hotels (Barber 2014).

Hu, Geertman and Hooimeijer (2014), studying the housing market in China, conclude that residents are only willing to pay a green premium when living comfort improves; however, little research has investigated the living comfort of green hotels. In fact, energy efficiency does not necessarily lead to reduced comfort level, and improved indoor environmental quality is a stated goal of green buildings (Cole 2000, World Green Building Council 2013). Some studies have proven that green buildings can achieve superior performance in thermal comfort (mainly temperature and humidity), acoustics, lighting and

indoor air quality (Abbaszadeh *et al.* 2006, Butler 2008, Lee *et al.* 2010, Zhang *et al.* 2017). The measures commonly adopted in green buildings to improve indoor environmental quality include both passive measures, such as optimizing their design to make full use of natural resources, including reinforcing wall insulation and utilizing daylight and improving natural ventilation, as well as the active measures of efficient mechanical systems, such as improving air-conditioning and installing air purifiers (Zhu and Lin 2004, Zhu, Lin and Yuan 2010).

In response, this article provides the first empirical evidence on whether and how "greenness" is valued by hotel customers. Using a unique dataset comprising 156 green hotels and matched comparable nongreen hotels in Beijing, we compare their performance based on online customer reviews in terms of indoor environmental quality and environmental responsibility. The results indicate that customers are more satisfied with the indoor environmental quality of green hotels, but environmental responsibility has no significant influence on customers' lodging experience. We also find that green hotels command a significant premium of 6.5% in room rates, compared with their all-else-equal nongreen counterparts. These results are robust when we adopt another set of survey data and take hotels' performance in occupancy rates into consideration. Such a room rate premium for green hotels can be fully explained by customers' higher satisfaction level with indoor environmental quality. Overall, hotel customers in Beijing value "greenness" in terms of comfort improvement, but customers currently pay little attention to environmental responsibility as they consider hotel choice. In addition, we provide preliminary evidence about the influence of outdoor air quality on the price premium and customer satisfaction level with green hotels. While we do not find significant evidence for an additional room rate premium for green hotels on polluted days, the gap in customer satisfaction level regarding indoor air quality between green and nongreen hotels did increase on days with more serious air pollution, which may be converted to a higher green price premium in the future.

The remainder of this article is organized as follows. The next section provides background information relating to green hotels in China, and then the data used in the analysis are introduced. The fourth section presents the methodology and empirical results, and the last section discusses the implications of study findings and suggests a future research agenda.

Green Hotel Certification in China

Recently, some of the world's leading hotel brands, in an effort to respond to environmental concerns, have begun to pursue the U.S. Green Building Council's LEED certification, a benchmark for green buildings

acknowledged throughout the world (Butler 2008). However, LEED certifies building sustainability, while for hotels, greenness should include not only building infrastructure but also procurement and services (Hsiao *et al.* 2014). Therefore, governments in many developed countries, such as the United States and Australia, have issued specific standards and rating systems for green hotels (Kuminoff, Zhang and Rudi 2010). Similarly, the China National Tourism Administration implemented its "Evaluation Standard for Green Hotels (LB/T007-2006)" to encourage hotels to "go green." The standard covers five categories, namely: Green Design, Energy Conservation, Environmental Protection, Green Products and Services and Social, Environmental and Economic Effects. The detailed requirements of each category are summarized in Table 1. Of the total possible score of 300, a gold rating requires a score of at least 240, while a silver rating requires a score of at least 180.

Once the owner of a hotel voluntarily submits an application and supporting materials to a municipal tourism authority, the authority completes a preliminary evaluation according to the standard. If the hotel scores at least 160, the municipal authority will recommend to the provincial authority that the hotel be approved for a green designation. The provincial authority then evaluates the hotel based on the supporting materials and test results from the environmental protection bureau about waste discharge, indoor air quality and noise levels.[1] Unfortunately, the diffusion of green hotels has been sluggish. According to the Beijing Tourism Development Committee,[2] as of 2012, only 276 hotels were green-certified, accounting for less than 3% of all hotels in Beijing.[3] Hoteliers are wary of the current emphasis on green hotel development as the link between the environmental performance and hotel profitability is tenuous (Butler 2008, Dief and Font 2010, Lee *et al.* 2010, Kang *et al.* 2012). Therefore, it is of great importance to provide empirical evidence about the market performance of green hotels to encourage hoteliers to embrace the green standard.

Data

Sample and Variables

We study hotels in Beijing, China's capital, due to better data availability. Several unique datasets were compiled. As introduced above, by the end of

[1]See the Beijing Tourism Development Committee Website (http://www.bjta.gov.cn/xxgk/zcwj/xybz/338947.htm) for more details on the application and evaluation procedures.

[2]http://www.bjta.gov.cn/tsfwzt/qyml/345517.htm

[3]There are a total of 9,926 hotels in Beijing (http://www.ctrip.com/).

Table 1 ■ Evaluation standards of green hotels.

Items		Scores
1	**Green Design**	**16**
1.1	Landscape and biodiversity	2
1.2	Thermal, acoustic and lighting quality of buildings	4
1.3	Application of renewable energy (*e.g.*, solar, biological, wind and geothermal energy)	5
1.4	Other green design methodology (*e.g.*, graywater reuse systems)	5
2	**Energy Conservation**	**88**
2.1	Energy monitoring (*e.g.*, energy submetering systems)	38
2.2	Efficiency of energy-consuming equipment	19
2.3	Application of energy-saving technologies	17
2.4	Application of water-saving technologies	14
3	**Environment Protection**	**56**
3.1	Control of pollution (*e.g.*, liquid waste, gaseous waste, solid waste and noise)	29
3.2	Adoption of environmentally friendly products	10
3.3	Indoor air quality	6
3.4	Indoor and outdoor planting	11
4	**Green Products and Services**	**69**
4.1	Green rooms (*e.g.*, smoke-free rooms, ventilation systems and reduced resource consumption)	36
4.2	Green food and beverage services (*e.g.*, organic food, recyclable utensils)	21
4.3	No use of products from firms that pollutes the environment	3
4.4	Consumption of other resources (*e.g.*, paper, detergent)	9
5	**Social, Environmental and Economic Effects**	**71**
5.1	Social and environmental effects (*e.g.*, environment-related awards from the government)	16
5.2	Economic effects (*e.g.*, ratio of energy costs to total operating revenue)	18
5.3	Environmental management system	37
Total		**300**

