



Article

Opaque or Transparent: Quality Disclosure Strategy for Accommodation-Sharing Platforms

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Abstract: Compared with the conventional hotel providing a standardized service, individual supply on an accommodation-sharing platform makes consumers uncertain about service quality, which is mainly caused by information asymmetry between the consumers and individual hosts. In this paper, we develop a game-theoretic model to study the accommodation-sharing platform's optimal quality information disclosure and its determining factors with consideration of consumer uncertainty. We find that it is optimal to provide either opaque, i.e., completely uninformative, or transparent, i.e., fully informative, quality information. We also examine the impacts of the incumbent hotel and market heterogeneity on the platform's quality disclosure. The results show that market heterogeneity and the hotel's service cost jointly affect the platform's information disclosure strategy. In general, the sharing platform provides opaque information when market heterogeneity is relatively low but provides transparent information when market heterogeneity is relatively high. However, when market heterogeneity is medium, the hotel's service cost plays a key role in affecting its pricing strategy, hence the information disclosure strategy of the platform. Specifically, a sufficiently high price of the hotel prompts the platform to disclose transparent information. These findings provide guidance for sharing platforms to design their information disclosure systems.

Keywords: e-commerce; platform; sharing economy; quality disclosure; consumer uncertainty



Citation: Fan, X.; Cheng, T.; Li, G. Opaque or Transparent: Quality Disclosure Strategy for Accommodation-Sharing Platforms. *J. Theor. Appl. Electron. Commer. Res.* **2022**, *17*, 414–438. <https://doi.org/10.3390/jtaer17020022>

Academic Editors: Eduardo Álvarez-Miranda and Inma Rodríguez-Ardura

Received: 14 November 2021

Accepted: 30 March 2022

Published: 2 April 2022

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1. Introduction

Advanced information technology has brought about the sharing economy, fueling the development of multiple sharing platforms such as Airbnb, Uber, and TaskRabbit, which enable people to share underutilized resources with others [1–3]. Serving as an alternative channel to access products and services, the sharing platform has a significant impact on traditional channels [4–6]. Among a myriad of sharing models, the accommodation-sharing service is an important representative. Governments in many countries, such as China and the United States, have developed policies to support and regulate accommodation-sharing platforms. As the world's largest accommodation-sharing platform, Airbnb offers over seven million properties across the world, providing alternatives to hotels of different types (e.g., budget, upscale, and mid-scale hotels) [7].

As a typical “experience good”, the quality of the accommodation service, especially the accommodation-sharing service provided by individual hosts, cannot be completely observed before consumer experience. Having existed for a long time with ample experience in developing standard service delivery and professional operating procedures, hotels are the incumbents in the lodging marketplace that enjoy a relatively high level of consumer trust. Relying on branding, advertisements and consumer reviews, hotels credibly convey their quality information to consumers. Compared with the conventional hotel, the accommodation-sharing platform offers more diversity of choice. For instance, it

offers more house structures such as castles and treehouses, more home amenities such as kitchens and laundries, and more authentic local experiences such as learning about the lived culture from the local hosts [8–10]. However, the individual and personalized supply of the accommodation-sharing service makes its service quality uncertain for consumers. As the host of the accommodation-sharing service is usually not a trained industry professional, consumers may worry about safety, unsatisfactory treatment or other unpleasant situations [11–14]. Competing as alternative service providers, hotels and accommodation-sharing platforms influence each other. As hotels are the incumbents in the industry, many researchers have investigated the impact of accommodation-sharing platforms on hotels. However, in this paper, we are interested in how the hotel affects the strategy of the entrant, i.e., the sharing platform.

In practice, the accommodation-sharing platform can regulate the service quality level of the individual host by checking that the listings on its website have met its standard. *“Unclear rules have made many people who used Airbnb as guests reluctant to take the next step and host”*, stated Airbnb after Japan legalized home sharing [15]. Many consumers have complained about the issues they have encountered with Airbnb, e.g., deceptive photos, review scams and threats, and terrible services that are dramatically different from expectations [16]. One of the primary reasons causing consumer uncertainty about the sharing service quality is the information asymmetry between consumers and individual hosts. Although many accommodation-sharing platforms, such as Airbnb, have established bilateral rating systems, which enable consumers and hosts to provide feedback on each other [17], reviews on a host may not tell the truth about its service quality. *“While most people aren’t likely to leave a positive review after a disappointing hotel stay, that’s not always true of a home share”*, said Georgios Zervas, who has analyzed hundreds of thousands of reviews on Airbnb [18]. Moreover, as reported by Vice [16], some consumers said that their bad reviews were hidden or removed entirely. Accordingly, the consumer will hesitate to experience the sharing service and those that are risk-averse will consider the conventional hotel as the best choice.

In essence, the sharing platform decides the “informativeness” level of the quality information. On the one hand, most sharing platforms provide an information list about the room attributes that hosts must provide, e.g., size and amenities. On the other hand, these platforms enable the hosts to autonomously hide or modify the adverse information to some extent [16,18]. Therefore, the quality information about the accommodation-sharing service that is accessible to consumers is limited [19]. For instance, by means of hiding negative reviews or posting deceptive photos to beautify the reality, hosts can attract some consumers that dare to experience new things, thus increasing the platform traffic despite reducing the informativeness of the quality information. As higher informativeness can help consumers make more appropriate choices between the hotel and the sharing service but ambiguous information may lead to more consumer attempts, how should the sharing platform decide the informativeness of the quality information with consideration of consumer uncertainty? Several empirical studies have examined the motivators and importance of information disclosure, such as personal profiles and consumer reviews, to gain trust from the perspective of individual hosts in the accommodation-sharing market [20–23]. By contrast, we develop an analytical model to examine the issue of quality information disclosure from the sharing platform’s point of view.

In general, the variety of service facilities and the quality of the facilities, environment, and labor service (e.g., the host’s hospitableness) can be broadly defined as the accommodation service quality. We observe that different sharing platforms have distinct quality disclosure strategies for their sharing services. For instance, for the accommodation-sharing service, most consumers are concerned about what amenities the host can provide. Taking the information about amenities for example, we can compare the information disclosed on Airbnb with that on HouseTrip (one of Europe’s largest holiday rental websites). As shown in Figure 1, the information about amenities shown on Airbnb is more detailed than that on HouseTrip. Airbnb even lists the amenities not included in the house to provide consumers

with more details, which makes consumers clearly understand what is available to them and what is not. In contrast, the information on HouseTrip is quite limited; it just shows the basic or characteristic amenities that are essential for almost all the accommodation services. This creates the question of why different platforms have different information strategies. We find that one important difference between Airbnb and HouseTrip is that Airbnb has more listings with heterogeneous quality levels, e.g., businesses like Airbnb Plus and Airbnb Luxe. This practice motivates us to question whether market heterogeneity shapes the information disclosure strategy of the sharing platform.

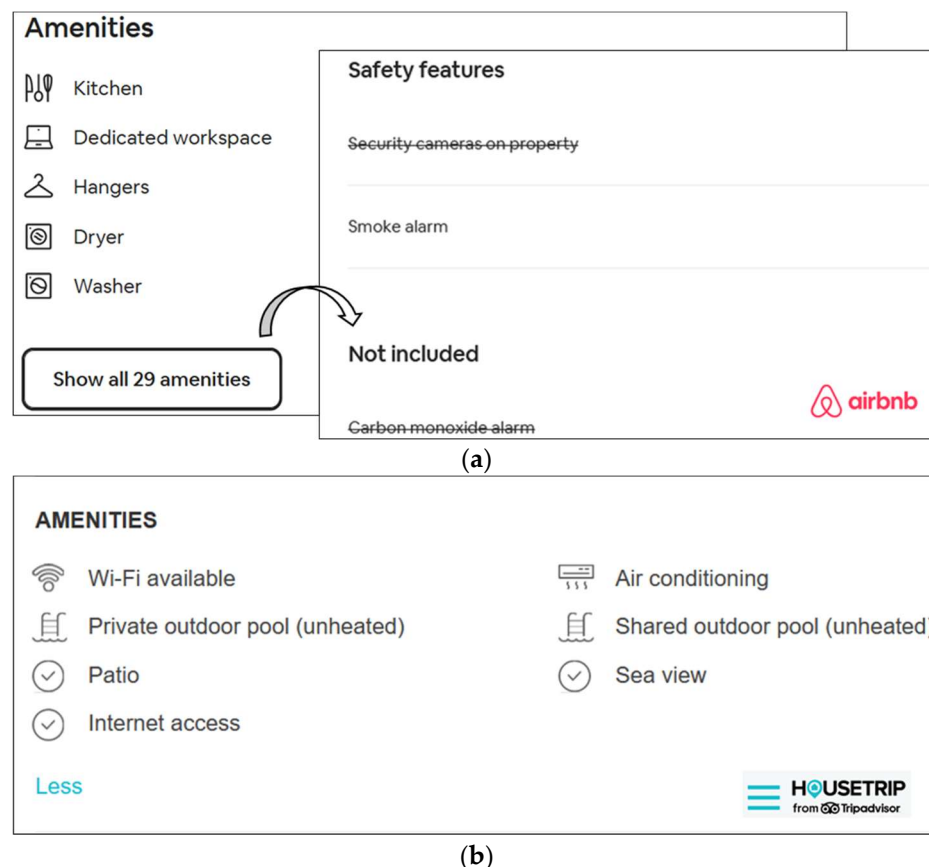


Figure 1. Displays of information disclosure on different sharing platforms. (a) Amenities information displayed on Airbnb. (b) Amenities information displayed on HouseTrip.

Motivated by the above observations and discussions, we pose three research questions. First, what is the optimal quality information disclosure strategy for the sharing platform? Second, how does the incumbent hotel influence the sharing platform's information strategy? Third, how does market heterogeneity affect the sharing platform's information strategy?

Attempting to answer these questions, we developed a game-theoretic model for the accommodation market that consists of an incumbent hotel providing a standard service whose quality is public knowledge and an accommodation-sharing platform offering services with different quality levels. We take consumer uncertainty into consideration and assume that consumers are heterogeneous in their perception uncertainty about the sharing service quality. We characterize the quality disclosure strategy of the sharing platform and find that it is optimal to provide either opaque, i.e., completely uninformative, or transparent, i.e., fully informative, information. We also analyze the impact of the incumbent hotel on the platform's quality disclosure. The results show that the hotel's service cost and, thus, the price have a significant effect on the platform's information strategy. Specifically, a sufficiently high price of the hotel prompts the platform to disclose

transparent information. Finally, we examine the impact of market heterogeneity on the platform's quality disclosure. In general, the sharing platform provides opaque information when market heterogeneity is relatively low but provides transparent information when market heterogeneity is relatively high. However, when market heterogeneity is medium, the hotel's service cost plays a key role in affecting the platform's information disclosure strategy by shaping the hotel's price. Interestingly, we show that the hotel always earns more profit when the platform provides opaque information.

Our results make three contributions to the literature on the sharing economy: First, we study the quality disclosure strategy from the perspective of the accommodation-sharing platform by developing an analytical model. We find that opaque or transparent quality information disclosure is always more beneficial to the sharing platform than partially informing the consumers. Second, we take consumer uncertainty into consideration and suggest that consumer uncertainty is a double-edged sword for the sharing platform. Higher consumer uncertainty enables the host to charge a premium price while leading to demand shrinkage of the platform. The platform should trade off these two effects of consumer uncertainty when developing an information strategy. Third, we examine the effect of the incumbent hotel on the entrant platform's information strategy. We also provide insight into the whole accommodation market in how the incumbent's quality positioning in the market and market heterogeneity jointly determine the market equilibrium. To the best of our knowledge, how to disclose quality information on the sharing platform has not been well explored. We believe that our findings can add a missing piece of knowledge on quality information disclosure and platform operations management.

We organize the rest of the paper as follows. In Section 2, we review the related literature. In Section 3, we present our model setup. In Section 4, we examine the hotel's optimal pricing strategy and the sharing platform's strategic response to the hotel's price, i.e., its information disclosure decision, analytically characterizing the impact of the model parameters on the equilibrium outcomes. Finally, in Section 5, we conclude the paper and suggest topics for future research.

2. Literature Review

As an emerging phenomenon, the sharing economy has recently received extensive research attention. We discuss three main streams of the literature related to our research.

