Platform Price Parity Clauses and Segmentation*

Joan Calzada[†] Ester Manna,[‡] Andrea Mantovani[§]

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Abstract

Price parity clauses (PPCs) are widely adopted by online travel agencies (OTAs) to force client hotels not to charge lower prices on alternative sales channels. In this paper, we investigate how PPCs affect the suppliers' listing decisions. We find OTAs adopt PPCs when they are highly substitutable, and to prevent showrooming. PPCs allow OTAs to charge hotels higher commission fees. However, hotels can respond by delisting from some OTAs to increase competition among platforms, thereby reducing commission fees. Our analysis reveals that the removal of PPCs enables hotels to list on more OTAs, thus benefiting consumers as prices decrease.

Keywords: Price parity clauses, online travel agencies, segmentation, vertical relations.

JEL Classification: D40, L42, L81.

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[†]University of Barcelona and BEAT, Av. Diagonal 696, 08034, Barcelona, Spain; email: calzada@ub.edu.

[‡]Serra Húnter Fellow, University of Barcelona and BEAT, Av. Diagonal 696, 08034, Barcelona, Spain; email: estermanna@ub.edu.

[§]Department of Economics, University of Bologna, Strada Maggiore 45, 40125 Bologna, Italy; email: a.mantovani@unibo.it.

1 Introduction

Price parity clauses (PPCs) are contractual terms used by online platforms to prevent client sellers from offering their services at cheaper prices on alternative sales channels. They are widespread in the lodging sector, but have been also applied to other industries such as entertainment, insurance, digital goods, and payment systems. In tourist accommodation, Online Travel Agencies (OTAs) such as *Booking.com* and *Expedia* often apply *wide* PPCs, which require that the prices posted by hotels in the contracted OTA cannot be higher than those offered to consumers who book directly or through rival OTAs. The objective of this measure is to prevent *showrooming*, which occurs when consumers use the platform to verify the availability of products and prices online, and then buy directly from the seller. In spite of this, antitrust authorities in several countries are concerned that PPCs may reinforce the dominant position of large OTAs. In particular, wide PPCs are deemed responsible for raising hotel prices and discouraging the entry of new platforms that may offer better conditions to client hotels. A milder version of these clauses, the *narrow* PPCs, allows hotels to price differentiate across OTAs, although still prohibiting them from charging lower prices when selling directly.

In the EU, the Bundeskartellamt (the German competition authority) prevented *HRS* in 2013 and *Booking.com* in 2015 from using PPCs. In August 2015, the French government imposed a law prohibiting any type of PPCs. A similar ban was adopted in Austria in 2016, Italy in 2017, Belgium and Sweden in 2018. In 2017, the EU commissioned a report to evaluate the effect of the removal of PPCs, but the results were not conclusive as the percentage of hotels responding to the survey was not very high.[1] No other countries have regulated the use of these clauses, with the notable exception of Australia and New Zealand, where *Booking.com* and *Expedia* reached an agreement with regulators to substitute wide PPCs for narrow PPCs. In most major markets, such as in the US, OTAs continue to apply wide PPCs, notwithstanding the fact that leading scholars such as Baker and Scott Morton (2018) have stressed that antitrust enforcement against this practice should become a priority.

A growing body of literature, both theoretical and empirical, has investigated the economic effects of adopting PPCs (see, among others, Edelman and Wright, 2015, Boik and Corts, 2016, Johnson, 2017, Hunold et al., 2018, Mantovani et al., 2018). However, an aspect that has received meager attention is how PPCs affect the suppliers' incentives (hotels in our example) to simultaneously participate in several platforms (OTAs). This is a relevant aspect since the imposition of price restrictions may mitigate competition and allow OTAs to charge high commission fees. Hotels may respond to this by delisting from OTAs, thereby forcing a reduction in these fees. The idea that PPCs may induce market segmentation has received some empirical attention. Hunold et al. (2018) show that German hotels increased their participation to multiple OTAs when PPCs were prohibited. They also find that prices decreased, especially in the direct channels, which were increasingly used by consumers.