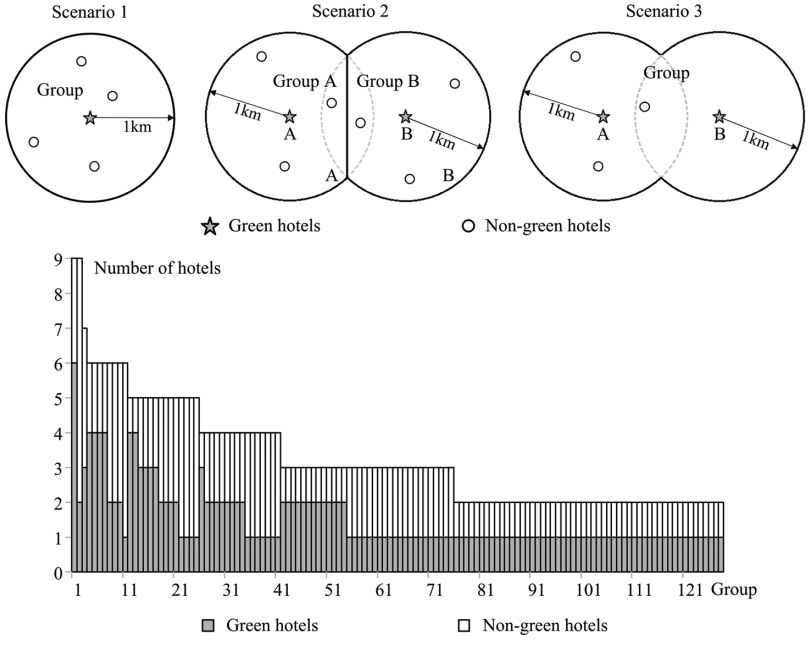
Source: Beijing Tourism Development Committee (http://www.bjta.gov.cn/xxgk/zcwj/xybz/338947.htm)

2012, there were 276 green-certified hotels in Beijing,[4] of which 195 hotels could be found on *Ctrip*,[5] a leading Chinese hotel reservation website. We then used *Ctrip* to search for nongreen hotels within a 1 km radius of

[4]Although there were 10 hotels certified by LEED or Chinese Green Building Label, we focus on hotels certified by the China National Tourism Administration program, because, as explained in the previous section, it is a more holistic standard for green hotels.

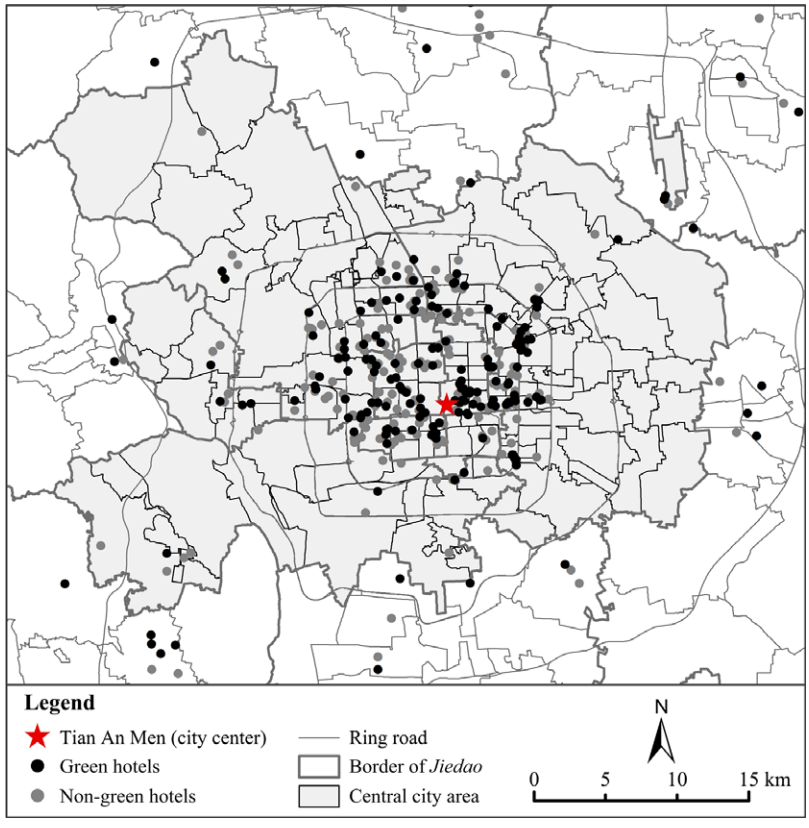
[5]http://www.ctrip.com/

Figure 1 ■ Construction of comparable project groups and sample composition.



each green hotel as the control group. The rules for constructing comparable project groups are shown in Figure 1. In particular, if a nongreen hotel is within a 1 km range of two different green hotels, it will be allocated to the comparable project group of the closer green hotel (scenario 2 in Figure 1). If all nongreen hotels within 1 km of green hotel B are grouped into another green hotel A's comparable project group according to the previously described rule, then green hotel B will also be included in the comparable project group (scenario 3 in Figure 1). In this way, 223 nongreen hotels were matched to 192 green hotels, forming 128 groups. Three green hotels could not be matched with any nongreen hotels and thus are excluded from the following analysis. One group typically consists of one green hotel and at least one matched nongreen hotel following scenario 1 or 2, while 42 groups contain more than one green hotel, as shown in scenario 3. Hotels in the same group, either green or nongreen, can be reasonably expected to share some common characteristics, especially from the perspective of location and market conditions. The geographical distribution of the green and nongreen hotels in the sample is depicted in Figure 2.

Figure 2 ■ Distribution of green and comparable nongreen hotels.
[Color figure can be viewed at wileyonlinelibrary.com]



Source: Authors' calculations based on data from www.bjta.gov.cn.