2.1. Impact of Accommodation-Sharing Platforms on Hotels

As a major player in the sharing economy, the hotel industry is recognized to be most affected by the emergence of accommodation-sharing platforms [1,14,24]. There is burgeoning literature studying the influence of accommodation-sharing platforms on hotels. On the one hand, some studies support that the rapid growth of accommodation-sharing platforms negatively influences the performance of hotels [25,26]. Blal et al. [27] identified the substitution effect between Airbnb and traditional hotels, and thus Airbnb has a disruptive impact on the growth of hotel revenue. Farronato and Fradkin [28] found that in the ten US cities with the largest share of Airbnb bookings, hotel night bookings decrease by 1.3% and hotel revenue decreases by 1.5%. Li and Srinivasan [29] suggested that Airbnb may disrupt the traditional seasonal pricing and even lead to counter-seasonal pricing of hotels. Indeed, the rapid permeation of accommodation-sharing platforms has affected hotels. Furthermore, there are different views on the classes of hotels that are mostly substituted by the accommodation-sharing service. Zervas et al. [25] observed that low-end and non-business hotels are most affected by Airbnb in Texas, whereas Guttentag and Smith [7] found that many consumers principally use Airbnb's service as a substitute for mid-scale hotels. Dogru et al. [26] showed that luxury hotels are hit by increases in Airbnb supply to the same extent as economy hotels.

On the other hand, some studies suggest that accommodation-sharing platforms have just brought additional consumers that would not otherwise choose hotels to the market and have not damaged hotel performance. Collecting and analyzing accommodation

market data in Boston, Mody et al. [30] found that Airbnb and hotels target different consumer segments and that the negative influence of Airbnb, if any, is very slight.

Previous research typically focused on the impact of accommodation-sharing platforms on hotels and was mostly based on empirical analysis. In contrast, we developed an analytical model and focused on how the hotel influences the strategy of the accommodation-sharing platform. We find that serving as an incumbent in the industry, the hotel's quality positioning in the market can significantly impact the competing sharing platform's information disclosure when the quality differentiation between the hotel and the sharing service is moderate, generating insight into the whole accommodation market.

2.2. Consumer Uncertainty

Our work is also closely related to the literature on consumer uncertainty. Urbany et al. [31] considered two types of consumer uncertainty, namely knowledge uncertainty (regarding information about alternatives) and choice uncertainty (about which alternative to choose). They found that choice uncertainty leads to increased consumer search behavior, whereas knowledge uncertainty has a slightly negative effect. Considering threads from behavioral economics, Chatterjee and Datta [32] proposed a model of consumer uncertainty in e-commerce and confirmed that three core e-commerce inefficiencies of seller anonymity and a lack of product and process transparency are the reasons causing consumer uncertainty. Moreover, the impact of consumer uncertainty about product fit or quality on firm decisions has been examined in the literature [33–36]. Specifically, some researchers have investigated the information strategies of competitive firms providing differentiated products, considering consumer uncertainty about product fit or quality [37,38]. Different from fit uncertainty, which is specific to a particular product for which consumers have heterogeneous preferences, quality uncertainty is specific to an individual. Hence, more quality information revelation will strictly reduce consumers' quality uncertainty [38]. In our study, we modeled consumers' quality uncertainty as a linear function of the quality information level, where greater information disclosure contributes to resolving consumer uncertainty. However, contrary to previous analysis suggesting that the elimination of consumer uncertainty will reduce decision reversals [39], Shulman et al. [40] incorporated behavioral theory of reference dependence into an analytical model and showed that the information provided to reduce consumer uncertainty may increase decision reversals under certain conditions with the support of both the model and experimental data.

Furthermore, empirical research on consumer uncertainty in the sharing economy, which is closely related to the trust problem, has recently been growing [22,41–44]. Similar to previous research on trust in the e-marketplace [45,46], Liang et al. [47] classified trust as institution-based trust (trust in Airbnb) and disposition to trust (trust in hosts) in the sharing economy. Showing that trust in Airbnb does not statistically have an impact on trust in hosts, they explored trust as a mediator between consumer satisfaction and repurchase intention. Phua [48] reviewed the complaints against Airbnb and showed that a crucial issue for consumers is concerning uncertainty and whether to trust Airbnb. The research also found that sharing economy platforms make consumers more uncertain than common business-oriented platforms.

Our work contributes to this stream of literature by considering the impact of consumer uncertainty in the context of the sharing economy, which is usually viewed as a barrier to consumer acceptance of the sharing service [22,41–44]. Our findings suggest that consumer uncertainty produces two opposing effects, namely price premium and demand shrinkage effects, which should be traded off by the sharing platform when developing its information disclosure strategy.

2.3. Quality Information Disclosure

Our study also contributes to the literature on quality information disclosure. Recognized as an important means of alleviating consumer uncertainty about product or service quality, quality information disclosure has been widely studied in the existing literature.

Previous research has studied the factors that have an impact on quality information disclosure, such as information disclosure cost [49], information acquisition cost [50,51], limited information understanding [52], disclosure format [53], and competition [54–56]. Moreover, researchers have also studied the amount of quality information disclosed by firms. For instance, Guo and Zhao [54] investigated the impact of competition and disclosure sequence on the amount of quality information disclosed by competitive firms with a positive disclosure cost. Sun [57] showed that a monopolist has the incentive to disclose favorable information but partially hides unfavorable information. Following [54], Ghosh and Galbreth [58] considered consumer attentiveness and search behavior in firms' quality disclosure under the assumption that firms choose to either disclose or not disclose quality information. Their research showed that less quality information should be revealed when more consumers are partially informed about only one firm or their search costs increase.

The impact of information generated by consumers, such as online reviews, on the sharing market has attracted attention in recent years [59,60]. However, in the sharing market, the seller/marketer-generated information seems even more important [61,62]. On the sharing platform, more effort is required for consumers to choose a product/service because the products/services on the platform are highly heterogeneous and personalized [63]. Moreover, due to the limited capacity of every product/service shared with consumers, the overall amount of consumer reviews for each product/service is scant [64]. These drive potential consumers to pay more attention to the information disclosed by sellers/markets. Nevertheless, limited research has explored information disclosure from the perspective of sellers/marketers in the sharing economy. Based on empirical analysis, researchers have studied the self-disclosure of hosts on accommodation platforms, such as a photograph of prominent appearance [22] and longer and readable self-descriptions [10,23], which help them win more trust and facilitate transactions. Liang et al. [20] empirically showed that high-quality consumer reviews and higher ratings are motivators behind hosts' disclosure intention. Using data from Airbnb, Liang et al. [21] confirmed the effectiveness of the information disclosed by hosts in driving consumer booking and review-posting behavior. Furthermore, modeling the matching process between buyers and sellers, Romanyuk [65] studied the information disclosure of matching platforms (e.g., Uber, Airbnb), which control the payoff-relevant information sellers observe about buyers before forming a match, and found that full information revelation is inefficient. Considering a service-sharing platform, Ke et al. [17] investigated the impact of bilateral ratings on market competition and segmentation. They found that with bilateral ratings, the platform may soften providers' competition, compared with only providers being rated.

Different from previous empirical studies on the disclosure strategy of consumer reviews or personal profiles from the perspective of individual hosts, we investigated how the sharing platform's information strategy influences consumers' quality perceptions about the sharing service and the market equilibrium by setting up an analytical model.

3. Model Setup

We developed a game-theoretic model for the accommodation market to characterize the accommodation-sharing platform's quality information disclosure and its determining factors. The model consists of an incumbent hotel, an accommodation-sharing platform with two communities of hosts, and a mass of consumers that are heterogeneous in their perception uncertainty about the sharing service quality.

3.1. Hotel

We considered a hotel A that offers a standard hotel service of quality q_A at price p_A per time period of unit length (e.g., one day). The rooms can be booked online. For simplicity, we assumed that a potential consumer would stay for a unit-length time. The service quality of the hotel is common knowledge to all the parties, which is a reasonable assumption because much information or experience of hotels can be easily obtained from advertisements, online consumer reviews, or third-party expert certifications. Without

loss of generality, we assumed that the unit-length service cost of the hotel with quality q_A is c_A ($c_A < p_A$) and denoted its profit as Π_A . Despite the rapid development of the accommodation-sharing service, hotels are still the industry leader as the incumbent.

3.2. Sharing Platform

Meanwhile, an accommodation-sharing platform B , which provides short-term accommodation services in heterogeneous quality levels, will enter the market and compete with hotel A . The hotel and the housings bookable on the sharing platform are in the same area in our research, which means that consumers can reach either the hotel or the housings on the sharing platform for almost the same travel cost. The accommodation-sharing platform acts as an intermediary to connect hosts and consumers. Furthermore, different from the hotel that can disclose quality information with freedom, hosts must reveal their quality information according to the requirement of the sharing platform. In essence, the accommodation-sharing platform decides the degree of informativeness of the quality information disclosed to consumers with a view to mitigating or eliminating consumer uncertainty about the service quality. Here, we ignored the scenario where the hosts and the sharing platform lie to consumers, i.e., the information revealed to consumers is truthful [66,67]. We used $I \in [0, 1]$ to denote the informativeness (accuracy and content) of the disclosed quality information [68]. We assumed that the sharing platform chooses I by deciding how much quality information to disclose to consumers [69]. A higher level of informativeness implies better information disclosure. Specifically, the quality information disclosed by the sharing platform is transparent, i.e., fully informative, when $I = 1$, and is opaque, i.e., completely uninformative, when $I = 0$. It is worth noting that $I = 0$ does not mean that there is no information but indicates that there is no informative quality information about the individual service beyond the public information that almost all the accommodation services must provide, such as supplying hot water and internet. For simplicity, we assumed that the cost of information disclosure of the sharing economy platform is zero. The sharing platform will charge a commission rate of δ ($0 < \delta < 1$) as a percentage of a host's posted price once the latter has completed a transaction with a consumer, which is the main component of the platform's revenue Π_B in our study. Without loss of generality, we assumed that δ is an exogenous variable.

3.3. Hosts

Following Weber [70], who considered accommodation-sharing services to be a mean-preserving spread of hotels, we assumed that there are two (communities of) hosts, denoted as L and H , that provide low-end and high-end accommodation-sharing services with quality q_L and q_H , respectively, where $q_L = q_A - \varepsilon$ and $q_H = q_A + \varepsilon$ are the true service quality levels of the two hosts. This assumption reflects that some services on the sharing platform are better whereas some are worse than that of the hotel. The parameter ε ($0 < \varepsilon < q_A$) represents the quality difference between the hotel and hosts, which we regarded as market heterogeneity of the hotel industry. We assumed that either type of host can accommodate all the demand [70]. Host i , $i \in \{L, H\}$, sets its price at p_i and incurs a unit-length service cost c_i ($0 < c_i < (1 - \delta)p_i$) for each room/house reservation. Without loss of generality, we let $c_L < c_H$. We denoted the profit of host i as Π_i . In addition, to characterize the price advantage of the accommodation-sharing services, we assumed $p_A > \frac{c_L + c_H}{2(1 - \delta)}$.

3.4. Consumers

Consumers are uncertain about the quality of the accommodation services provided by individual hosts, which may make them reluctant to choose the accommodation-sharing platform as an alternative channel for hotel service acquisition. One important reason is that the rooms on the sharing platform are provided by individual hosts with whom consumers are unfamiliar, and the service quality cannot be guaranteed without close supervision, although the hosts may provide consumers with wonderful services surpassing their

expectations. Moreover, consumers find it hard to fully perceive the true quality until they experience the actual service. Hence, the quality information consumers receive from the sharing platform is almost the only way to help them make purchase decisions.

In general, there is a gap between the true service quality and the quality consumers perceive when the quality information is not transparently disclosed. We used $\hat{\varepsilon}_i$ to denote consumers' perceived quality difference between the service of host i and the hotel, and consumers are normally heterogeneous in perceiving the service quality difference. Consistent with Yin et al. [71], we assumed that $\hat{\varepsilon}_i$ is uniformly distributed on the interval $[\varepsilon - \sigma_i^I, \varepsilon + \sigma_i^I]$ ($i \in \{L, H\}$), where σ_i^I represents the maximum degree of consumers' perception uncertainty of the service quality difference between host i and the hotel at the informativeness level I , which reflects the consumer uncertainty about the host's service quality. To simplify the calculations, we assumed that the consumer uncertainty is linear in the level of quality information disclosure. That is, $\sigma_i^I = (\underline{\sigma}_i - \bar{\sigma}_i)I + \bar{\sigma}_i$ and $0 < \underline{\sigma}_i < \bar{\sigma}_i < \varepsilon$, where $\underline{\sigma}_i$ represents the maximum degree of consumers' perception uncertainty with transparent quality information, i.e., $I = 1$, whereas $\bar{\sigma}_i$ represents the maximum degree of uncertainty with opaque quality information, i.e., $I = 0$. Indeed, we can show that other forms of the relationship between consumer uncertainty and informativeness level do not qualitatively change our results, as long as the consumer uncertainty decreases with the informativeness, which is intuitive that the more effective quality information is disclosed, the more accurate a consumer's perception is of the service quality (see the proof of Proposition 1 in Appendix A). It is noted that $\underline{\sigma}_i$ may be caused by the fact that consumers may doubt whether the actual quality of the accommodation-sharing service is consistent with their expectations, even though they possess transparent quality information; a typical example of which is the over-embellished pictures online. To simplify, we assumed that $\underline{\sigma}_L = \underline{\sigma}_H = \underline{\sigma}$ and $\bar{\sigma}_L = \bar{\sigma}_H = \bar{\sigma}$ ($0 < \underline{\sigma} < \bar{\sigma} < \varepsilon$). Then, we re-wrote the uncertainty of consumers' perception as $\sigma_L^I = \sigma_H^I = \sigma^I = (\underline{\sigma} - \bar{\sigma})I + \bar{\sigma}$, and $\hat{\varepsilon}_i$ follows a uniform distribution on $[\varepsilon - \sigma^I, \varepsilon + \sigma^I]$. Consumers may either over-estimate (with $\hat{\varepsilon}_L < \varepsilon$ or $\hat{\varepsilon}_H > \varepsilon$) or under-estimate (with $\hat{\varepsilon}_L > \varepsilon$ or $\hat{\varepsilon}_H < \varepsilon$) the true quality of the sharing service.