[1] European Commission and the Belgian, Czech, French, German, Hungarian, Irish, Italian, Dutch, Swedish and UK NCAs, 'Report on the monitoring exercise carried out in the online hotel booking sector by the EU competition authorities in 2016', April 2017, available at: http://ec.europa.eu/competition/ecn/hotel_monitoring_report_en.pdf.

The aim of this paper is to develop a theoretical model to examine how platforms' contractual arrangements may affect the suppliers' pricing and listing decisions. In particular, we consider a model in which two horizontally differentiated hotels resort to OTAs in order to reach hotel seekers that would have not known they existed otherwise. OTAs allow hotels to expand their customer base but charge them a per-sale commission. We assume there are two symmetric OTAs that are perceived by customers as horizontally differentiated in terms of the booking experience. Hotels decide how many sales channels to use. This decision crucially depends on the contractual restrictions imposed by OTAs, which can apply PPCs. The main contribution of the paper is twofold. On the one hand, we explain under which conditions OTAs benefit from adopting PPCs. On the other hand, we show that the imposition of PPCs can induce hotels to limit the number of sales channels in which they are listed.

Our paper starts by considering the benchmark case in which hotels are free to set their prices in all the sales channels they use. In order to account for showrooming, we assume that a fraction of consumers book directly with the hotel after visiting the OTAs. We find that hotels end up being listed on both OTAs (multi-homing) as this allows them to attract more consumers. Then, we investigate what happens when OTAs impose PPCs. This price restriction allows OTAs to set very high commission fees when hotels multi-home by stifling the competitive pressure across sales channels. At this juncture, we show that hotels: *(i)* can smooth out the impact of this measure by delisting from one OTA; *(ii)* prefer not to sell through their direct channel. Regarding the first point, single-homing increases competition across OTAs, which are forced to lower their commissions fees. This intensifies the price margin for hotels, without necessarily sacrificing quantity. Hence, hotels prefer segmentation when PPCs are applied. As to the second point, we demonstrate that the fees under PPCs sharply increase in the amount of showrooming, thus inducing hotels to cease the direct channel. We confirm this result also in the case of partial application of PPCs, *i.e.*, when only one OTA applies PPCs.

Finally, we investigate the OTAs' contractual arrangements by comparing the profits they obtain with and without PPCs. We show that OTAs always apply PPCs when showrooming is particularly intense. Nonetheless, OTAs also adopt PPCs when showrooming is limited, if the degree of substitutability between them is sufficiently high. In this case, by adopting PPCs, OTAs induce hotels to single-home, which reduces the competitive pressure and enables OTAs to increase the commission fees. In contrast, when OTAs are perceived as sufficiently differentiated, they refrain from adopting PPCs to induce multi-homing on the hotels side. In this case, the increase in the amount of booking offers compensates for the lower commission fee and the occurrence of showrooming, given that hotels activate their direct channel.

In the last part of our paper, we analyze the economic effect of PPCs in terms of industry profits and consumers' well-being. The adoption of PPCs has an ambiguous effect for hotels. As previously indicated, PPCs induce hotels to single-home in order to lower the commission fee charged by OTAs. This hurts hotels if they are sufficiently differentiated, as they would have preferred competing over multiple platforms. Hotels gain instead if they are perceived as very substitutable, given that by single-homing they can increase the price margin per unit sold on the platform. Conversely, if OTAs leave prices unconstrained, there exists a parametric region in which hotels would have preferred PPCs, as in their absence they are trapped in a prisoner's dilemma. This occurs when hotels are very similar and would therefore benefit from the segmentation induced by PPCs. However, if OTAs are sufficiently differentiated, they maintain prices unrestrained to induce multi-homing.

Regarding consumers, they are never better off with PPCs. On the one hand, platform prices increase following the surge in the commission fees. On the other hand, as PPCs *de facto* eliminate showrooming, those consumers who would have used the hotel's direct channel end up being worse off with PPCs. Taking this into account, the removal of PPCs should lead to a price decline, thereby benefitting consumers. This result is consistent with the complementary empirical evidence provided by Hunold et al. (2018) and Mantovani et al. (2019).