In addition to green certification indicators (*GREEN*, *GOLD*, *SILVER*), we also collected other hotel attributes. *Ctrip* defines four quality levels for hotels, and we follow their labels, using dummies of *ECONOMY*, *MIDSCALE*, *UPSCALE* and *LUXURY* to indicate hotel quality.[6] We also obtained customer ratings for hotel location, facility, service and hygiene (*SCORE_LOCATION*, *SCORE_FACILITY*, *SCORE_SERVICE*, *SCORE_HYGIENE*) from the website. Other hotel attributes include hotel brand, number of rooms and age. A

[6]The star grades awarded by the China National Tourism Administration are not used, as half the hotels in the sample, including some upscale and luxury hotels, have not been rated by the system.

dummy variable, *FAMOUS*, is introduced to indicate whether the hotel is a prestigious foreign hotel brand such as Hilton, Marriott, InterContinental, Wyndham, Choice, Accor, Starwood, Best Western, Carlson Rezidor and Hyatt.[7] Hotel scale is measured by the total number of rooms (*ROOMNUM*). As for hotel age, the literature always adopts effective age, which is calculated as the time elapsed since the last renovation (Corgel, Liu and White 2015). This is optimized by two variables: a dummy variable indicating whether the hotel has been renovated (*RENOVATION*) and the year since opening or the latest renovation (*AGE*).

Propensity Score Matching

We adopted propensity score matching (PSM) procedures to match each green hotel with the hotel that was most similar from the comparable but nongreen group (Deng, Li and Quigley 2012, Deng and Wu 2014). We followed this process in order to avoid the potential problem that apparent difference in outcome between green and nongreen hotels may depend on characteristics that determined whether the hotel received green certification, instead of green certification itself.[8] The propensity scores, which reflect the probability that the attributes of nongreen hotels are identical to those of the green hotels, are estimated by the Probit model specified in Equation (1):

$$\text{Prob}(GREEN_i) = \alpha + \boldsymbol{\beta}\,\mathbf{L_i} + \boldsymbol{\gamma}\,\mathbf{S_i} + \boldsymbol{\delta}\,\mathbf{X_i} + \varepsilon_i. \quad (1)$$

In this formulation, $GREEN_i$ indicates whether hotel i has been awarded green certification; $\mathbf{L_i}$ is a vector of hotel quality levels with *ECONOMY* being the reference; $\mathbf{S_i}$ are the scores for hotel location, facility, service and hygiene; $\mathbf{X_i}$ are other attributes, including *FAMOUS*, ln(*ROOMNUM*), *RENOVATION*, *AGE* and AGE^2; α is a constant; $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ are coefficients; and ε_i is the error term. With such procedures, we matched 156 green hotels with 156 nongreen hotels, and 36 green hotels were dropped because they could not be matched to any nongreen hotels in the group.

[7]Famous hotel brands are identified according to the "Hotel 325 Rank" by *HOTELS*, which is a leading magazine in the hospitality field (http://www.hotelsmag.com/). The top 10 foreign hotel brands are included here. Chinese hotels, such as Home Inns, are excluded as they are all economy hotels and their rank is mainly attributed to their size while foreign brands are all luxury hotels.

[8]As a robustness check, we also tried directly using all the 192 green hotels and 223 nongreen hotels in the 128 groups without PSM matching, and all the following empirical findings remained consistent. The results are available upon request.

Customer Satisfaction and Room Rate

Customer satisfaction and daily room rate are two sets of dependent variables and obtained from *eLong*, another leading Chinese hotel reservation website.[9] All 225,861 reviews written during the period of 2014–2015 for the 269 hotels in the sample were collected.[10] Online reviews reflect customers' experiences that these customers think will be of high reference value to other customers as they choose a hotel. Given the aforementioned potential incentives for customers to choose green hotels, a set of keywords was established relating to indoor environmental quality and environmental responsibility, respectively. Indoor environmental quality is a measure of living comfort, including temperature, humidity, acoustics, lighting and indoor air quality (Abbaszadeh *et al.* 2006, Lee and Guerin 2010, Zuo and Zhao 2014, Zhang *et al.* 2017). Customer satisfaction levels regarding indoor environmental quality and environmental responsibility (*REVIEW_IEQ*, *REVIEW_ENV*) are measured by calculating the ratio of compliments in customer reviews minus the ratio of complaints in customer reviews. We also analyze the complaint rates in particular (*REVIEW_IEQ_NEG*, *REVIEW_ENV_NEG*), as negative reviews are of particular interest and a cause of angst to hoteliers (Levy, Duan and Boo 2013).[11]

Taking the negative reviews about temperature as an example, the reviews containing keywords relating to indoor temperature were first searched, such as "temperature" (*wen-du*), "hot" (*re*), "warm" (*nuan*), "cool" (*liang*), "cold" (*leng*), "freezing" (*dong*) and "air-conditioner" (*kong-tiao*). Reviews employing these words to describe features not related to temperature were then excluded. For instance, some reviews used "cold" to complain about reception staff or food and beverage. Finally, the reviews were read to identify whether the emotion expressed was negative, and the number of reviews complaining about indoor temperature was counted. Similarly, keywords relating to environmental responsibility were identified, such as "green" (*lv-se*), "energy-saving" (*jie-neng*), "environmentally friendly" (*huan-bao*) and "sustainable" (*ke-chi-xu*). Based on the numbers of recognized positive and

[9]http://www.elong.com/. *Ctrip* and *eLong* are two of the most well-known hotel reservation websites in China, and they cover almost the same hotels in Beijing. We adopted *Ctrip* in the hotel selection procedures because it provides more completed and detailed information on hotel attributes, and used *eLong* to collect room rate and comment data because its website is friendlier to our data collection program.

[10]To avoid a biased conclusion from limited observations, hotels with no more than eight reviews (accounting for 1% of the sample) are dropped from the analysis on customer reviews.

[11]Clemons and Gao (2008) find that hotel customers exhibit "satisfying" rather than "optimizing" behavior. In other words, there is a quality threshold when they select a hotel. Therefore, customers will be more strongly influenced by the absence of strong negative reviews than by the presence of strong positive reviews.

negative reviews, four ratio variables (*REVIEW_IEQ*, *REVIEW_ENV*, *REVIEW_IEQ_NEG* and *REVIEW_ENV_NEG*) were calculated.