Naturally, we assumed that the consumers are segmented into three groups. One group of consumers care less about the accommodation service quality but prefers a low price. They are willing to look for an alternative with a lower price than the hotel. One group of consumers are less sensitive to price but is concerned more about the service quality. They have a willingness to search for an alternative with a higher quality to the hotel. Moreover, the last group of consumers prefer the standardized service taking both price and service quality into account (e.g., hotel loyalists).

When there is no accommodation-sharing service, the hotel is the only choice for the consumer. A consumer's net utility of getting the service from the hotel is $U_A = q_A - p_A$. No consumer will stay in the hotel when it is over-priced, i.e., $p_A > q_A$. Therefore, it suffices to focus on the case where $p_A < q_A$. Then, the emergence of the accommodation-sharing service re-groups the consumers and enables them to have more choices according to their preferences. As a new channel for consumers, the sharing platform motivates some consumers to transfer from the hotel to the sharing service. However, it is noteworthy that some consumers resist the sharing service for various reasons (e.g., aversion to the potential risks in the sharing economy) and are loyal to the hotel. Once the sharing service can sufficiently meet some consumers' demands, they have the incentive to experience it. For simplicity, we assumed that the low-end sharing service meets the demands of a segment of consumers of size α ($0 < \alpha < 1/2$). These consumers will choose it if they receive higher utility than staying in the hotel. The high-end sharing service, likewise, meets the demands of a segment of consumers of size α , and these consumers finally select it when they receive higher utility than from the hotel. The consumers that have lower utility from purchasing the sharing service than choosing the hotel will stick to the hotel. The remaining $1 - 2\alpha$ consumers are always loyal to the hotel. Furthermore, we assumed that the market is fully covered and consumers' utility of taking other options is $\bar{U} = -\infty$, i.e., consumers will have no place to stay if they choose other options. All the consumers

will purchase a unit-length service from a host or the hotel. Without loss of generality, we normalized the total number of consumers to one. Table 1 summarizes the notations used throughout the paper.

Table 1. Summary of the primary notation.

Notation	Description
q_J	Accommodation service provider J 's service quality.
$\hat{q}_i$	Consumers' perceived service quality of host i , $i \in \{L, H\}$.
I	The informativeness of the quality information disclosed by the sharing platform.
δ	Commission rate charged by the accommodation-sharing platform.
ε	The true service quality difference between the hotel and hosts.
$\hat{\varepsilon}_i$	Consumers' perceived quality difference between host i and the hotel.
σ_i^I	Consumers' perception uncertainty about the service quality difference between host i and the hotel.
$\bar{\sigma}$	The maximum degree of consumers' perception uncertainty when $I = 0$.
$\underline{\sigma}$	The maximum degree of consumers' perception uncertainty when $I = 1$.
p_J	Accommodation service provider J 's price.
U_J	The net utility of purchasing service from provider J .
$\bar{U}$	Consumers' utility of taking other options.
c_J	Accommodation service provider J 's unit-length service cost.
D_K	The demand for accommodation service of participant K .
Π_K	The profit/revenue of participant K .

Notes: $J \in \{A, L, H\}$ and $K \in \{A, L, H, B\}$, where A , L , H , B denote the hotel, host L , host H , and the accommodation-sharing platform, respectively.

In practice, hotels are the incumbents of the accommodation market. Airbnb Statistics from the website of iProperty Management shows that Airbnb listings constituted 5.5% of the total demand for lodging in the US in 2018. Research from the World Bank Group indicates that, in 2018, P2P accommodation made up about 7% of accommodation globally. Therefore, in our model, we assumed that the hotel is the incumbent in the market and de-coupled the hotel's pricing from the individual hosts' pricing [70].

The game sequence consists of four stages. In stage 1, the hotel sets the price. In stage 2, the accommodation-sharing platform decides the informativeness level of the quality information about the sharing service. Then, in stage 3, the two types of hosts on the accommodation-sharing platform set their prices simultaneously. Finally, in stage 4, consumers make their decisions to stay in the property of either a host or the hotel. We solved the problem by backward induction. For ease of exposition, we used the superscript '*' to denote the optimal results under certain conditions and the superscript 'e' to denote the final equilibrium results in the following text.

4. Equilibrium Strategies for Participants

4.1. Stage 4: Market Segmentation

When the accommodation-sharing platform discloses the service quality information at informativeness level I , consumers perceive the service quality levels of hosts L and H as $\hat{q}_L = q_A - \hat{\varepsilon}_L$ and $\hat{q}_H = q_A + \hat{\varepsilon}_H$, respectively. Thus, the respective net utility of purchasing services from hotel A and hosts L and H are

$$U_A = q_A - p_A \quad (1)$$

$$U_L = \hat{q}_L - p_L = (q_A - \hat{\varepsilon}_L) - p_L \quad (2)$$

and

$$U_H = \hat{q}_H - p_H = (q_A + \hat{\varepsilon}_H) - p_H \quad (3)$$

A consumer that is indifferent between choosing the hotel and host L or H would perceive the quality difference as $\hat{\varepsilon}_L^*$ or $\hat{\varepsilon}_H^*$, respectively, where $\hat{\varepsilon}_L^* = p_A - p_L$ and $\hat{\varepsilon}_H^* = p_H - p_A$.

Lemma 1 (viability of the accommodation-sharing market). *The market segments of the hotel and the two types of accommodation-sharing services co-exist only if*

$$p_A > \max\{p_L + \varepsilon - \sigma^I, p_H - \varepsilon - \sigma^I\} \quad (4)$$

From Equations (1)–(3), only a low (high) enough perceived quality difference, i.e., $\hat{\varepsilon}_L < \hat{\varepsilon}_L^*$ ($\hat{\varepsilon}_H > \hat{\varepsilon}_H^*$), would motivate the consumers whose demands can be satisfied by the low (high)-end sharing service to enter the sharing market. Accordingly, the low-end sharing market vanishes ($D_L = 0$) if $\hat{\varepsilon}_L^* \leq \varepsilon - \sigma^I$, i.e., $p_A \leq p_L + \varepsilon - \sigma^I$, whereas the high-end sharing market vanishes ($D_H = 0$) if $\varepsilon + \sigma^I \leq \hat{\varepsilon}_H^*$, i.e., $p_A \leq p_H - \varepsilon - \sigma^I$. Therefore, for the sharing market to exist, the price of the hotel cannot be too low. This is in accordance with the observation from Statista, the global number one business data platform, which reported that the average room price per night on Airbnb was cheaper than those of the hotels in each of eight major tourist destinations around the world [72].

To simplify our analysis, we focused on the most interesting case where the hotel and the two types of accommodation-sharing services co-exist in the market. In addition, the most realistic case is that not all the consumers that have the incentive to experience the sharing service will eventually stay in the sharing market. Therefore, we assumed that the price of the hotel enables the viability of the accommodation-sharing service, and the demand for each type of sharing service is less than α , i.e., $\hat{\varepsilon}_L^*, \hat{\varepsilon}_H^* \in (\varepsilon - \sigma^I, \varepsilon + \sigma^I)$.

4.2. Stage 3: Pricing Game of Individual Hosts

Each host tries to maximize the profit given the information disclosure strategy of the sharing platform and the price of the hotel. As consumers interested in the sharing service will choose host L (H) when their perception of the quality difference $\hat{\varepsilon}_L$ ($\hat{\varepsilon}_H$) is lower (higher) than the indifferent point $\hat{\varepsilon}_L^*$ ($\hat{\varepsilon}_H^*$), the demands of the two hosts are

$$D_L = \frac{\alpha(p_A - p_L - \varepsilon + \sigma^I)}{2\sigma^I} \quad (5)$$

and

$$D_H = \frac{\alpha(p_A - p_H + \varepsilon + \sigma^I)}{2\sigma^I} \quad (6)$$

The total demand of the accommodation-sharing platform is $D_B = D_L + D_H$ and the demand of the hotel is $D_A = 1 - D_B$.

As the sharing platform charges the commission rate δ , the profit of host i is

$$\Pi_i = ((1 - \delta)p_i - c_i)D_i, \quad i \in \{L, H\} \quad (7)$$

and the revenue of the sharing platform is

$$\Pi_B = \delta(p_L D_L + p_H D_H) \quad (8)$$

Applying the first-order and second-order conditions, we derived the optimal prices, demands and profits of the hosts, given the information disclosure strategy of the sharing platform and the price of the hotel in Table 2.

4.3. Stage 2: Quality Information Disclosure

The accommodation-sharing platform decides the informativeness of the quality information to maximize its revenue. Substituting p_L^* and p_H^* into Equation (8), we can derive platform B 's revenue as follows:

$$\Pi_B = \frac{\alpha\delta((p_A + \sigma^I)^2 + \varepsilon^2)}{4\sigma^I} - \frac{\alpha\delta(c_H^2 + c_L^2)}{8\sigma^I(1 - \delta)^2} \quad (9)$$

Proposition 1. (i) Define $\hat{p}_A = \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \sigma\bar{\sigma}$. Given a low price of the hotel, i.e., $p_A^2 < \hat{p}_A$, the optimal information strategy for the sharing platform is to leave the service quality opaque to consumers ($I^* = 0$); given a high price of the hotel, i.e., $p_A^2 \geq \hat{p}_A$, offering consumers transparent information ($I^* = 1$) is always preferred by the sharing platform. (ii) Providing transparent information is more likely to be the strategy adopted with increasing market heterogeneity ε , i.e., $\frac{\partial \hat{p}_A}{\partial \varepsilon} < 0$.

Proof. See Appendix A. $\square$

Given the hotel's price, higher consumer uncertainty, i.e., a larger σ^I , caused by less information raises the mean perceived quality $q_A \mp \varepsilon + \frac{\sigma^I}{2}$ of consumers that over-estimate the true quality of hosts L and H , i.e., consumers with $\hat{\varepsilon}_L < \varepsilon$ and $\hat{\varepsilon}_H > \varepsilon$. This enables the hosts to charge a higher price (p_i^* increases with σ^I), which we refer to as the price premium effect. Meanwhile, higher consumer uncertainty also makes consumers hesitate to use the sharing service, leading to the platform's total demand reduction ($D_B^* = D_L^* + D_H^*$ decreases with σ^I), which we refer to as the demand shrinkage effect. The sharing platform has a trade-off between these two effects of consumer uncertainty when choosing its information strategy. If the hotel sets a low price, it means that the hotel is positioned in the low-end market and mainly competes with the low-quality sharing service (the value of $p_A - p_L$ increases, whereas $p_H - p_A$ decreases with p_A). Then, the sharing platform is motivated to exploit the price premium effect of consumer uncertainty to soften the price competition. Therefore, the platform offers the minimum information, i.e., setting informativeness at the zero level. In contrast, if the hotel sets a high price, it is positioned in the high-end market and mainly competes with the high-quality sharing service. In this case, price premium no longer matters, and the platform has more incentive to inhibit the demand shrinkage effect by eliminating consumer uncertainty. Thus, the platform provides consumers with transparent information.

Furthermore, increasing ε will lower the threshold $\hat{p}_A$ and make transparent information disclosure more possible. The underlying rationale is that when market heterogeneity increases, which implies that the quality levels of the accommodation service differ widely, the sharing platform is more willing to transparently disclose the quality information to improve consumers' perception accuracy about the differentiation between the hosts and the hotel. In other words, higher market heterogeneity may contribute to improving information transparency.

Contrary to most of the prior research that suggests sharing services require more information to win consumer trust [60–62,64], Proposition 1 shows that, under certain conditions, the sharing platform is better off by disclosing opaque quality information and the hotel's price significantly influences the platform's quality disclosure.

Table 2. The optimal reactions of the hosts.