To sum up, our simplified model of the lodging sector highlights the role of PPCs for market segmentation and price dynamics on different sales channels. We show that the removal of PPCs goes in the desired direction of increasing the number of hotels listed on different OTAs, thus promoting platform competition. This reduces the commission fees levied on client hotels, which translates into a lower retail prices for end customers. Moreover, we demonstrate that hotels are willing to use direct sales channels in the absence of PPCs. Our analysis also reveals that there exist cases in which OTAs do not find it profitable to adopt PPCs. Furthermore, we show that hotels benefit from these clauses when they are not very differentiated.

Overall, we believe the results of our paper have relevant implications for policy makers interested in the economic effect of platform regulation in terms of prohibiting PPCs. Although the primary objective of these clauses is to avoid showrooming, they can restrict market competition, leading to undesirable consequences in terms of hotel offers and prices.

Literature review. In the last years, a growing number of studies have analyzed the economic effect of PPCs, and their removal thereof, in the context of online platforms. From a theoretical perspective, we build upon and contribute to these recent works. Boik and Corts (2016) and Johnson (2017) show that PPCs increase commissions fees set by the OTAs, thereby damaging final consumers. However, in their models they do not explicitly include a direct sales channel and they do not examine the effect of PPCs on market segmentation. Edelman and Wright (2015) consider consumers who can purchase directly from the preferred sellers or from a platform. In this context, PPCs enable platforms to prevent showrooming by raising the price of the direct channel. They also find that PPCs lead to excessive investment in ancillary services by the platform in order to lock-in consumers. The result is a reduction in consumer surplus and sometimes welfare. Wang and Wright (2018) consider instead a sequential search model in which platforms provide both a search and intermediation service. In this context, competition implies that wide PPCs lead to higher prices in order to eliminate showrooming, whereas narrow PPCs may preserve competition and limit price surges while avoiding free-riding on the platforms' search services. Wals and Schinkel (2018) find that narrow PPCs combined with a best price guarantee (BPG) may reproduce the detrimental effects for consumers of wide PPCs. In fact, the dominant platform can deter entry with the BPG, while at the same time using narrow PPCs to eliminate competition from direct sales channels.

Ronayne and Taylor (2018) analyze a market where two producers sell a homogenous product to consumers through both a direct and a competitive channel, whose size signicantly affects market outcomes. In this context, they analyze the effect of Most Favored Nation (MFN) clauses, a form of PPCs. Similarly to our analysis, they find that some firms delist under MFNs, and that consumers are harmed by MFNs. However, our paper differs from theirs as we analyze competition between horizontally differentiated platforms in addition to competition between sellers. This allows us to highlight that OTAs' decision about the adoption of price restrictions crucially depends on their degree of substitutability.

Johansen and Vergé (2017) develop a model where there are two OTAs, several sellers, and consumers characterized by preferences *à la* Singh and Vives (1984), based on a representative agent and elastic demand. An important feature of their analysis is the interplay between hotels' substitutability and their possibility to delist from the OTAs, which imposes a limit to the fee they can charge. They also assume the fees are secretely offered to hotels. As a consequence, each supplier does not observe the commission fee paid by its rivals. They adopt the "contract equilibrium" approach developed by Cremer and Riordan (1987) and Horn and Wolinsky (1988), finding scenarios in which PPCs may benefit both hotels and consumers. Differently from them, we assume that all commissions fees are observed by hotels, which allows them to single-home when OTAs adopt PPCs. Another difference is that we consider a model in which travellers visit OTAs to discover the availability of hotels in a specific location. Once they know about their existence, consumers can book from the OTAs or from the hotels' websites.

Our paper contributes to the literature on competition in two-sided markets. Seminal contributions by Caillaud and Jullien (2003), Rochet and Tirole (2003, 2006), and Armstrong (2006), *inter alios*, focus on cross-group externalities between agents on both sides. However, we explicitly study competition between agents on the same side. Hence, we are close to Karle et al. (2017), who consider agglomeration (all buyers and sellers in one platform) *vs.* segmentation on the sides of both consumers and sellers in the presence of homogeneous platforms.[2] They show that single-homing may relax seller competition on each platform. Indeed, in case of agglomeration, consumers are informed about all prices that sellers charge on the platform. Similarly to their paper, we find that sellers prefer to be active on different platforms if competition is very intense, even though they may fail to reach market segmentation in the absence of PPCs. In general, while their analysis mainly focuses on how competition in the product market affects platform market structure, our particular interest concerns how these resulting differences in the market structure affects the OTAs' decision about whether or not to adopt PPCs.