The second dependent variable is the daily room rate (*R*) offered online, which was also collected on *eLong*. It is noteworthy that, like most hotel reservation websites around the world, the hotel room rates offered via *eLong* are set by the so-called "dynamic pricing" technique, which takes actual demand and occupancy conditions into consideration (Oses, Gerrikagoitia and Alzua 2016a, b). Such room rates are actually marginal prices at a particular point in time, instead of traditional average daily rates (ADRs).[12] To ensure representativeness, the room rate data were collected for a period of four separate weeks during 2015–2016, including one week in summer, one week in winter and two weeks in spring to represent different weather conditions, and this period covers a public holiday (January 1–3, 2016). Within each week, we collected room rates for all seven days, including both weekdays and weekends. As customers always book hotels in advance, we searched for the hotel room rate one day in advance of the target date. The most typical room type for each hotel is chosen to determine the room rate, with rooms on the executive floors excluded. Breakfast prices are deducted if they are included in the daily room rate. The room rates of standard rooms and suites are distinguished by the dummy variable (*SUITE*), and *ROOMSIZE* is the floor area of the room.

Table 2 provides definitions and summary statistics for all variables. Of the online reviews, the complaint rate about indoor environmental quality and environmental responsibility is 6.854% and 0.019%, respectively, implying that environmental responsibility is seldom mentioned in hotel customer reviews. The daily room rates for the green and nongreen hotels average CNY 810 and CNY 736, respectively, providing preliminary evidence for a green price premium, while more definitive conclusions are provided later.

[12]Theoretically, the combination of ADR and occupancy rate, or revenue per available room (RevPar = ADR*occupancy rate), could directly measure the financial performance of hotels, but in most cases, such indicators are not available (Oses, Gerrikagoitia and Alzua 2016c). In particular, hotel-level information on occupancy and RevPar is regarded as a key business secret of hotels (Israeli 2002; Abrate, Fraquelli and Viglia 2012; Oses, Gerrikagoitia and Alzua 2016c; Pan and Yang 2017). The popularity of online travel agents provides a new source for hotel data collection. The room rates offered online are set by "dynamic pricing"—the seller uses real-time sales data from the realized demand to fine-tune the occupancy rate estimation and update the demand curve, and then increases the price if the expected demand increases (Gallego and Van Ryzin 1994; Lin 2006). Because of this price adjusting process, several recent studies suggest that such marginal room rates offered online include the information of both prices and occupancy rates to some extent, and thus employ this indicator to indicate the financial performance of hotels (Kuminoff, Zhang and Rudi 2010; Yacouel and Fleischer 2012; Oses, Gerrikagoitia and Alzua 2016a, c).

Table 2 ■ Definition and summary statistics of key variables.

Variables	Definition	*N*	Mean	*SD*	Min	Max
1. Green certification indicators						
GREEN	Whether the hotel is green-certified by Beijing Tourism Development Committee (1 = yes, 0 = o/w)	312	0.50	0.50	0	1
GOLD	Whether the hotel is gold-rated (1 = yes, 0 = o/w)	312	0.29	0.46	0	1
SILVER	Whether the hotel is silver-rated (1 = yes, 0 = o/w)	312	0.21	0.41	0	1
2. Hotel attributes						
ECONOMY	Whether the hotel is labeled as economy on *Ctrip* (1 = yes, 0 = o/w)	312	0.06	0.24	0	1
MIDSCALE	Whether the hotel is labeled as midscale on *Ctrip* (1 = yes, 0 = o/w)	312	0.32	0.47	0	1
UPSCALE	Whether the hotel is labeled as upscale on *Ctrip* (1 = yes, 0 = o/w)	312	0.42	0.49	0	1
LUXURY	Whether the hotel is labeled as luxury on *Ctrip* (1 = yes, 0 = o/w)	312	0.20	0.40	0	1
SCORE_LOCATION	Location score on *Ctrip* (1–5)	312	4.33	0.31	2.5	5
SCORE_FACILITY	Facility score on *Ctrip* (1–5)	312	4.08	0.41	1	4.8
SCORE_SERVICE	Service score on *Ctrip* (1–5)	312	4.21	0.38	1	4.8
SCORE_HYGIENE	Hygiene score on *Ctrip* (1–5)	312	4.31	0.34	2	4.9
FAMOUS	Whether the hotel is under the top 10 famous foreign hotel brands (1 = yes, 0 = o/w)	312	0.05	0.22	0	1
ROOMNUM	Total number of rooms in the hotel	312	243.4	159.9	22	1,092
RENOVATION	Whether the hotel is renovated (1 = yes, 0 = o/w)	312	0.62	0.49	0	1
AGE	Number of years since opening or the latest renovation	312	6.88	4.71	1	62

Table 2 ■ Continued.

Variables	Definition	*N*	Mean	*SD*	Min	Max
3. Customer satisfaction						
REVIEW_IEQ	Percentage of compliments minus complaints about the indoor environmental quality in customer reviews (%)	269	−5.18	4.28	−35.70	5.80
REVIEW_IEQ_NEG	Percentage of complaints about the indoor environmental quality in customer reviews (%)	269	6.85	4.57	0.00	43.76
REVIEW_ENV	Percentage of compliments minus complaints about environmental responsibility in customer reviews (%)	269	−0.004	0.08	−0.47	0.54
REVIEW_ENV_NEG	Percentage of complaints about environmental responsibility in customer reviews (%)	269	0.02	0.06	0.00	0.47
4. Room rates offered online						
R	Daily room rate (CNY)	14,050	773.7	604.7	81	5,851
SUITE	Whether the room is a suite (1 = yes, 0 = o/w)	14,050	0.42	0.49	0	1
ROOMSIZE	Room area (m^2)	14,050	41.6	20.2	12	145
5. Hotel performance indicators from statistics agency						
ADR	Average daily rate in 2016 (CNY)	138	526.6	230.6	157.7	1,779
OCCUPANCY	Average occupancy rate in 2016	138	0.66	0.15	0.14	0.91
REVPAR	Average revenue per available room in 2016 (CNY)	138	358.7	195.7	39.5	1,295
6. Outdoor conditions						
AQI	Air quality index	13,929	160.9	98.8	32	458