	Host L	Host H
p_i^*	$\frac{p_A - \varepsilon + \sigma^I}{2} + \frac{c_L}{2(1-\delta)}$	$\frac{p_A + \varepsilon + \sigma^I}{2} + \frac{c_H}{2(1-\delta)}$
D_i^*	$\frac{\alpha(p_A - \varepsilon + \sigma^I)}{4\sigma^I} - \frac{\alpha c_L}{4\sigma^I(1-\delta)}$	$\frac{\alpha(p_A + \varepsilon + \sigma^I)}{4\sigma^I} - \frac{\alpha c_H}{4\sigma^I(1-\delta)}$
Π_i^*	$\frac{\alpha((p_A - \varepsilon + \sigma^I)(1-\delta) - c_L)^2}{8\sigma^I(1-\delta)}$	$\frac{\alpha((p_A + \varepsilon + \sigma^I)(1-\delta) - c_H)^2}{8\sigma^I(1-\delta)}$

4.4. Stage 1: The Pricing Decision of the Hotel

The hotel makes pricing decision to maximize its profit. Substituting the responsive actions of hosts L and H into the formula of the hotel's profit, we have

$$\Pi_A = \left(1 - \frac{\alpha(p_A + \sigma^I)}{2\sigma^I} + \frac{\alpha(c_H + c_L)}{4\sigma^I(1-\delta)} \right) (p_A - c_A) \quad (10)$$

To simplify the analysis and guarantee interior solutions, we made the following sufficient technical assumptions. The proof and the expressions of $\underline{c}_A$, $\bar{c}_A$, $\underline{\varepsilon}$, and $\bar{\varepsilon}$ are provided in the Appendix A.

Technical Assumptions. (i) $\underline{c}_A < c_A < \bar{c}_A$; (ii) $\alpha > \frac{2(\bar{\sigma}-\underline{\sigma})}{7\bar{\sigma}-\underline{\sigma}}$; and (iii) $\underline{\varepsilon} < \varepsilon < \bar{\varepsilon}$.

Supposing that the technical assumptions hold, we derived the final equilibrium price p_A^e for the hotel and the equilibrium information strategy I^e for the sharing platform under different combined conditions of market heterogeneity and the hotel's service cost in Table 3.

Table 3. The equilibrium strategies for the hotel and the sharing platform.

	$c_A \leq c_{A1}$	$c_{A1} < c_A < c_{A2}$	$c_A \geq c_{A2}$
$\varepsilon^2 \leq \varepsilon_1$		$p_A^e = \frac{\bar{\sigma}}{\alpha} - \frac{\bar{\sigma}-c_A}{2} + \frac{c_L+c_H}{4(1-\delta)}, I^e = 0$	
$\varepsilon_1 < \varepsilon^2 < \varepsilon_2$	$p_A^e = \frac{\bar{\sigma}}{\alpha} - \frac{\bar{\sigma}-c_A}{2} + \frac{c_L+c_H}{4(1-\delta)}, I^e = 0$	$p_A^e = \sqrt{\frac{c_L^2+c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \underline{\sigma}\bar{\sigma}}, I^e = 0$	$p_A^e = \frac{\underline{\sigma}}{\alpha} - \frac{\underline{\sigma}-c_A}{2} + \frac{c_L+c_H}{4(1-\delta)}, I^e = 1$
$\varepsilon^2 \geq \varepsilon_2$		$p_A^e = \frac{\underline{\sigma}}{\alpha} - \frac{\underline{\sigma}-c_A}{2} + \frac{c_L+c_H}{4(1-\delta)}, I^e = 1$	

Note: The expressions of the notations and the proof are provided in Appendix A.

The results in Table 3 indicate that the hotel's service cost c_A and market heterogeneity ε jointly determine the equilibrium strategies of the hotel and the sharing platform. In general, the equilibrium strategy for the sharing platform is to reveal opaque information when market heterogeneity is relatively low and to disclose transparent quality information when market heterogeneity is high. In other words, compared with the hotel, when the quality differentiation of the sharing platform is not very high, the platform has an incentive to keep consumers from distinguishing between the services of the hosts and the hotel by disclosing uninformative information, i.e., the opaque strategy. Otherwise, the platform will motivate the hosts to "differentiate" their offerings from the hotel by disclosing fully informative information, i.e., pursuing the transparent strategy.

Given the equilibrium price of the hotel and the corresponding quality information strategy of the sharing platform, we derived the final equilibrium prices, demands, and profits of all the participants under different conditions, as shown in Table 4 (in front of the references). From the results in Tables 3 and 4, we have the following propositions.

Proposition 2. (i) When market heterogeneity is low (high), i.e., $\varepsilon^2 \leq \varepsilon_1$ ($\varepsilon^2 \geq \varepsilon_2$), the sharing platform's information strategy is opaque (transparent), which is independent of the hotel. (ii) When market heterogeneity is medium, i.e., $\varepsilon_1 < \varepsilon^2 < \varepsilon_2$, the sharing platform's information strategy is affected by the hotel's service cost: (a) if the hotel has a low cost, i.e., $c_A \leq c_{A1}$, or medium cost, i.e., $c_{A1} < c_A < c_{A2}$, the platform has the incentive to provide opaque information; (b) if the hotel has a high cost, i.e., $c_A \geq c_{A2}$, the platform is motivated to disclose transparent information.

Proof. See Appendix A. $\square$

Table 4. The equilibrium results.

	$\varepsilon^2 \leq \varepsilon_1$ or $\varepsilon_1 < \varepsilon^2 < \varepsilon_2$ and $c_A \leq c_{A1}$	$\varepsilon_1 < \varepsilon^2 < \varepsilon_2$ and $c_A \geq c_{A2}$ or $\varepsilon^2 \geq \varepsilon_2$	$\varepsilon_1 < \varepsilon^2 < \varepsilon_2$ and $c_{A1} < c_A < c_{A2}$
p_A^e	$\frac{\bar{\sigma}}{\alpha} - \frac{\bar{\sigma} - c_A}{2} + \frac{c_L + c_H}{4(1-\delta)}$	$\frac{\underline{\sigma}}{\alpha} - \frac{\underline{\sigma} - c_A}{2} + \frac{c_L + c_H}{4(1-\delta)}$	$\sqrt{\frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2} + \underline{\sigma}\bar{\sigma}$
I^e	0	1	0
p_L^e	$\frac{\bar{\sigma}}{2\alpha} + \frac{\bar{\sigma} + c_A - 2\varepsilon}{4} + \frac{5c_L + c_H}{8(1-\delta)}$	$\frac{\underline{\sigma}}{2\alpha} + \frac{\underline{\sigma} + c_A - 2\varepsilon}{4} + \frac{5c_L + c_H}{8(1-\delta)}$	$\frac{1}{4}\sqrt{\frac{2(c_L^2 + c_H^2)}{(1-\delta)^2} - 4\varepsilon^2} + 4\underline{\sigma}\bar{\sigma} - \frac{\varepsilon - \bar{\sigma}}{2} + \frac{c_L}{2(1-\delta)}$
p_H^e	$\frac{\bar{\sigma}}{2\alpha} + \frac{\bar{\sigma} + c_A + 2\varepsilon}{4} + \frac{5c_H + c_L}{8(1-\delta)}$	$\frac{\underline{\sigma}}{2\alpha} + \frac{\underline{\sigma} + c_A + 2\varepsilon}{4} + \frac{5c_H + c_L}{8(1-\delta)}$	$\frac{1}{4}\sqrt{\frac{2(c_L^2 + c_H^2)}{(1-\delta)^2} - 4\varepsilon^2} + 4\underline{\sigma}\bar{\sigma} + \frac{\varepsilon + \bar{\sigma}}{2} + \frac{c_H}{2(1-\delta)}$
D_L^e	$\frac{1}{4} + \alpha \left(\frac{\bar{\sigma} + c_A - 2\varepsilon}{8\bar{\sigma}} + \frac{c_H - 3c_L}{16\bar{\sigma}(1-\delta)} \right)$	$\frac{1}{4} + \alpha \left(\frac{\underline{\sigma} + c_A - 2\varepsilon}{8\underline{\sigma}} + \frac{c_H - 3c_L}{16\underline{\sigma}(1-\delta)} \right)$	$\alpha \left(\frac{\bar{\sigma} - \varepsilon}{4\bar{\sigma}} + \frac{\sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} - 2c_L}{8\bar{\sigma}(1-\delta)} \right)$
D_H^e	$\frac{1}{4} + \alpha \left(\frac{\bar{\sigma} + c_A + 2\varepsilon}{8\bar{\sigma}} + \frac{c_L - 3c_H}{16\bar{\sigma}(1-\delta)} \right)$	$\frac{1}{4} + \alpha \left(\frac{\underline{\sigma} + c_A + 2\varepsilon}{8\underline{\sigma}} + \frac{c_L - 3c_H}{16\underline{\sigma}(1-\delta)} \right)$	$\alpha \left(\frac{\bar{\sigma} + \varepsilon}{4\bar{\sigma}} + \frac{\sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} - 2c_H}{8\bar{\sigma}(1-\delta)} \right)$
D_A^e	$\frac{1}{2} - \alpha \left(\frac{c_A + \bar{\sigma}}{4\bar{\sigma}} - \frac{c_L + c_H}{8\bar{\sigma}(1-\delta)} \right)$	$\frac{1}{2} - \alpha \left(\frac{c_A + \underline{\sigma}}{4\underline{\sigma}} - \frac{c_L + c_H}{8\underline{\sigma}(1-\delta)} \right)$	$1 - \frac{\alpha}{2} - \frac{\alpha \left(\sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} - c_L - c_H \right)}{4\bar{\sigma}(1-\delta)}$
D_B^e	$\frac{1}{2} + \alpha \left(\frac{c_A + \bar{\sigma}}{4\bar{\sigma}} - \frac{c_L + c_H}{8\bar{\sigma}(1-\delta)} \right)$	$\frac{1}{2} + \alpha \left(\frac{c_A + \underline{\sigma}}{4\underline{\sigma}} - \frac{c_L + c_H}{8\underline{\sigma}(1-\delta)} \right)$	$\frac{\alpha}{2} + \frac{\alpha \left(\sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} - c_L - c_H \right)}{4\bar{\sigma}(1-\delta)}$
Π_L^e	$\frac{(\alpha(2(2\varepsilon - \bar{\sigma} - c_A)(1-\delta) - c_H + 3c_L) - 4\bar{\sigma}(1-\delta))^2}{128\alpha\bar{\sigma}(1-\delta)}$	$\frac{(\alpha(2(2\varepsilon - \underline{\sigma} - c_A)(1-\delta) - c_H + 3c_L) - 4\underline{\sigma}(1-\delta))^2}{128\alpha\underline{\sigma}(1-\delta)}$	$\frac{\alpha \left(\sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} - 2(\varepsilon - \bar{\sigma})(1-\delta) - 2c_L \right)^2}{32\bar{\sigma}(1-\delta)}$
Π_H^e	$\frac{(\alpha(2(2\varepsilon + \bar{\sigma} + c_A)(1-\delta) - 3c_H + c_L) + 4\bar{\sigma}(1-\delta))^2}{128\alpha\bar{\sigma}(1-\delta)}$	$\frac{(\alpha(2(2\varepsilon + \underline{\sigma} + c_A)(1-\delta) - 3c_H + c_L) + 4\underline{\sigma}(1-\delta))^2}{128\alpha\underline{\sigma}(1-\delta)}$	$\frac{\alpha \left(\sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} + 2(\varepsilon + \bar{\sigma})(1-\delta) - 2c_H \right)^2}{32\bar{\sigma}(1-\delta)}$
Π_A^e	$\frac{(\alpha(c_L + c_H - 2(\bar{\sigma} + c_A)(1-\delta)) + 4\bar{\sigma}(1-\delta))^2}{32\alpha\bar{\sigma}(1-\delta)^2}$	$\frac{(\alpha(c_L + c_H - 2(\underline{\sigma} + c_A)(1-\delta)) + 4\underline{\sigma}(1-\delta))^2}{32\alpha\underline{\sigma}(1-\delta)^2}$	$\frac{\left(\alpha \left(c_L + c_H - \sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} \right) + 2\bar{\sigma}(2 - \alpha)(1-\delta) \right) \left(\sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} - 2c_A(1-\delta) \right)}{8\bar{\sigma}(1-\delta)^2}$
Π_B^e	$\delta \left(\frac{\alpha \left(\frac{(2(\bar{\sigma} + c_A)(1-\delta) + c_L + c_H)^2}{+16\varepsilon^2(1-\delta)^2} - 8(c_L^2 + c_H^2) \right)}{\frac{64\bar{\sigma}(1-\delta)^2}{+ \frac{(1+\alpha)\bar{\sigma} + \alpha c_A}{4\alpha}} + \frac{c_L + c_H}{8(1-\delta)}} \right)$	$\delta \left(\frac{\alpha \left(\frac{(2(\underline{\sigma} + c_A)(1-\delta) + c_L + c_H)^2}{+16\varepsilon^2(1-\delta)^2} - 8(c_L^2 + c_H^2) \right)}{\frac{64\underline{\sigma}(1-\delta)^2}{+ \frac{(1+\alpha)\underline{\sigma} + \alpha c_A}{4\alpha}} + \frac{c_L + c_H}{8(1-\delta)}} \right)$	$\frac{\alpha \delta \left(\sqrt{2(c_L^2 + c_H^2) - 4(\varepsilon^2 - \underline{\sigma}\bar{\sigma})(1-\delta)^2} + (\underline{\sigma} + \bar{\sigma})(1-\delta) \right)}{4(1-\delta)}$

Proposition 2 explores the impact of market heterogeneity and the hotel's service cost on the platform's quality disclosure decision. Intuitively, when market heterogeneity is extremely low, i.e., $\varepsilon^2 \leq \varepsilon_1$, the service quality levels of the hotel and the hosts are almost homogeneous and consumer segmentation is hard to realize. The hotel and the hosts almost compete in the same market segment. In this case, although hiding quality information leads to consumers' ambiguous perceptions, thus decreasing the sharing platform's total demand, the price premium effect of consumer uncertainty enables the hosts to charge a higher price. Then, the platform receives more commission per transaction. The price premium effect more than offsets the demand shrinkage effect of consumer uncertainty. As a result, the optimal strategy for the sharing platform is to keep consumer uncertainty by hiding useful information, i.e., pursuing the opaque strategy.