A few empirical papers have analyzed the impact of PPCs in European markets. The aforementioned paper by Hunold et al. (2018) is based on meta-search data of more than 30,000 hotels in *Kayak.com* from January 2016 until January 2017.[3] Consistently with our results, they obtain that the abolition of PPCs in Germany at the end of 2015, although not changing

[2] Armstrong and Wright (2007) endogenize the decision of agents to single-home or multi-home by considering how platform differentiation affects this choice. They also investigate the use of exclusive contracts that prevent agents from multi-homing.

[3] Recently, an European Commission monitoring report has considered similar data as Hunold et al. (2018) and analyzed the impact of removing PPCs in different European countries.

the commission rates, encouraged hotels to publish their offers on more OTAs and to increase their offers on direct channels. They also document a sharper price decrease of hotel rooms on the direct channel in Germany, as compared to countries that did not abolish PPCs. Cazaubiel et al. (2018) obtain an exhaustive dataset of reservations from 2013 to 2016 in 13 hotels in Oslo belonging to the same chain. They estimate the degree of substitution between *Booking.com* and *Expedia*, and hotels' own websites, and show that the direct sales channel appears to be a credible alternative to the OTAs. Finally, Mantovani et al. (2019) have collected data of listed prices on *Booking.com* in the period 2014-17 for tourism regions that belong to France, Italy, and Spain. They compare prices before and after the most relevant EU antitrust decisions and find limited effects in the short run followed by a significant reduction in room prices in the medium run. Moreover, they find that hotels affiliated with chains decreased their prices more than independent hotels, both in the short and medium run.

The remainder of the article proceeds as follows. The next section presents the basic model. Section 3 considers the hotels' decision regarding how many OTAs to use, whereas Section 4 investigates the OTAs' decision regarding the adoption of PPCs. Section 5 highlights the economic effects of adopting PPCs. Section 6 provides concluding remarks.

2 The model

We develop a model where two horizontally differentiated sellers (1 and 2) can be listed on one or two horizontally differentiated platforms (A and B). We refer to hotels and OTAs as representative examples of sellers and platforms. In order to simplify the analysis, we consider that OTAs are the only way for hotels to inform consumers about their presence in the market. Hotels must pay a per-sale commission when consumers buy their products through the OTAs.[4] However, they can also sell directly to those consumers who decide to bypass the OTAs' sales channel.

The consumers' inverse demand functions when they respectively book their rooms through the OTAs or directly through the hotels' websites are given by:

$$p_{ij} = 1 - [q_{ij} + \alpha q_{ik} + \beta(q_{hj} + \alpha q_{hk})], \tag{1}$$

$$p_{Dj} = 1 - (q_{Dj} + \alpha q_{Dk}), \tag{2}$$

where p_{ij} is the price charged by hotel j on platform i with $j \neq k \in \{1, 2\}$ and $i \neq h \in \{A, B\}$, whereas p_{Dj} is the price offered by hotel j on its website. This demand specification is a simplified version of that used by Johansen and Vergé (2017) and Ziss (1995). The parameter $\alpha \in (0, 1)$ measures the degree of *inter*-brand competition (*i.e.*, between hotels), while $\beta \in (0, 1)$ measures the degree of *intra*-brand competition (*i.e.*, between platforms). A relatively high value of α (resp. β) means that hotels (resp. OTAs) are perceived as close substitutes, and *vice versa*.