Empirical Analysis

Impact on Customer Satisfaction

We first compare the satisfaction levels of green and nongreen hotel customers based on the review data. To estimate the effect of green certification, we need to control for factors such as hotel quality level, location, facility, service, hygiene, hotel brand, scale and age. Considering unobserved characteristics, especially in terms of location and market conditions, we follow Eichholtz, Kok and Quigley (2010) and Zhang, Liu and Wu (2016) to take advantage of the inherent homogeneity between hotels in each group (within a 1 km radius) by including group-fixed effects in the model, as specified in Equations (2) and (3):

$$REVIEW\_IEQ_i = \alpha_1 + \eta_1 GREEN_i + \boldsymbol{\beta_1}\mathbf{L_i} + \boldsymbol{\gamma_1}\mathbf{S_i} + \boldsymbol{\delta_1}\mathbf{X_i} + \boldsymbol{\theta_1}\mathbf{G_i} + \varepsilon_i, \quad (2)$$

$$REVIEW\_ENV_i = \alpha_1 + \eta_2 GREEN_i + \boldsymbol{\beta_2}\mathbf{L_i} + \boldsymbol{\gamma_2}\mathbf{S_i} + \boldsymbol{\delta_2}\mathbf{X_i} + \boldsymbol{\theta_2}\mathbf{G_i} + \varepsilon_i, \quad (3)$$

where $GREEN_i$ indicates whether hotel i is awarded green certification; $\mathbf{G_i}$ is a vector of dummies representing the group in which each hotel is located; the other variables are the same as in Equation (1). The results are reported in Table 3. It is clear from columns (1) and (2) that, after controlling for other variables, green hotels receive more positive reviews than their counterparts do in terms of indoor environmental quality, but the difference in reviews concerning environmental responsibility is not significant.

Some studies suggest that, compared with positive reviews, negative reviews are more credible and altruistic (Papathanassis and Knolle 2011). Therefore, in columns (3) and (4), we focus on the negative reviews and replace the dependent variable with the complaint rates. The results do not change qualitatively, suggesting that, *ceteris paribus*, green hotels tend to receive lower complaint rates about indoor environmental quality than nongreen hotels, with a significant gap of 1.4%, and thus the complaint rate for green hotels is 19% lower than the average complaint rate for nongreen hotels. The result in column (4) also suggests that there is no significant difference between green and nongreen hotels in terms of number of reviews mentioning energy savings or environmental protection. In fact, environmental responsibility-related keywords are rarely mentioned in the reviews, implying that hotel customers care little about this issue when choosing or evaluating hotels. This finding is consistent with the results of Kasim (2004), suggesting that residents do not consider environmental issues when they choose a hotel, regardless of their environmental behaviors when they are at home.

As for control variables, the complaint rate for indoor environmental quality is lower for hotels with better hygiene conditions. The model estimate exhibits

Table 3 ■ Comparison of green and nongreen hotel customer reviews.

	Positive Reviews – Negative Reviews				Negative Reviews			
	(1)		(2)		(3)		(4)	
Dependent Variable	*REVIEW_IEQ*		*REVIEW_ENV*		*REVIEW_IEQ_NEG*		*REVIEW_ENV_NEG*	
GREEN	1.03*	(1.7)	−0.00	(−0.1)	−1.44**	(−2.3)	−0.01	(−0.8)
MIDSCALE	3.59	(0.7)	−0.05	(−0.8)	−4.90	(−0.9)	−0.00	(−0.1)
UPSCALE	3.99	(0.8)	−0.04	(−0.7)	−5.34	(−1.0)	0.00	(0.0)
LUXURY	4.54	(0.9)	−0.04	(−0.6)	−5.94	(−1.1)	0.00	(0.1)
SCORE_LOCATION	4.32	(1.6)	0.03	(0.5)	−3.81	(−1.6)	−0.06	(−1.0)
SCORE_FACILITY	−7.88**	(−2.2)	0.14	(1.2)	5.28	(1.5)	−0.16	(−1.6)
SCORE_SERVICE	−4.64	(−1.5)	−0.08	(−0.7)	5.54*	(1.8)	0.16	(1.5)
SCORE_HYGIENE	14.42***	(3.2)	−0.09	(−0.9)	−12.22***	(−2.8)	0.04	(0.5)
FAMOUS	−0.53	(−0.4)	−0.00	(−0.1)	0.17	(0.1)	0.00	(0.0)
ln(*ROOMNUM*)	−0.68	(−0.9)	−0.00	(−0.2)	0.13	(0.2)	0.01	(0.7)
RENOVATION	−0.08	(−0.1)	0.03	(1.1)	−0.42	(−0.5)	−0.02	(−0.9)
AGE	1.24**	(2.3)	−0.01	(−0.8)	−1.48**	(−2.6)	−0.00	(−0.0)
AGE^2	−0.07*	(−1.9)	0.00	(0.8)	0.08**	(2.2)	−0.00	(−0.2)
Group-fixed effects	Yes		Yes		Yes		Yes	
Constant	−39.78***	(−4.7)	0.04	(0.2)	41.22***	(4.9)	0.05	(0.3)
Observations	269		269					
Adj R^2	0.26	−0.25	0.34	−0.27				

Notes: Robust *t*-statistics in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

a U-shaped relationship between the complaint rate and hotel age, implying that the complaint rate is high for too new or too old hotels.

Existence of Green Price Premium

A more direct question for hoteliers is whether the adoption of green practices can produce significant economic returns. The hedonic pricing model is employed, which regresses prices on product attributes to estimate consumers' marginal willingness-to-pay for the individual attributes of a differentiated product (Rosen 1974, Kuminoff, Zhang and Rudi 2010). Following standard practices, we specify the hedonic pricing model with the following flexible functional form:

$$\ln(R_{it}) = \alpha + \eta\, GREEN_i + \boldsymbol{\beta}\, \mathbf{L_i} + \boldsymbol{\gamma}\, \mathbf{S_i} + \boldsymbol{\delta}\, \mathbf{X_i} + \theta \mathbf{G_i} + \rho\, \mathbf{T_t} + \varepsilon_{it}, \tag{4}$$

where $\ln(R_{it})$ is the log-transformed daily room rate of hotel i on date t; $GREEN_i$ is the dummy variable indicating green certification; $\mathbf{L_i}$, $\mathbf{S_i}$ and $\mathbf{X_i}$ are vectors of hotel attributes as described in Table 2, which cover the major hedonic characteristics of hotels suggested by Kuminoff, Zhang and Rudi (2010) and Corgel, Liu and White (2015); $\mathbf{G_i}$, a group indicator, is added to capture the influence of potentially omitted locational characteristics and market conditions; $\mathbf{T_t}$ is a vector of date dummies to control for the time trends of hotel room rates and ε_{it} is the error term and clustered at the hotel level.