Conversely, when market heterogeneity is extremely high, i.e., $\varepsilon^2 \geq \varepsilon_2$, different providers offer heterogeneous services and consumer segmentation is well realized. The hotel and the hosts compete in different market segments. In this case, providing transparent information can help consumers make a clear distinction between the hotel and the two types of sharing services. Thus, more consumers whose demands can be met by the sharing services consider them as good alternatives to the hotel and switch from the hotel to the platform. That is, transparent information inhibits the demand shrinkage effect of consumer uncertainty, which outperforms the price premium effect. Consequently, the optimal strategy for the sharing platform is to alleviate consumer uncertainty by disclosing fully informative information. The example shown in Figure 1 validates our findings. The quality differentiation between the sharing services on Airbnb is quite large, and Airbnb adopts the transparent disclosure strategy.

When market heterogeneity is medium, i.e., $\varepsilon_1 < \varepsilon^2 < \varepsilon_2$, the market segments of the hotel and the hosts partially overlap. In this case, the hotel's service cost plays a key role because it is essentially a reflection of the hotel's service quality in the market. The service cost affects the hotel's price, and thus influences the platform's information disclosure. Meanwhile, the hotel will expect the platform's corresponding information disclosure when setting the price, thus the hotel's equilibrium price is also constrained by the platform's reaction. If the hotel has a low cost, i.e., $c_A \leq c_{A1}$, we regarded it as a budget hotel that has a strong incentive to generate more demand by setting a low price. Then, the low-end sharing service is the hotel's major rival. In this case, the price premium effect of consumer uncertainty can help the hosts, especially host L , alleviate the price competition. In addition, the price premium effect more than counteracts the demand shrinkage effect of consumer uncertainty. Therefore, the sharing platform is motivated to keep consumer uncertainty by providing opaque information despite the total market shrinkage. If the hotel has a medium cost, i.e., $c_{A1} < c_A < c_{A2}$, we regarded it as a mid-scale hotel. Recall Proposition 1, in which the hotel can either charge a low price to retain more consumers or charge a high price to obtain a higher marginal profit; in this case, it is better off for the hotel to retain more demand by setting a low price, which results in the platform pursuing the opaque information strategy. If the hotel has a high cost, i.e., $c_A \geq c_{A2}$, we regarded it as an upscale hotel that has the motivation to pursue a high marginal profit by setting a high price. Then, the high-end sharing service is the hotel's major competitor. In this case, the platform has the incentive to expand the total market rather than being concerned about the price premiums of the hosts because the market price is already at a high level. That is, the price premium effect less than counteracts the demand shrinkage effect of consumer uncertainty. Thus, the platform is motivated to inhibit the demand shrinkage effect of consumer uncertainty by improving information transparency.

Corollary 1. *The hotel prefers the sharing platform to pursue the opaque information strategy.*

If the platform's information disclosure does not respond to the hotel's price, the hotel always earns more profit when the platform discloses less informative information. As in the analysis in Proposition 1, the demand shrinkage effect of consumer uncertainty

on the sharing platform will drive more consumers to stick to the choice of the hotel service. Meanwhile, from Equation (10), we can derive the hotel's optimal price, given the information level I of the sharing platform as $p_A^*(I) = \frac{\sigma^I}{\alpha} - \frac{\sigma^I - c_A}{2} + \frac{c_L + c_H}{4(1-\delta)}$, which increases with consumer uncertainty, i.e., $\frac{\partial p_A^*(I)}{\partial \sigma^I} = \frac{2-\alpha}{2\alpha} > 0$. In other words, increasing consumers' ambiguous perceptions allows the hotel to retain more of the market and extract more surplus from the consumers at the same time. Consequently, under the premise that the platform decides the information disclosure independently, the hotel benefits from the platform pursuing the opaque information strategy.

Proposition 3. *The profit of host L decreases with market heterogeneity, i.e., $\frac{\partial \Pi_L^e}{\partial \varepsilon} < 0$, whereas the profit of host H increases with market heterogeneity, i.e., $\frac{\partial \Pi_H^e}{\partial \varepsilon} > 0$.*

Proof. See Appendix A. $\square$

All things being equal, greater market heterogeneity means a larger quality difference between the individual hosts. Host L will reduce the price for the lower service quality and host H will raise the price for the higher service quality. Furthermore, greater market heterogeneity expands the market of host H at the expense of shrinking the market of host L. As a result, the profit of host H increases as their price and demand simultaneously increase, whereas the situation of host L is the reverse.

Proposition 4. *The hotel's equilibrium price and demand are not affected by market heterogeneity unless both the hotel's service cost and market heterogeneity are at the medium level, i.e., $\varepsilon \in (\varepsilon_1, \varepsilon_2)$ and $c_A \in (c_{A1}, c_{A2})$, in which case the hotel is worse off with increasing market heterogeneity.*

Proof. See Appendix A. $\square$

The results in Tables 3 and 4 suggest that market heterogeneity and the cost factor jointly determine market equilibrium. When market heterogeneity is extremely low (high), i.e., $\varepsilon^2 \leq \varepsilon_1$ ($\varepsilon^2 \geq \varepsilon_2$), the competition is quite fierce (weak), and changing heterogeneity (within the above interval) has no effect on the equilibrium market segmentation between the hotel and the sharing platform. Meanwhile, as the incumbent, the hotel's service cost represents its quality positioning in the market. An extremely low (high) service cost, i.e., $c_A < c_{A1}$ ($c_A > c_{A2}$) indicates that the hotel is budget (upscale), and thus prices are at a low (high) level. In this case, from the perspective of the whole hotel industry, no matter how market heterogeneity changes, the hotel positioning at either end of the market primarily competes with one of the two types of sharing services. Therefore, the hotel's equilibrium is not impacted by market heterogeneity. However, when both the hotel's quality positioning and market heterogeneity are medium, the market competition is modest and the hotel is mid-scale. In this case, changing market heterogeneity will alter the extent of the market overlap between the hotel and the two different sharing services. Then, greater market heterogeneity will contribute to a better consumer segmentation, which motivates the hotel to lower its price in exchange for larger demand.

The next proposition further shows the effects of different quality-level sharing services on the platform under changing market heterogeneity.

Proposition 5. *With market heterogeneity increasing, the sharing platform is worse off when both the hotel's service cost and market heterogeneity are at the medium level, i.e., $\varepsilon \in (\varepsilon_1, \varepsilon_2)$ and $c_A \in (c_{A1}, c_{A2})$; otherwise, the sharing platform is better off.*

Proof. See Appendix A. $\square$

Proposition 5 reveals that, when the hotel's quality positioning in the market and the market competition are at the medium level, the effect of the low-end sharing service on

the platform dominates the effect of the high-end sharing service if market heterogeneity increases, which leads to a drop in the platform's total demand and revenue. Otherwise, the effect of the high-end sharing service dominates, which contributes to the revenue growth of the sharing platform. This implies that the platform should consider the quality positioning of the incumbent, i.e., the hotel, in the market to balance the impact of different quality-level sharing services when positioning its sharing market, i.e., deciding the service heterogeneity.

Propositions 4 and 5 suggest that the incumbent's quality positioning and market heterogeneity jointly determine the market equilibrium. An interesting point is that, when the market competition is modest and the hotel is mid-scale, the preferences for market heterogeneity of the hotel and the sharing platform are consistent.

5. Conclusions

5.1. Discussion of the Main Findings

In this paper, we developed a game-theoretic model for an accommodation market to study the quality information disclosure of an emerging sharing platform. We took consumer uncertainty into consideration and characterized the optimal quality disclosure strategy of the sharing platform. We also examined the impacts of the incumbent hotel and market heterogeneity on the platform's information strategy.

The main findings of our research are as follows: First, we found that opaque or transparent quality information disclosure is always more beneficial for the sharing platform than partially informing consumers. Second, we showed that the competitor's price significantly influences the platform's quality disclosure. We took consumer uncertainty into consideration and found that the rise in the hotel's price can shift the information strategy of the platform from completely uninformative to fully informative. The reason for this is that consumer uncertainty brings the platform two different effects, namely the price premium effect for the hosts and the demand shrinkage effect for the whole sharing market, which the platform should trade off when making decisions. Third, we also explored the impact of market heterogeneity and the hotel's service cost on the hotel's pricing strategy and the platform's quality disclosure decision. In general, the platform is more likely to provide transparent information with greater market heterogeneity. When the differentiation between the hotel and the sharing services is relatively small, the platform will disclose opaque information to keep consumers from distinguishing between the hosts and the hotel. In contrast, when the differentiation between the hotel and the sharing services is relatively high, the platform will disclose transparent information to enable the hosts to differentiate their services from the hotel. However, when market heterogeneity is medium, the hotel's service cost that signals its quality positioning in the market affects the hotel's pricing and thus influences the platform's information disclosure. Accordingly, market heterogeneity and the service cost jointly determine the equilibrium strategies and payoffs of the participants. The example of Airbnb and HouseTrip in the Introduction verifies our results. Airbnb has more listings with heterogeneous service quality than HouseTrip, which means market heterogeneity is higher on Airbnb than on HouseTrip. We can see that Airbnb discloses more quality information than HouseTrip. Meanwhile, we also observe that different levels of accommodation-sharing businesses on Airbnb are different in quality disclosure. For example, the listings on Airbnb Luxe usually reveal more quality information than the listings on normal Airbnb. Airbnb Luxe mainly competes with luxury hotels with higher service costs, while normal Airbnb mainly competes with budget hotels with lower service costs. This follows our results that when service heterogeneity is moderate within each level of the accommodation-sharing business, the competitor's service level plays a key role in affecting the platform's quality disclosure. Finally, we demonstrated that when both market heterogeneity and the hotel's service cost are medium, the hotel and the sharing platform will be worse off when further differentiating their services.

The main contributions of our research are as follows: First, different from previous empirical studies on self-disclosure of individual hosts, we studied the quality disclosure

strategy from the perspective of the accommodation-sharing platform by developing an analytical model. Contrary to most of the prior empirical research suggesting that the sharing service requires more information to win consumer trust [60–62,64], we found that, under certain conditions, the sharing platform is better off when disclosing opaque quality information. Second, we took consumer uncertainty into consideration, which is usually viewed as a barrier to consumer acceptance of the accommodation-sharing service in most past studies. Our findings suggest that consumer uncertainty is a double-edged sword for the sharing platform. The platform should trade off the two opposing effects of consumer uncertainty when deciding its quality disclosure strategy. Third, prior literature mainly focuses on how the hotel is influenced by the sharing platform. In contrast, our research sheds light on the effect of the incumbent hotel on the entrant platform's information strategy. Different from some analytical literature suggesting that firms providing a single kind of product (service) are more likely to disclose quality information when their quality exceeds a certain threshold [51,58], our study found that the quality disclosure strategy of the firm (e.g., the sharing platform) that offers mixed quality-level products (services) is indeed complex and interacts closely with its competitor (e.g., the hotel). We also found that the incumbent's quality positioning in the market and market heterogeneity jointly determine the market equilibrium.