Consumers are unaware of the hotels' offers and browse through OTAs. They observe which hotels are available on each platform and select the combination hotel-OTA according to their

[4] As it is common in the literature, we assume that sellers consider the competing platforms as homogeneous while consumers have preferences over them (see Armstrong and Wright, 2007).

preferences. We assume there is a fraction γ of consumers that, after visiting the OTAs, decide to book directly from the hotel websites if the prices are lower. The remaining fraction $(1-\gamma)$ represents instead those consumers who decide to book through the platform. Parameter γ captures therefore the intensity of "showrooming".[5]

Hotels decide whether to be listed on one or two OTAs; the profits of hotel j when it multi-homes (no segmentation) and when it single-homes by showcasing its rooms only on OTA i (segmentation) are respectively given by:

$$\pi_j = \gamma[p_{Dj}\, q_{Dj}] + (1-\gamma)[(p_{ij} - f_{ij})q_{ij} + (p_{hj} - f_{hj})q_{hj}], \tag{3}$$
$$\pi_j = \gamma[p_{Dj}\, q_{Dj}] + (1-\gamma)[(p_{ij} - f_{ij})q_{ij}], \tag{4}$$

where f_{ij} is the commission fee hotel j pays to platform i. For simplicity, we also assume that the cost hotels bear for directly offering their booking services is equal to zero. We also allow hotels to shut down their direct channel if it is not profitable. In such a case, consumers cannot showroom and we impose $\gamma = 0$ in (3)-(4).

The profits of the OTAs also depend on the number of hotels that are listed in their websites. In particular, when direct selling is in place, OTA i's profits when it lists the two hotels and when it only lists hotel j are respectively given by:

$$\pi_i = (1-\gamma)[f_{ij}\, q_{ij} + f_{ik}\, q_{ik}]; \tag{5}$$
$$\pi_i = (1-\gamma)[f_{ij}\, q_{ij}]. \tag{6}$$

The timing of the model is as follows. In *Stage 1*, the OTAs decide whether to impose PPCs or not. In *Stage 2*, hotels simultaneously choose how many sales channels to activate. In *Stage 3*, OTAs simultaneously set the linear commission fees for hotels. In *Stage 4*, hotels simultaneously set the prices in all channels in which they are active.[6] Finally, in *Stage 5*, consumers choose from which channel to book the room and profits are realized.[7]

We proceed by backward induction and solve for the Subgame Perfect Nash Equilibria of the game. In case of multiple equilibria, we use Pareto dominance as the refinement criterion. All the computations and proofs of lemmas and propositions are in the appendices.

[5]We are implicitly assuming that some consumers look for lower prices in the hotels websites and are willing to bear some additional search cost and/or to give up additional services provided by the OTAs when hotels offer cheaper prices in their websites. In other words, consumers are informed about the prices and buy the item from the sale channel with the lowest price as in Varian (1980). Along the same line, Ronayne and Taylor (2018) distinguish between two types of consumer: captive consumers (who shop directly on the seller's website) and shoppers (who buy at the lowest price).

[6]Our modelling choice is supported by the fact that associations of hotels such as HOTREC in the EU and AHLA in the US are increasingly taking initiatives to inform their members about different practises adopted by OTAs, including the levels of commission fees. Hence, we consider that hotels choose on how many OTAs to be listed anticipating the commission fees OTAs will charge in each different scenario.

[7]In our model, there is commitment on the side of the hotels to stay in one or both platforms. Also notice that our setting is equivalent to the one in which OTAs offer a menu of commission fees that hotels will accept if their *ex-post* participation constraints are satisfied.

3 The hotels' pricing and listing decisions

The objective of this section is to determine the market equilibrium prices and the hotels' listing strategy under three scenarios: *(i)* the benchmark case of unrestricted prices, in which hotels are free to set their prices in all sales channels; *(ii)* full adoption of PPCs, which are applied by both OTAs towards client hotels; *(iii)* partial adoption of PPCs, which occurs when only one OTA adopts PPCs, while the other does not. Section 4 then considers the OTAs' decision about whether or not to adopt these price restrictions. In order to focus on the most relevant parametric regions, we do not consider the extreme case in which hotels are so similar that they use segmentation as a way to differentiate themselves.

Assumption 1. $\alpha < \alpha_1$.

The threshold value for α_1 is not reported as algebraically very complex, but it will be graphically represented along the paper. In the concluding section we will we provide a brief explanation of what happens when $\alpha \geq \alpha_1$.