The first column in Table 4 reports the result of Equation (4). *Ceteris paribus*, rooms in green hotels can enjoy a price premium of about 6.5% ($\exp(0.0632) \approx 1.065$) compared with their nongreen counterparts, and the coefficient is significant at the 1% level. Given that the daily room rates of nongreen hotels averages CNY 736, a room in a green hotel will command a price premium of approximately CNY 48 per day. The coefficients of the control variables are generally consistent with expectations, and the explanatory power of the model is 83.9%.[13] In column (2), two dummy variables are used to denote rating levels, suggesting that gold-rated and silver-rated hotels can command a premium of 6.6% and 6.4%, respectively.

Considering that the prices of green and nongreen hotels may also differ in the marginal prices of other hedonic attributes that are not related to "greenness," as a robustness check, in the latter two columns of Table 4, we further introduce the interaction terms between the green certification

[13]The green price premium does not vary significantly between weekdays and weekends or holidays. The results are not reported here to save space, but are available upon request.

Table 4 ■ Price premium of green hotels.

	(1)		(2)		(3)		(4)	
Dependent Variable	ln(*R*)		ln(*R*)		ln(*R*)		ln(*R*)	
GREEN	0.06***	(2.6)			1.11*	(1.7)		
GOLD			0.06**	(2.1)			1.18*	(1.9)
SILVER			0.06*	(1.8)			1.11*	(1.7)
*GREEN * SUITE*					0.11	(1.4)	0.12	(1.4)
GREEN * ln(*ROOMSIZE*)					−0.03	(−0.2)	−0.03	(−0.3)
*GREEN * MIDSCALE*					0.00	(0.0)	0.01	(0.1)
*GREEN * UPSCALE*					0.07	(0.5)	0.07	(0.5)
*GREEN * LUXURY*					−0.02	(−0.1)	−0.02	(−0.2)
*GREEN * SCORE_LOCATION*					−0.21	(−1.5)	−0.22	(−1.6)
*GREEN * SCORE_FACILITY*					−1.04***	(−3.1)	−1.11***	(−3.2)
*GREEN * SCORE_SERVICE*					−0.14	(−0.5)	−0.13	(−0.5)
*GREEN * SCORE_HYGIENE*					1.26***	(2.9)	1.34***	(3.1)
*GREEN * FAMOUS*					0.16	(1.3)	0.16	(1.3)
GREEN * ln(*ROOMNUM*)					−0.07	(−1.4)	−0.09*	(−1.7)
*GREEN * RENOVATION*					−0.17**	(−2.5)	−0.16**	(−2.3)
*GREEN * AGE*					−0.03**	(−2.4)	−0.03**	(−2.4)
SUITE	0.45***	(10.6)	0.45***	(10.6)	0.42***	(6.8)	0.42***	(6.7)
ln(*ROOMSIZE*)	0.31***	(5.0)	0.31***	(5.0)	0.28***	(3.1)	0.29***	(3.2)
MIDSCALE	0.43***	(7.7)	0.43***	(7.7)	0.42***	(5.1)	0.39***	(4.9)

Table 4 ■ Continued.

	(1)		(2)		(3)		(4)	
Dependent Variable	ln(*R*)		ln(*R*)		ln(*R*)		ln(*R*)	
UPSCALE	0.65***	(10.2)	0.65***	(9.8)	0.59***	(6.5)	0.56***	(6.1)
LUXURY	1.00***	(11.7)	1.00***	(11.2)	0.96***	(7.5)	0.93***	(7.3)
SCORE_LOCATION	0.25**	(2.5)	0.25**	(2.5)	0.39***	(3.1)	0.41***	(3.3)
SCORE_FACILITY	−0.17	(−1.1)	−0.17	(−1.1)	0.56*	(1.9)	0.62**	(2.1)
SCORE_SERVICE	−0.00	(−0.0)	−0.00	(−0.0)	0.20	(0.9)	0.19	(0.9)
SCORE_HYGIENE	0.31	(1.5)	0.31	(1.5)	−0.62*	(−1.8)	−0.69**	(−2.0)
FAMOUS	0.34***	(5.8)	0.34***	(5.8)	0.26***	(3.0)	0.26***	(3.0)
ln(*ROOMNUM*)	0.04	(1.4)	0.04	(1.3)	0.11***	(2.7)	0.10***	(2.6)
RENOVATION	−0.03	(−0.7)	−0.03	(−0.7)	0.06	(1.2)	0.06	(1.1)
AGE	0.01	(0.9)	0.01	(0.9)	0.01	(1.2)	0.01	(1.2)
AGE^2	−0.00	(−1.2)	−0.00	(−1.2)	0.00	(1.3)	0.00	(1.5)
Time-fixed effects	Yes		Yes		Yes		Yes	
Group-fixed effects	Yes		Yes		Yes		Yes	
Constant	2.42***	(5.3)	2.43***	(5.3)	1.66***	(3.1)	1.67***	(3.1)
Observations	14,050		14,050		14,050		14,050	
Adj R^2	0.84		0.84		0.85		0.85	

Notes: Robust *t*-statistics in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

indicator ($GREEN_i$) and hotel attributes ($\boldsymbol{L_i}$, $\boldsymbol{S_i}$ and $\boldsymbol{X_i}$) in the hedonic model. Based on the coefficients in column (3), we use the mean values of the 312 hotels for those independent variables ($\boldsymbol{L_i}$, $\boldsymbol{S_i}$ and $\boldsymbol{X_i}$) to estimate the daily room rates for green and nongreen hotels, which turn out to be CNY 651 and CNY 617, respectively. These results imply a green price premium of 5.5%, which is very close to the results based on the basic specification. We also reestimate the price premiums for gold and silver-rated hotels in column (4), and find that compared with all-else-equal nongreen hotels, the gold-rated hotels enjoy a premium of 8.4% in room rates, and the corresponding premium for silver-rated hotels is only 1.5%.