5.2. Managerial Implications

Our research has several strategic implications for the incumbents in the hotel industry and the entrants in the sharing market. First, for the incumbent, i.e., the hotel, it is optimal to adjust the pricing strategy according to its own quality positioning in the market and its quality differentiation from the sharing service. The incumbent should use its price tool to influence the information strategy of the entrant, i.e., the sharing platform, and the pricing strategies of competitive accommodation service providers, i.e., the hosts, to reduce the adverse effects of competition. Second, as an entrant, it is always more beneficial for the sharing platform to provide opaque or transparent quality information than partial disclosure. This requires the platform to design a flexible information system so that the hosts can provide either uninformative or informative information about quality, as appropriate. Moreover, when developing the information strategy, the sharing platform should consider the impact factors from all the anticipants, i.e., the incumbent, consumers, and its own sharing services. Third, as consumer uncertainty brings double-edged effects, the platform should trade off the impact of consumer uncertainty in different situations through the information strategy. Finally, we argue that the sharing platform should consider the quality positioning of the competing incumbent when targeting the market. In most situations, differentiating the sharing services from the hotel is beneficial for the platform; however, when they compete in the mid-scale accommodation market, the platform is better off by reducing the difference with the hotel and blurring the consumers' perception.

5.3. Limitations and Future Research

There are several limitations in this research that could be extended in the future. First, we modeled a mass of individual hosts as two communities, and those who are in the same community offer sharing services of the same quality. Further research may consider a finite number of individual hosts, each of whom provides a unique level of service quality. Second, for ease of determining the equilibria, we assumed that market heterogeneity is symmetric. Further research may study the case where market heterogeneity is asymmetric. Third, our study focused on the vertical attribute of the sharing service. It would be very interesting to study the problem from the perspective of a horizontal attribute or both attributes. Finally, we used the analytical model to examine the quality disclosure strategy of the sharing platform. For ease of tractability, we ignored some factors that may also impact the results. Empirical research can make up for the limitations of our method to some extent. For example, using actual data, we can study the effects of some factors,

such as geographic distribution of sharing services and the consumer base of the sharing platform, on the hotel's price and the platform's quality disclosure in the future.

Author Contributions: Conceptualization, G.L. and X.F.; Methodology, X.F.; Software, X.F.; Validation, T.C.E.C., G.L. and X.F.; Formal Analysis, X.F.; Writing—Original Draft Preparation, X.F.; Writing—Review and Editing, T.C.E.C., G.L. and X.F.; Supervision, T.C.E.C. and G.L.; Project Administration, T.C.E.C. and G.L.; Funding Acquisition, G.L. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded in part by the National Natural Science Foundation of China under grant number 71832011 and in part by the Science and Technology Innovation Team Plan of Shaanxi Province, funding number Project 2020TD-006.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Proofs and Analysis

Appendix A.1. Proof of Proposition 1

From Equation (9), we have the derivative of the platform's revenue with respect to consumer uncertainty σ^I as $\frac{\partial \Pi_B}{\partial \sigma^I} = -\frac{\alpha \delta (2(p_A^2 + \varepsilon^2 - (\sigma^I)^2)(1-\delta)^2 - c_L^2 - c_H^2)}{8(\sigma^I)^2(1-\delta)^2}$. Assuming that consumer uncertainty is a general function of the information level $\sigma^I = f(I)$, which satisfies the conditions $f'(I) < 0$, $f(0) = \bar{\sigma}$ and $f(1) = \underline{\sigma}$. Then, we can derive the derivative of the platform's revenue with respect to the information level $\frac{\partial \Pi_B}{\partial I}$ according to the derivation rules for compound functions. We obtain that if $p_A^2 \leq \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \underline{\sigma}^2$, then $\frac{\partial \Pi_B}{\partial \sigma^I} \geq 0$ and $\frac{\partial \Pi_B}{\partial I} \leq 0$, therefore the platform's revenue is maximized when the information level is zero. If $p_A^2 \geq \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \bar{\sigma}^2$, then $\frac{\partial \Pi_B}{\partial \sigma^I} \leq 0$ and $\frac{\partial \Pi_B}{\partial I} \geq 0$, thus the platform's revenue is maximized when the information level equals one. If $\frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \underline{\sigma}^2 < p_A^2 < \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \bar{\sigma}^2$, then $\frac{\partial \Pi_B}{\partial \sigma^I} \leq 0$ when $\underline{\sigma} \leq \sigma^I \leq \hat{\sigma}$ and $\frac{\partial \Pi_B}{\partial \sigma^I} > 0$ when $\hat{\sigma} < \sigma^I \leq \bar{\sigma}$, where $\hat{\sigma} = \frac{\sqrt{4(p_A^2 + \varepsilon^2)(1-\delta)^2 - 2c_L^2 - 2c_H^2}}{2(1-\delta)}$. Given that σ^I decreases with the information level I , we have $\frac{\partial \Pi_B}{\partial I} < 0$ when $0 \leq I < f^{-1}(\sigma^I)|_{\sigma^I=\hat{\sigma}}$ and $\frac{\partial \Pi_B}{\partial I} \geq 0$ when $f^{-1}(\sigma^I)|_{\sigma^I=\hat{\sigma}} \leq I \leq 1$. Specifically, given the function $\sigma^I = (\underline{\sigma} - \bar{\sigma})I + \bar{\sigma}$, we have $f^{-1}(\sigma^I)|_{\sigma^I=\hat{\sigma}} = \frac{\bar{\sigma}}{\bar{\sigma} - \underline{\sigma}} - \frac{\sqrt{4(p_A^2 + \varepsilon^2)(1-\delta)^2 - 2c_L^2 - 2c_H^2}}{2(\bar{\sigma} - \underline{\sigma})(1-\delta)}$, then $\frac{\partial \Pi_B}{\partial I} < 0$ when $0 \leq I < \frac{\bar{\sigma}}{\bar{\sigma} - \underline{\sigma}} - \frac{\sqrt{4(p_A^2 + \varepsilon^2)(1-\delta)^2 - 2c_L^2 - 2c_H^2}}{2(\bar{\sigma} - \underline{\sigma})(1-\delta)}$ and $\frac{\partial \Pi_B}{\partial I} \geq 0$ when $\frac{\bar{\sigma}}{\bar{\sigma} - \underline{\sigma}} - \frac{\sqrt{4(p_A^2 + \varepsilon^2)(1-\delta)^2 - 2c_L^2 - 2c_H^2}}{2(\bar{\sigma} - \underline{\sigma})(1-\delta)} \leq I \leq 1$. In this case, the platform's revenue is maximized when the information level equals either zero or one. We further find that if $\frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \underline{\sigma}^2 < p_A^2 < \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \underline{\sigma}\bar{\sigma}$, then $\Pi_B|_{I=0} > \Pi_B|_{I=1}$; if $\frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \underline{\sigma}\bar{\sigma} \leq p_A^2 < \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \bar{\sigma}^2$, then $\Pi_B|_{I=0} \leq \Pi_B|_{I=1}$. It follows that when the hotel sets a low price, i.e., $p_A^2 < \hat{p}_A = \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \underline{\sigma}\bar{\sigma}$, the optimal information strategy for the sharing platform is $I = 0$, and when the hotel sets a high price, i.e., $p_A^2 \geq \hat{p}_A$, the optimal information strategy for the sharing platform is $I = 1$.

From Table 2 in the main text, we derive the total demand of the sharing platform as $D_B^* = D_L^* + D_H^* = \frac{\alpha(p_A + \sigma_I)}{2\sigma_I} - \frac{\alpha(c_L + c_H)}{4\sigma_I(1-\delta)}$. Given the hotel's price p_A and the assumption that $p_A > \frac{c_L + c_H}{2(1-\delta)}$, it is easy to verify that D_B^* decreases with σ_I .

Appendix A.1.1. Analysis of the Technical Assumptions

The expressions of c_A , $\bar{c}_A$, $\underline{\varepsilon}$, and $\bar{\varepsilon}$ in the technical assumptions are as follows:

$$\begin{aligned} c_A &= \max \left\{ \frac{c_L + c_H}{2(1-\delta)} - \frac{(2-\alpha)\sigma}{\alpha}, \frac{3c_L - c_H}{2(1-\delta)} + 2\varepsilon - \frac{(2+\alpha)\sigma}{\alpha}, \frac{3c_H - c_L}{2(1-\delta)} - 2\varepsilon - \frac{(2+\alpha)\sigma}{\alpha} \right\}, \\ \bar{c}_A &= \min \left\{ \frac{c_L + c_H}{2(1-\delta)}, \frac{3c_L - c_H}{2(1-\delta)} + 2\varepsilon + \min \left\{ (7 - \frac{2}{\alpha})\bar{\sigma}, (7 - \frac{2}{\alpha})\underline{\sigma} \right\}, \frac{3c_H - c_L}{2(1-\delta)} - 2\varepsilon + \min \left\{ (7 - \frac{2}{\alpha})\bar{\sigma}, (7 - \frac{2}{\alpha})\underline{\sigma} \right\} \right\}, \\ \underline{\varepsilon} &= \max \left\{ \frac{c_H - c_L}{2(1-\delta)} - 2\sigma, \frac{c_H - c_L}{2(1-\delta)} - \frac{7\bar{\sigma} - \sigma}{2} + \frac{\bar{\sigma} - \sigma}{\alpha}, \frac{c_H - c_L}{2(1-\delta)} - \frac{7\bar{\sigma} + \sigma}{4} + \frac{\bar{\sigma} - \sigma}{2\alpha} \right\}, \\ \bar{\varepsilon} &= \min \left\{ \frac{c_H - c_L}{2(1-\delta)} + 2\sigma, \frac{c_H - c_L}{2(1-\delta)} + \frac{7\bar{\sigma} - \sigma}{2} - \frac{\bar{\sigma} - \sigma}{\alpha}, \frac{c_H - c_L}{2(1-\delta)} + \frac{7\bar{\sigma} + \sigma}{4} - \frac{\bar{\sigma} - \sigma}{2\alpha} \right\}. \end{aligned}$$

From the hotel's profit function $\Pi_A = \left(1 - \frac{\alpha(p_A + \sigma^I)}{2\sigma^I} + \frac{\alpha(c_H + c_L)}{4\sigma^I(1-\delta)}\right)(p_A - c_A)$ and the function of consumer uncertainty $\sigma^I = (\sigma - \bar{\sigma})I + \bar{\sigma}$, we derive the optimal price $p_A^*(I) = \frac{\sigma^I}{\alpha} - \frac{\sigma^I - c_A}{2} + \frac{c_L + c_H}{4(1-\delta)}$ for the hotel expecting the information level $I \in \{0, 1\}$ of the sharing platform by solving the first-order condition of its profit function and checking that the second-order condition is negative. It is worth noting that this optimal price may not be an equilibrium because there is a price threshold $\hat{p}_A$ for the hotel to change the platform's information strategy (recalling Proposition 1). For instance, if $(p_A^*(0))^2$ is larger than $\hat{p}_A$, then $p_A^*(0)$ is no longer an equilibrium price because the sharing platform will provide transparent information at $p_A^*(0)$. Furthermore, we obtain that the hotel's profits at two different information levels are equal when setting the price p_A at c_A or $\frac{c_L + c_H}{2(1-\delta)}$. According to the properties of the quadratic function, we have $0 < c_A < \frac{c_L + c_H}{2(1-\delta)}$ and $c_A < p_A^*(1) < p_A^*(0)$. If $c_A \leq \frac{c_L + c_H}{2(1-\delta)} - \frac{(2-\alpha)\sigma}{\alpha}$, then $p_A^*(1) \leq \frac{c_L + c_H}{2(1-\delta)}$; if $c_A > \frac{c_L + c_H}{2(1-\delta)} - \frac{(2-\alpha)\sigma}{\alpha}$, then $p_A^*(1) > \frac{c_L + c_H}{2(1-\delta)}$. When the proportion of consumers that prefer the (high-/low-end) sharing service α is small enough, $\frac{c_L + c_H}{2(1-\delta)} - \frac{(2-\alpha)\sigma}{\alpha}$ may be negative. Therefore, to simplify our analysis and make the analysis worthwhile, we assume that $c_A > \frac{c_L + c_H}{2(1-\delta)} - \frac{(2-\alpha)\sigma}{\alpha}$. With this assumption being valid, we verify that $\Pi_A(0)|_{p_A=p_A^*(0)} > \Pi_A(1)|_{p_A=p_A^*(1)}$ and depict the hotel's profit functions under different information strategies in Figure A1. The notation p_{A0} donates the price that renders the hotel gaining no profit with opaque information.