3.1 The benchmark case: unrestricted pricing

We first consider the case in which hotels can freely set the retail prices both on their websites and on the OTAs in which they are listed. We want to know whether in this scenario they prefer to be listed on both OTAs or just on one of them. In order to address this question, we compute hotels' profits in all possible scenarios: No Segmentation (NS), in which both hotels multi-home and are therefore listed on both OTAs; Segmentation (S), in which each hotel is listed on a different OTA; Partial Segmentation (PS), where only one hotel is listed on both OTAs, whereas the other only on one.[8] In all these situations, we check whether hotels decide to also sell directly or not. All proofs are in Appendix A.

No Segmentation (NS). Lemma 1 illustrates the equilibrium prices, commission fees, hotels' and OTAs' profits, when both hotels decide to be listed on the two OTAs. Given symmetry, we omit i and j from the equilibrium prices and commission fees. For ease of exposition, we use subscript D for direct prices and P for prices charged on the platform.

Lemma 1. *When both hotels are listed on the two OTAs, their retail prices are:*

$$p_D^{NS} = \frac{1-\alpha}{2-\alpha} \quad \textit{and} \quad p_P^{NS} = \frac{3-2(\alpha+\beta)+\alpha\beta}{(2-\alpha)(2-\beta)}.$$

Both OTAs set the commission fee:

$$f^{NS} = \frac{1-\beta}{2-\beta}.$$

[8] OTAs are the only way for hotels to inform consumers about their existence. As a consequence, hotels never have an incentive to delist from both OTAs. In an alternative version of the model, we consider the case in which hotels receive the direct visits of some consumers. Calculations are more complicated, as we need to extend the hotels' decision set. However, we can prove that the strategy of selling only through the direct channel is always dominated. Therefore, the profit comparison boils down to the decision between one and two OTAs, as in the simple model that we consider. Calculations are available upon request.

Hotels' and OTAs' profits are respectively:

$$\pi_j^{NS} = \frac{(1-\alpha)[2+2\gamma-\gamma\beta^2(3-\beta)]}{(1+\alpha)(2-\alpha)^2(1+\beta)(2-\beta)^2}, \quad \textit{with} \quad j=1,2;$$
$$\pi_i^{NS} = \frac{2(1-\gamma)(1-\beta)}{(1+\alpha)(2-\alpha)(1+\beta)(2-\beta)^2}, \quad \textit{with} \quad i=A,B.$$

Lemma 1 shows that without PPCs the retail prices set by the hotels in their direct channels only depend on how differentiated they are. In particular, as α increases, hotels become more similar and the competitive pressure reduces their prices. Notice that $p_P^{NS} > p_D^{NS}$: the prices charged by hotels on the OTAs are always higher than those posted in the hotels' websites, as they are affected by the commission fee f^{NS}. The existence of such price difference is one of the arguments used by the OTAs to justify the adoption of PPCs, which aim at uniformizing prices and avoiding (or at least reducing) showrooming. Interestingly, the two prices converge when $\beta \to 1$, as the commission fee goes to zero as the two OTAs become perfect substitutes.

We also find that hotels' profits obviously decrease in α, while they increase in β and γ. As indicated above, an increase in *inter*-brand (hotel) competition α diminishes hotel's direct prices and, consequently, their profits. In contrast, an increase in *intra*-brand (platform) competition β reduces commission fees. This drives down platform prices, but less in proportion to the fees, which explains why hotels' profits increase in β. In other words, the price margin per unit sold through the OTA ($p_P^{NS} - f^{NS}$) enlarges in β. Lastly, hotels benefit from showrooming and this confirms that they always decide to use their direct channel.

Segmentation (S). Lemma 2 illustrates the equilibrium prices, commission fees, hotels' and OTAs' profits, when hotels are active only in one OTA.