These results remain robust when we take hotels' performance in occupancy rate into consideration by introducing another dataset. The data are provided by a local professional statistics agency,[14] which conducts regular surveys on ADRs and occupancy rates for major hotels in Beijing. With the help of this statistics agency, we are able to get the microlevel data of average ADRs and occupancy rates in 2016 for 138 hotels in our sample, consisting of 102 green hotels and 36 nongreen hotels. In Table 5, we reestimate the price premium using the model in Equation (4).[15] In column (1), we focus on the effect on the *ADR*. The green price premium reaches 10.5% and is significant at the 1% level, which is consistent with the finding based on the room rates offered online. Meanwhile, we find no significant difference in occupancy rate (*OCCUPANCY*) between green and nongreen hotels, as shown in column (2). Furthermore, the revenue per available room is calculated ($REVPAR = ADR * OCCUPANCY$) and used as the dependent variable in column (3). The coefficient of *GREEN* turns out to be significant at the 10% level and indicates that green hotels enjoy a premium of 8.3% in *REVPAR* compared with their nongreen counterparts. These results suggest that the green hotels do achieve higher room rates without reducing occupancy rates, and provide more direct evidence on a better financial performance for green hotels.

Sources of Green Price Premium

To investigate the contributors to the green price premium, variables from customer reviews are introduced into the hedonic pricing model. According to the marketing literature, customer satisfaction is closely related to purchase

[14] As required by the data provider, we could not release its name here.

[15] Since this sample is relatively small and many nongreen hotels are not included, we eliminate the group-fixed effects in this model, but keep *SCORE_LOCATION* to control for the effects of location on hotel room rates. *SUITE*, *ROOMSIZE* and time-fixed effects are dropped, as the room rate is the average rate of different room types in each hotel during 2016.

Table 5 ■ Robustness checks.

	(1)		(2)		(3)	
Dependent Variable	ln(*ADR*)		ln(*OCCUPANCY*)		ln(*REVPAR*)	
GREEN	0.10***	(3.4)	−0.00	(−0.1)	0.08*	(2.1)
MIDSCALE	0.60***	(9.6)	−0.07	(−0.9)	0.46***	(3.2)
UPSCALE	0.69***	(16.3)	−0.08	(−1.2)	0.60***	(5.5)
LUXURY	0.89***	(20.0)	−0.13	(−1.7)	0.71***	(5.3)
SCORE_LOCATION	0.32**	(2.9)	0.02	(0.3)	0.32	(1.2)
SCORE_FACILITY	0.05	(0.3)	0.03	(0.4)	−0.01	(−0.1)
SCORE_SERVICE	−0.25	(−0.8)	0.18	(1.1)	0.19	(0.4)
SCORE_HYGIENE	0.69*	(1.8)	0.04	(0.2)	0.81	(1.1)
FAMOUS	0.36**	(2.6)	0.04	(1.2)	0.43**	(2.8)
ln(*ROOMNUM*)	−0.05	(−1.3)	0.02	(0.9)	−0.03	(−0.7)
RENOVATION	0.07	(1.2)	−0.00	(−0.1)	0.10	(1.2)
AGE	−0.00	(−0.2)	0.00	(1.5)	0.01	(1.1)
AGE^2	0.00	(0.2)	−0.00	(−0.7)	−0.00	(−0.6)
Constant	2.07***	(3.3)	−0.53	(−1.7)	−0.49	(−0.4)
Observations	138		138		138	
Adj R^2	0.66		0.28		0.61	

Notes: Robust *t*-statistics in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

intentions and thus may directly influence price (Swan and Combs 1976, Xie, Zhang and Zhang 2014). Because review data are not available for all hotels, we first reestimate the hedonic pricing models using the hotels whose review data are accessible, as a benchmark for the following models including customer reviews as explanatory variables. The coefficient of *GREEN* decreases slightly but is still significant in columns (1) and (2) of Table 6.

Then, we introduce *REVIEW_IEQ* and *REVIEW_ENV* in the model. The result in column (3) suggests that the more satisfied customers are with indoor environmental quality, the higher price the hotel will command, and these results show statistical significance. By contrast, the coefficient of *REVIEW_ENV* is positive but not statistically significant, suggesting that environmental responsibility has no significant influence on daily room rates. More importantly, with *REVIEW_IEQ* and *REVIEW_ENV* included in the model, the coefficient of *GREEN* decreases and stops being significant. In other words, the green price premium is almost fully explained by better customer reviews, implying that the price premium for green hotels is mainly driven by a higher level of customer satisfaction due to indoor environmental quality. The gold-rated and silver-rated hotels are distinguished in column (4), where customer reviews also perfectly explain their price premiums. We further focus on negative

Table 6 ■ Sources of green price premium.

Dependent Variable	(1) ln(*R*)		(2) ln(*R*)		(3) ln(*R*)		(4) ln(*R*)		(5) ln(*R*)		(6) ln(*R*)		(7) ln(*R*)	
GREEN	0.05*	(1.8)			0.04	(1.4)			0.03	(1.2)			0.06**	(2.1)
GOLD			0.07**	(2.1)			0.06	(1.6)			0.06	(1.6)		
SILVER			0.02	(0.6)			0.01	(0.3)			0.00	(0.1)		
REVIEW_IEQ					0.01**	(2.3)	0.01**	(2.2)						
REVIEW_ENV					0.03	(0.2)	0.02	(0.1)						
REVIEW_IEQ_NEG									−0.01**	(−2.3)	−0.01**	(−2.3)		
REVIEW_ENV_NEG									0.03	(0.2)	0.07	(0.3)		
*GREEN * AQI*													−0.00	(−0.2)
AQI													0.00	(1.4)
Control variables	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Time-fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Group-fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Constant	2.30***	(4.3)	2.35***	(4.4)	2.79***	(4.9)	2.82***	(5.0)	2.79***	(4.8)	2.84***	(4.9)	2.12***	(3.7)
Observations	12,286		12,286		12,286		12,286		12,286		12,286		6,337	
Adj R^2	0.85		0.85		0.85		0.85		0.85		0.85		0.85	

Notes: The control variables are consistent with columns (1) and (2) in Table 4. Robust *t*-statistics in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

reviews, namely, complaint rates, in columns (5) and (6). It seems that negative reviews have a slightly stronger impact on the company's image and consumer purchasing behaviors than total reviews, which is consistent with the existing literature (Mizerski 1982, Clemons and Gao 2008, Litvin, Goldsmith and Pan 2008). In summary, these results suggest that green hotels do enjoy a higher customer satisfaction level due to comfort improvement, and thus command a price premium.