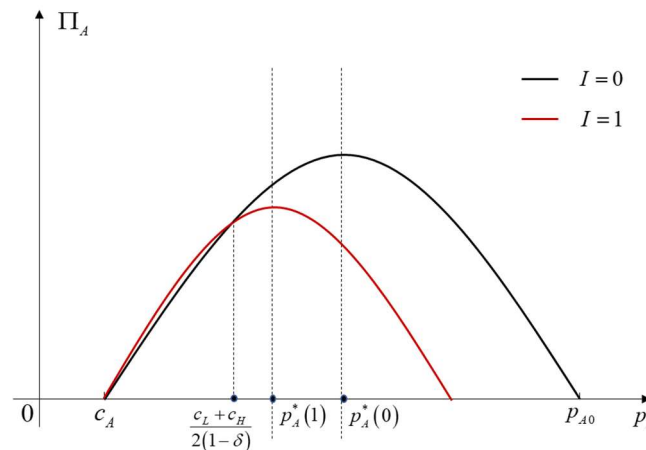


Figure A1. The hotel's profit as a function of price under different information strategies.

Then, from the reaction functions in Table 2, we derive the corresponding prices (p_L^*, p_H^*) and demands (D_L^*, D_H^*) of the hosts, given the hotel's price and the sharing platform's information strategy. To make our analysis valuable and guarantee that the interior solutions are feasible, the conditions $(1 - \delta)p_L^* > c_L$, $D_L^* > 0$ and $(1 - \delta)p_H^* > c_H$, $D_H^* > 0$ must be simultaneously satisfied when the hotel sets the price at $p_A^*(I)$, $I \in \{0, 1\}$. Then, we have $c_A > \frac{3c_L - c_H}{2(1-\delta)} + 2\varepsilon - \frac{(2+\alpha)\sigma}{\alpha}$ and $c_A > \frac{3c_H - c_L}{2(1-\delta)} - 2\varepsilon - \frac{(2+\alpha)\sigma}{\alpha}$. Thus, we have $c_A > c_A$. Meanwhile, we only consider the most realistic case where not all the consumers that are willing to try the sharing service will finally choose the properties provided

by the individual hosts, regardless of the information strategy the platform adopts, i.e., $D_i^* < \alpha$, $i \in \{L, H\}$. Then, we obtain that $c_A < \frac{3c_L - c_H}{2(1-\delta)} + 2\varepsilon + \min\{(7 - \frac{2}{\alpha})\bar{\sigma}, (7 - \frac{2}{\alpha})\underline{\sigma}\}$ and $c_A < \frac{3c_L - c_H}{2(1-\delta)} - 2\varepsilon + \min\{(7 - \frac{2}{\alpha})\bar{\sigma}, (7 - \frac{2}{\alpha})\underline{\sigma}\}$. Thus, we have $c_A < \bar{c}_A$. As a result, we make the assumptions in (i).

Furthermore, to guarantee that the assumptions in (i) are feasible, the condition $\underline{c}_A < \bar{c}_A$ must be satisfied. We find that when $\varepsilon < \frac{c_H - c_L}{2(1-\delta)} - \underline{\sigma}$, $\underline{c}_A = \frac{3c_L - c_H}{2(1-\delta)} - 2\varepsilon - \frac{(2+\alpha)\underline{\sigma}}{\alpha}$; when $\frac{c_H - c_L}{2(1-\delta)} - \underline{\sigma} \leq \varepsilon \leq \frac{c_H - c_L}{2(1-\delta)} + \underline{\sigma}$, $\underline{c}_A = \frac{c_L + c_H}{2(1-\delta)} - \frac{(2-\alpha)\underline{\sigma}}{\alpha}$; and when $\varepsilon > \frac{c_H - c_L}{2(1-\delta)} + \underline{\sigma}$, $\underline{c}_A = \frac{3c_L - c_H}{2(1-\delta)} + 2\varepsilon - \frac{(2+\alpha)\underline{\sigma}}{\alpha}$. If $\alpha \leq \frac{2}{7}$, then when $\varepsilon < \frac{c_H - c_L}{2(1-\delta)}$, $\bar{c}_A = \frac{3c_L - c_H}{2(1-\delta)} + 2\varepsilon + (7 - \frac{2}{\alpha})\bar{\sigma}$; when $\varepsilon > \frac{c_H - c_L}{2(1-\delta)}$, $\bar{c}_A = \frac{3c_L - c_H}{2(1-\delta)} - 2\varepsilon + (7 - \frac{2}{\alpha})\bar{\sigma}$. Moreover, if $\frac{2}{7} < \alpha < \frac{1}{2}$, then when $\varepsilon < \frac{c_H - c_L}{2(1-\delta)} + \frac{(2-7\alpha)\underline{\sigma}}{2\alpha}$, $\bar{c}_A = \frac{3c_L - c_H}{2(1-\delta)} + 2\varepsilon + (7 - \frac{2}{\alpha})\underline{\sigma}$; when $\frac{c_H - c_L}{2(1-\delta)} + \frac{(2-7\alpha)\underline{\sigma}}{2\alpha} \leq \varepsilon \leq \frac{c_H - c_L}{2(1-\delta)} - \frac{(2-7\alpha)\underline{\sigma}}{2\alpha}$, $\bar{c}_A = \frac{c_L + c_H}{2(1-\delta)}$; when $\varepsilon > \frac{c_H - c_L}{2(1-\delta)} - \frac{(2-7\alpha)\underline{\sigma}}{2\alpha}$, $\bar{c}_A = \frac{3c_L - c_H}{2(1-\delta)} - 2\varepsilon + (7 - \frac{2}{\alpha})\underline{\sigma}$. We present the results in Figure A2a,b.

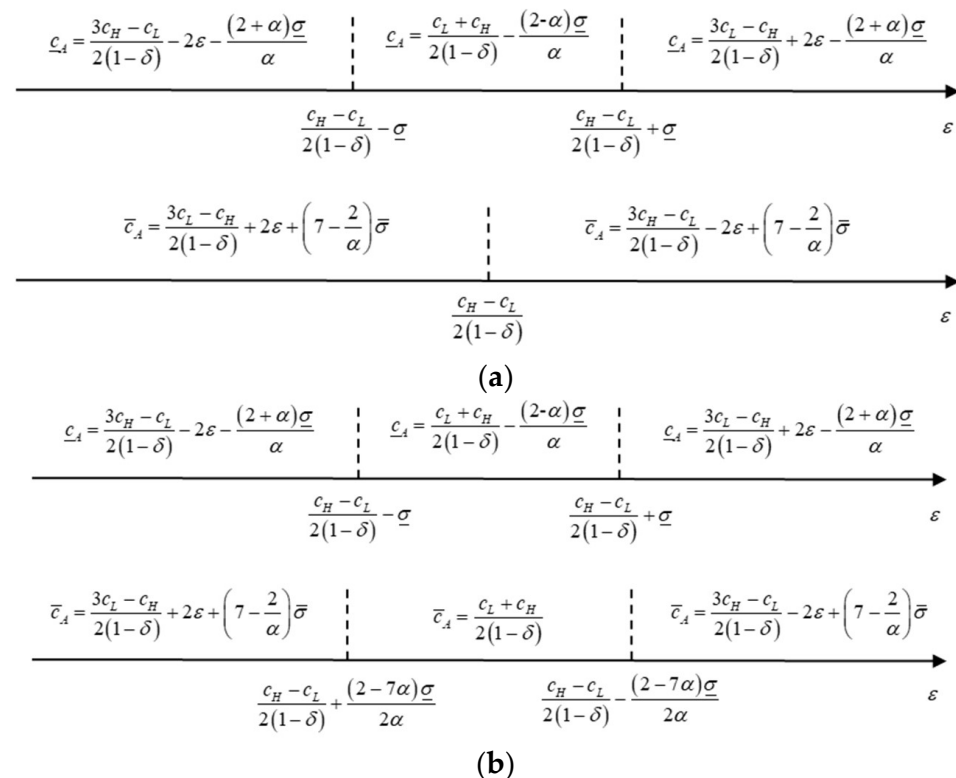


Figure A2. The values of $\underline{c}_A$ and $\bar{c}_A$ for different combinations of α and ε . (a) $\alpha \leq \frac{2}{7}$. (b) $\frac{2}{7} < \alpha < \frac{1}{2}$.

To meet the condition that $\underline{c}_A < \bar{c}_A$, we verify that when $\alpha \leq \frac{2}{7}$, the proportion of consumers that are willing to try the sharing service should be large enough, i.e., $\frac{2(\bar{\sigma} - \underline{\sigma})}{7\bar{\sigma} - \underline{\sigma}} < \alpha \leq \frac{2}{7}$. Thus, we make the assumption in (ii). Meanwhile, market heterogeneity should satisfy the conditions $\varepsilon > \max\left\{\frac{c_H - c_L}{2(1-\delta)} - \frac{7\bar{\sigma} - \underline{\sigma}}{2} + \frac{\bar{\sigma} - \underline{\sigma}}{\alpha}, \frac{c_H - c_L}{2(1-\delta)} - \frac{7\bar{\sigma} + \underline{\sigma}}{4} + \frac{\bar{\sigma} - \underline{\sigma}}{2\alpha}\right\}$ and $\varepsilon < \min\left\{\frac{c_H - c_L}{2(1-\delta)} + \frac{7\bar{\sigma} - \underline{\sigma}}{2} - \frac{\bar{\sigma} - \underline{\sigma}}{\alpha}, \frac{c_H - c_L}{2(1-\delta)} + \frac{7\bar{\sigma} + \underline{\sigma}}{4} - \frac{\bar{\sigma} - \underline{\sigma}}{2\alpha}\right\}$. On the other hand, when $\frac{2}{7} < \alpha < \frac{1}{2}$, we must have $\frac{c_H - c_L}{2(1-\delta)} - 2\underline{\sigma} < \varepsilon < \frac{c_H - c_L}{2(1-\delta)} + 2\underline{\sigma}$ to guarantee that $\underline{c}_A < \bar{c}_A$. Further, we find that $\frac{c_H - c_L}{2(1-\delta)} - 2\underline{\sigma} \leq \max\left\{\frac{c_H - c_L}{2(1-\delta)} - \frac{7\bar{\sigma} - \underline{\sigma}}{2} + \frac{\bar{\sigma} - \underline{\sigma}}{\alpha}, \frac{c_H - c_L}{2(1-\delta)} - \frac{7\bar{\sigma} + \underline{\sigma}}{4} + \frac{\bar{\sigma} - \underline{\sigma}}{2\alpha}\right\}$ and $\frac{c_H - c_L}{2(1-\delta)} + 2\underline{\sigma} \geq \min\left\{\frac{c_H - c_L}{2(1-\delta)} + \frac{7\bar{\sigma} - \underline{\sigma}}{2} - \frac{\bar{\sigma} - \underline{\sigma}}{\alpha}, \frac{c_H - c_L}{2(1-\delta)} + \frac{7\bar{\sigma} + \underline{\sigma}}{4} - \frac{\bar{\sigma} - \underline{\sigma}}{2\alpha}\right\}$ when $\alpha \leq \frac{2}{7}$; whereas $\frac{c_H - c_L}{2(1-\delta)} - 2\underline{\sigma} > \max\left\{\frac{c_H - c_L}{2(1-\delta)} - \frac{7\bar{\sigma} - \underline{\sigma}}{2} + \frac{\bar{\sigma} - \underline{\sigma}}{\alpha}, \frac{c_H - c_L}{2(1-\delta)} - \frac{7\bar{\sigma} + \underline{\sigma}}{4} + \frac{\bar{\sigma} - \underline{\sigma}}{2\alpha}\right\}$ and $\frac{c_H - c_L}{2(1-\delta)} + 2\underline{\sigma} < \min$

$\left\{ \frac{c_H - c_L}{2(1-\delta)} + \frac{7\bar{\sigma} - \underline{\sigma}}{2} - \frac{\bar{\sigma} - \underline{\sigma}}{\alpha}, \frac{c_H - c_L}{2(1-\delta)} + \frac{7\bar{\sigma} + \underline{\sigma}}{4} - \frac{\bar{\sigma} - \underline{\sigma}}{2\alpha} \right\}$ when $\frac{2}{7} < \alpha < \frac{1}{2}$. Therefore, we make the assumptions in (iii).

In summary, the assumptions in (i) correspond to the situations where the service costs of different service providers c_A , c_L , c_H are within reasonable ranges. Then, the assumption in (ii) ensures the attraction of the sharing market to consumers. Finally, the assumptions in (iii) indicate that the market heterogeneity of the hotel industry is within an appropriate range.

Appendix A.1.2. Proof of the Equilibrium Strategies for the Hotel and the Sharing Platform

The expressions of $\varepsilon_1, \varepsilon_2, c_{A1}$, and c_{A2} in Table 3 in the main text are as follows:

$$\begin{aligned} \varepsilon_1 &= \frac{c_L^2 + c_H^2}{2(1-\delta)^2} + \underline{\sigma}\bar{\sigma} - \left(\frac{c_L + c_H}{2(1-\delta)} + \frac{(2-\alpha)\bar{\sigma}}{\alpha} \right)^2, & \varepsilon_2 &= \frac{(c_H - c_L)^2}{4(1-\delta)^2} + \underline{\sigma}\bar{\sigma}, \\ c_{A1} &= 2\sqrt{\frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2} + \underline{\sigma}\bar{\sigma} - \frac{\bar{\sigma}(2-\alpha)}{\alpha} - \frac{c_L + c_H}{2(1-\delta)}, \\ c_{A2} &= \frac{1}{2\alpha\bar{\sigma}(1-\delta)} \left(\left(4\underline{\sigma}(\underline{\sigma} - \bar{\sigma})\alpha \left(\begin{aligned} &-2((c_L + c_H)\alpha + \bar{\sigma}(2-\alpha)(1-\delta))\sqrt{2(c_L^2 + c_H^2 + (2\underline{\sigma}\bar{\sigma} - 2\varepsilon^2)(1-\delta)^2)} \\ &+ ((c_L + c_H)^2 + 2(c_L^2 + c_H^2 + (2\underline{\sigma}\bar{\sigma} - 2\varepsilon^2)(1-\delta)^2))\alpha \\ &+ 2\bar{\sigma}(2-\alpha)(1-\delta)(c_L + c_H) \end{aligned} \right) \right)^{\frac{1}{2}} \right. \\ &\quad \left. + 2\alpha\underline{\sigma}\sqrt{2(c_L^2 + c_H^2 + (2\underline{\sigma}\bar{\sigma} - 2\varepsilon^2)(1-\delta)^2)} + \alpha(\bar{\sigma} - 2\underline{\sigma})(c_L + c_H) - 2\underline{\sigma}\bar{\sigma}(2-\alpha)(1-\delta) \right). \end{aligned}$$

Recall that $\hat{p}_A = \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - \varepsilon^2 + \underline{\sigma}\bar{\sigma}$ in Proposition 1 is a threshold to change the information strategy of the sharing platform. As shown in Figure A3, on the left side of the line $p_A = \sqrt{\hat{p}_A}$, the function image takes the solid part where $I = 0$; whereas on the right side, the image takes the solid part where $I = 1$. Moreover, the hotel's profit equals zero at the price $p_{A0} = \frac{c_L + c_H}{2(1-\delta)} + \frac{\bar{\sigma}(2-\alpha)}{\alpha}$ when $I = 0$. Supposing $\varepsilon^2 \leq \varepsilon_1$, it is easy to verify that $\sqrt{\hat{p}_A} > p_{A0}$, as shown in Figure A3a. We observe that the equilibrium strategy for the hotel is to set the price at $p_A^*(0)$, which then drives the sharing platform to disclose uninformative quality information.

Similarly, Figure A3b–e illustrates the other cases for the hotel's profit pattern. By observing each subfigure, we summarize the equilibrium strategies for the hotel and the sharing platform in Table 3. It is worth noting that when $\varepsilon_1 < \varepsilon^2 < \varepsilon_2$ and $c_{A1} < c_A < c_{A2}$ (Figure A3c), we have $p_{A1} < \sqrt{\hat{p}_A} < p_A^*(0)$, where $p_{A1} = \frac{\bar{\sigma}(2-\alpha)}{2\alpha} + \frac{c_L + c_H + 2c_A(1-\delta)}{4(1-\delta)} - \frac{\sqrt{\underline{\sigma}(\bar{\sigma} - \underline{\sigma})(4\underline{\sigma}\bar{\sigma}(1-\delta)^2(2-\alpha)^2 - \alpha^2(c_L + c_H - 2c_A(1-\delta))^2)}}{4\alpha\underline{\sigma}(1-\delta)}$. If the hotel sets the price at p_{A1} , the sharing platform will take the information strategy at $I = 0$, and the hotel can gain a profit that is the same as the maximum profit it can gain at the information level $I = 1$, i.e., $\Pi_A(0)|_{p_A=p_{A1}} = \Pi_A(1)|_{p_A=p_A^*(1)}$. Figure A3c indicates that to gain more profit, the hotel has the incentive to motivate the sharing platform to provide completely uninformative information. In addition, to guarantee that the sharing platform adopts the zero-level information strategy, the equilibrium strategy for the hotel is to set the price at $\sqrt{\hat{p}_A}$.

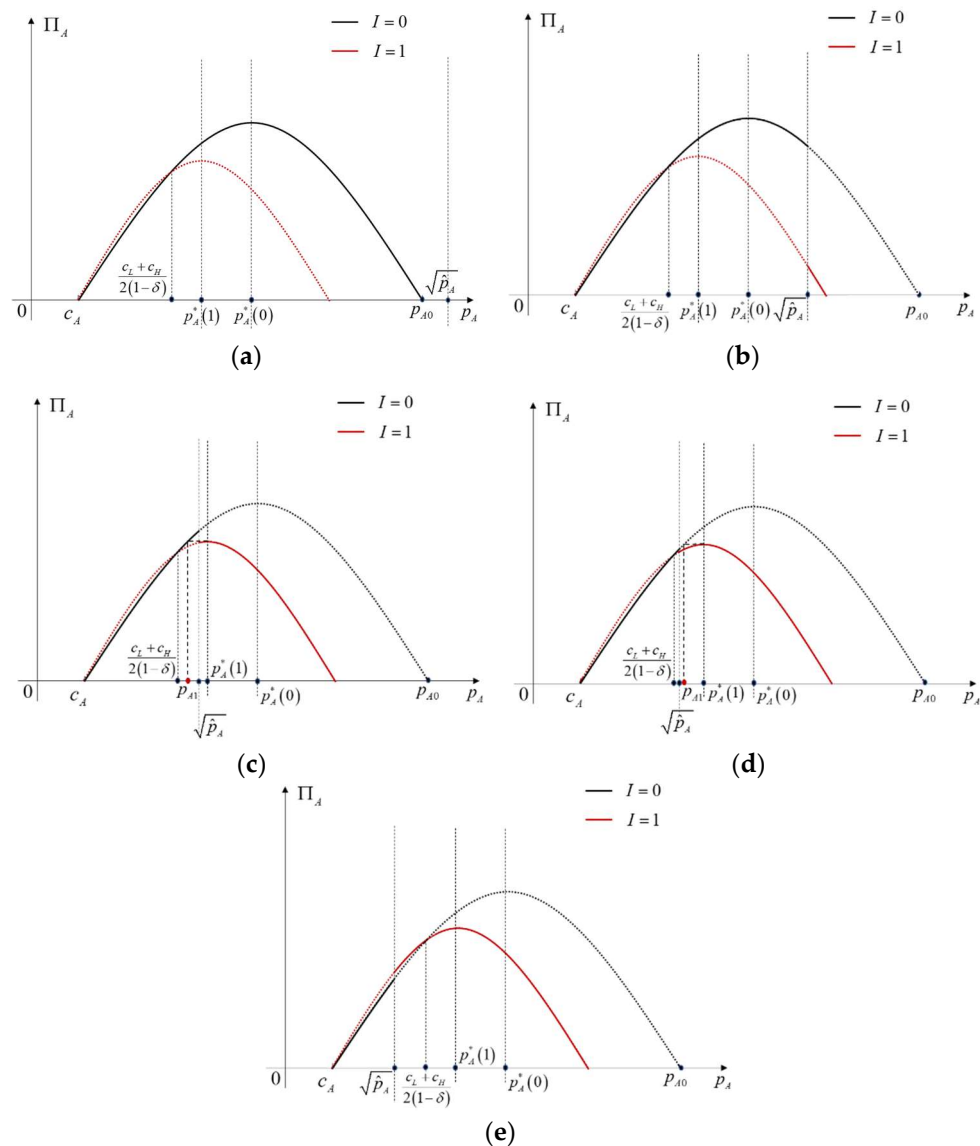


Figure A3. The hotel's profit as a function of price for different cases. (a) $\varepsilon^2 \leq \varepsilon_1$ ($\sqrt{\hat{p}_A} \geq p_{A0}$). (b) $\varepsilon_1 < \varepsilon^2 < \varepsilon_2, c_A \leq c_{A1}$ ($p_A^*(0) \leq \sqrt{\hat{p}_A} < p_{A0}$). (c) $\varepsilon_1 < \varepsilon^2 < \varepsilon_2, c_{A1} < c_A < c_{A2}$ ($p_{A1} < \sqrt{\hat{p}_A} < p_A^*(0)$). (d) $\varepsilon_1 < \varepsilon^2 < \varepsilon_2, c_A \geq c_{A2}$ ($\frac{c_L + c_H}{2(1-\delta)} < \sqrt{\hat{p}_A} \leq p_{A1}$). (e) $\varepsilon^2 \geq \varepsilon_2$ ($\sqrt{\hat{p}_A} \leq \frac{c_L + c_H}{2(1-\delta)}$).

Appendix A.2. Proof of Proposition 2

Recall Proposition 1. To see Proposition 2 (i), consider an accommodation market with extremely low and high heterogeneity, respectively. When market heterogeneity is very low (high), i.e., $\varepsilon^2 \leq \varepsilon_1$ ($\varepsilon^2 \geq \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - c_A^2 + \underline{\sigma}\bar{\sigma}$), the value of parameter $\hat{p}_A$ is so large (small) that $\hat{p}_A > p_{A0}^2$ ($\hat{p}_A < c_A^2$), and the hotel cannot gain any profit if it sets the price p_A such that $p_A^2 > \hat{p}_A$ ($p_A^2 < \hat{p}_A$), as there will be no demand (no marginal profit) for its service. Then, by Proposition 1, the sharing platform will always provide opaque (transparent) information regardless of how the hotel sets its price, anticipating that the hotel aims to maximize its profit. In addition, when market heterogeneity is relatively high, i.e., $\varepsilon_2 \leq \varepsilon^2 < \frac{c_L^2 + c_H^2}{2(1-\delta)^2} - c_A^2 + \underline{\sigma}\bar{\sigma}$, the value of parameter $\hat{p}_A$ is greater than zero but

smaller than or equal to $\left(\frac{c_L+c_H}{2(1-\delta)}\right)^2$. For this case, the hotel cannot maximize its profit if it sets the price such that $p_A^2 < \hat{p}_A$ (of course $p_A < \frac{c_L+c_H}{2(1-\delta)}$). Therefore, expecting the pricing decision of the profit-maximizing hotel, i.e., $p_A^2 > \hat{p}_A$, the platform will always disclose full information. In other words, extremely low or high market heterogeneity makes the hotel lose the power to influence the sharing platform's information strategy.

Appendix A.3. Proof of Proposition 3

From the results in Tables 3 and 4 in the main text, we can easily verify that in all the cases, the equilibrium price and demand of the low-quality sharing service decrease with market heterogeneity, i.e., $\frac{\partial P_L^*}{\partial \varepsilon} < 0$ and $\frac{\partial D_L^*}{\partial \varepsilon} < 0$, whereas the equilibrium price and demand of the high-end sharing service increase with market heterogeneity, i.e., $\frac{\partial P_H^*}{\partial \varepsilon} > 0$ and $\frac{\partial D_H^*}{\partial \varepsilon} > 0$.

Appendix A.4. Proof of Proposition 4

From the results in Tables 3 and 4, when both the hotel's service cost and market heterogeneity are medium, we have $\sqrt{\hat{p}_A} < p_A^*(0)$. Then, we can prove that the hotel's equilibrium profit decreases with market heterogeneity, i.e., $\frac{\partial \Pi_A^*}{\partial \varepsilon} \big|_{\varepsilon \in (\varepsilon_1, \varepsilon_2), c_A \in (c_{A1}, c_{A2})} < 0$. For the other cases, we see that the expressions of the hotel's equilibrium price, demand, and profit are independent of market heterogeneity.

Appendix A.5. Proof of Proposition 5

When both the hotel's service cost and market heterogeneity are medium, we find that the equilibrium revenue and total demand of the sharing platform decrease with market heterogeneity, i.e., $\frac{\partial \Pi_B^*}{\partial \varepsilon} \big|_{\varepsilon \in (\varepsilon_1, \varepsilon_2), c_A \in (c_{A1}, c_{A2})} = -\frac{\varepsilon \alpha \delta (1-\delta)}{\sqrt{2(c_L^2+c_H^2)-4(\varepsilon^2-\sigma\bar{\sigma})(1-\delta)^2}} < 0$, $\frac{\partial D_B^*}{\partial \varepsilon} \big|_{\varepsilon \in (\varepsilon_1, \varepsilon_2), c_A \in (c_{A1}, c_{A2})} = -\frac{\varepsilon \alpha (1-\delta)}{\bar{\sigma} \sqrt{2(c_L^2+c_H^2)-4(\varepsilon^2-\sigma\bar{\sigma})(1-\delta)^2}} < 0$. For the other cases, we can easily prove that the platform's equilibrium revenue increases with market heterogeneity, i.e., $\frac{\partial \Pi_B^*}{\partial \varepsilon} \big|_{\text{other cases}} > 0$.

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