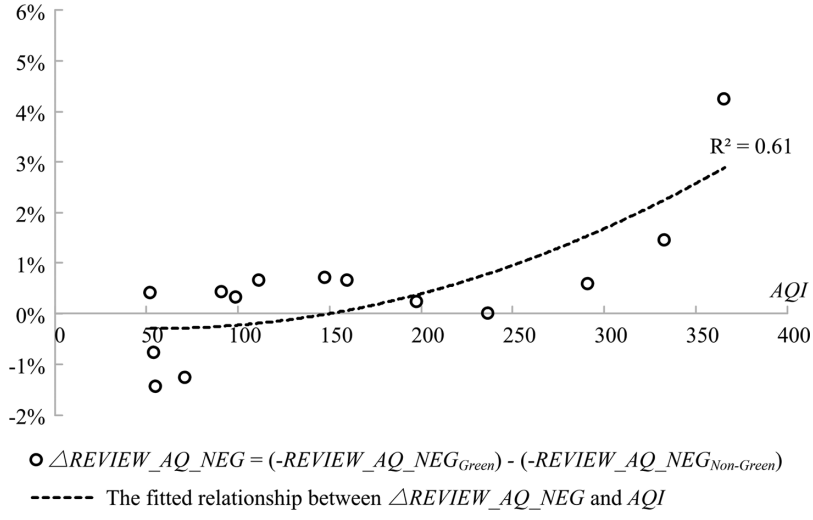
Our final question is whether the gap between green and nongreen hotels, in either comments or room rates, varies with outdoor conditions. A particularly interesting topic here is the effect of outdoor air quality. Given the severity of smog in large parts of China in recent years, Chinese people are willing to pay for self-protection products that offset some of their pollution exposure risks (Sun, Kahn and Zheng 2017, Zhang and Mu 2017). Indoor air quality improvement is a stated goal of green hotels (see item 3.3 in Table 1), which may also be one source of the green price premium. Therefore, we investigate the influence of outdoor air pollution on hotel room rates and customer reviews.

We adopt the air quality index (*AQI*) of each hotel's nearest monitoring station as the outdoor air quality indicator,[16] and introduce its interaction term with *GREEN* in the hedonic model in column (7) of Table 6, but find that the influence of air pollution on green price premium is not significant.[17] One possible explanation is that customers typically book hotels in advance and thus cannot predict the outdoor air quality. Therefore, air quality can hardly affect customers' booking behaviors. We further investigate the influence of *AQI* on the difference in customer satisfaction level about indoor air quality between green and nongreen hotels. In order to avoid the error caused by the small number of online reviews per hotel per day, we calculate the complaint rate of all green hotels and the complaint rate of all nongreen hotels every day. Figure 3 shows a positive relationship between *AQI* and $\triangle REVIEW\_AQ\_NEG$, implying that air pollution is likely to make green hotels more appealing. This is reasonable, as customers have already experienced the indoor air quality and green hotels might have demonstrated the advantage of improved indoor air quality. Overall, though we have not found a significant impact of air pollution on the price premium of green hotels, the impact of air pollution on the difference in customer satisfaction level between green and nongreen

[16] *AQI* ranges from 0 to 500, with a larger number indicating poorer air quality. Data source: Beijing Municipal Environmental Monitoring Center (http://www.bjmemc.com.cn/).

[17] In order to be consistent with the following analysis on customer reviews, we only use price data for days with review data.

Figure 3 ■ Influence of AQI on the difference in customer satisfaction level between green and nongreen hotels.



hotels does exist, and may further increase the price premium commanded by green hotels in the future.

Conclusion

As the green momentum grows globally, "going green" provides an excellent opportunity for hotels to reshape their competitive advantage. The existing literature emphasizes that green hotels can benefit from lower operating costs and contribute to substantial social and environmental gains (Kahn and Liu 2015). This article further investigates an important question for the owners and operators of hotels: whether "greenness" is valued by hotel customers, and if it is, how?

Based on several unique datasets, we combine the traditional hedonic pricing model with the state-of-the-art content analysis of online reviews. The difference in customer satisfaction with comfort level and environmental responsibility between green and nongreen hotels is analyzed. The results suggest that customers of green hotels are more satisfied with indoor environmental quality. Green hotels do command a significant premium of approximately 6.5% in room rates, and this result remains robust when we adopt another set of survey data considering occupancy rates. This premium can be fully explained by the lower rate of complaints about indoor environmental

quality. However, environmental responsibility, on the other hand, does not play a significant role in customers' evaluation of green hotels. In addition, though air pollution has no significant impact on the room rate premium of green hotels on a given day, the advantage of green hotels in terms of indoor air quality as revealed in customer reviews may still make green hotels more appealing in the future.

Although this study in Beijing points to a green price premium similar to that found in the U.S. study by Kuminoff, Zhang and Rudi (2010), the mechanisms for the price premium of green hotels are quite different. While customers' environmental consciousness positively affects the markets in developed countries, in this study, the role of enhanced living comfort in the China context is more important, which is similar to the finding of a study set in another developing country, Malaysia (Kasim 2004). These results may suggest that a gap exists between developing and developed countries, because the living comfort level in developing countries is still much lower (Zhu and Lin 2004); a more conclusive explanation is left to future research. Overall, the results here strongly suggest that "going green" may allow hotels to simultaneously reduce their operating costs and create a better indoor environment for customers in a way that is financially feasible.

This study provides the first evidence to promote an understanding of China's green hotel practices from an economic perspective, but several important issues require further research. First, findings based on Beijing data alone cannot necessarily be generalized to the whole country, so future research with a larger sample and that covers different cities would be helpful, especially if the data allow a comparison of the performance of green hotels in different climatic and socioeconomic conditions. Second, while this article highlights the importance of the indoor environmental quality of green hotels but finds no significant influence of customers' environmental responsibility, examining the impact of these factors on different customer segments would provide an important extension. Third, it is important to investigate the most cost-effective green building technology that can create synergies between the quality of customers' experience and hotels' environmentally responsible initiatives, and thus provide guidance to hoteliers about green practices.

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