Lemma 2. *When each hotel is listed on a different OTA, their retail prices are:*

$$p_D^S = \frac{1-\alpha}{2-\alpha} \quad \textit{and} \quad p_P^S = \frac{2(1-\alpha\beta)(3-\alpha^2\beta^2)}{(2-\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]}.$$

Each OTA sets the commission fee:

$$f^S = \frac{(1-\alpha\beta)(2+\alpha\beta)}{4-\alpha\beta(1+2\alpha\beta)}.$$

Hotels' and OTAs' profits are respectively:

$$\pi_j^S = \frac{\gamma(1-\alpha)}{(1+\alpha)(2-\alpha)^2} + \frac{(1-\gamma)(1-\alpha\beta)(2-\alpha^2\beta^2)^2}{(1+\alpha\beta)(2-\alpha\beta)^2[4-\alpha\beta(1+2\alpha\beta)]^2};$$
$$\pi_i^S = \frac{(1-\gamma)(1-\alpha\beta)(2+\alpha\beta)(2-\alpha^2\beta^2)}{(1+\alpha\beta)(2-\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]^2}.$$

By comparing Lemma 2 with Lemma 1, it is immediate to notice that direct prices do not change, *i.e.*, $p_D^{NS} = p_D^S$, because direct demand functions are the same. In contrast, the prices posted in the OTAs are higher with segmentation: $p_P^S > p_P^{NS}$. Therefore, the price difference between the platform and the direct channel enlarges when hotels single-home. By segmenting the market, competition within OTAs is relaxed since each platform becomes the only way for hotels to access consumers. For this reason, the commission fee is higher ($f^S > f^{NS}$), and it remains positive even if $\beta = 1$.[9] This explains why platform prices increase.

As expected, hotels' profits decrease in α, but now we find that profits are also negatively affected by the intensity of platform competition β. Differently from the previous case, under segmentation an increase in β reduces the prices charged by hotels on the OTAs more than it decreases the commission fees, *i.e.* $(p_P^S - f^S)$ decreases in β. We also find that hotels' profits increase in γ, thus confirming that hotels maintain their direct sales channels.

Partial Segmentation (PS). We now consider the case in which one hotel multi-homes, while the other single-homes. Without loss of generality, hotel j is listed on both OTAs, while hotel k is active only on OTA h. Lemma 3 illustrates the equilibrium prices and commission fees. Hotels' profits are π_j^{PS} and π_k^{PS}, while OTAs' profits are π_i^{PS} and π_h^{PS}. Their expressions are extremely long and therefore are presented in Appendix A.

Lemma 3. *When hotel j is listed on both OTAs i and h, while hotel k is listed only on OTA h, their retail prices are:*

$$
\begin{aligned}
p_D^{PS} &= \frac{1-\alpha}{2-\alpha}; \;\; p_{ij}^{PS} = \frac{(2-\alpha)[12-\beta^2(4+5\alpha^2)] - 2\beta(2+\alpha) + \alpha[1+\alpha(1+\alpha)]\beta^3}{2(2-\alpha)[8-\beta^2(2+3\alpha^2)]}; \\
p_{hj}^{PS} &= \frac{8(3-2\alpha) - (2-\alpha)\beta - [8-\alpha(5-9\alpha+6\alpha^2)]\beta^2}{2(2-\alpha)[8-\beta^2(2+3\alpha^2)]}; \\
p_{hk}^{PS} &= \frac{4(3-2\alpha) - (2-\alpha)\alpha\beta - [3-\alpha+4\alpha^2-3\alpha^3]\beta^2}{2(2-\alpha)[8-\beta^2(2+3\alpha^2)]}.
\end{aligned}
$$

OTAs set the following commission fees:

$$
\begin{aligned}
f_{ij}^{PS} &= \frac{(1-\beta)[4+\beta(2-\alpha^2\beta)]}{[8-(2+3\alpha^2)\beta^2]}; \;\; f_{hj}^{PS} = \frac{(1-\beta)[4+\beta(2+\alpha^2)]}{[8-(2+3\alpha^2)\beta^2]}; \\
f_{hk}^{PS} &= \frac{2(4-\alpha\beta) - \beta^2(2+\alpha+3\alpha^2)}{2[8-(2+3\alpha^2)\beta^2]}.
\end{aligned}
$$

It is relatively straightforward to demonstrate that $f_{hk}^{PS} > f_{hj}^{PS} > f_{ij}^{PS}$. In other words, OTA h, that hosts both hotels, takes advantage of its privileged position to set higher fees than OTA j, that hosts only one hotel. Moreover, it charges hotel k more due to exclusivity. In terms of prices, we find that $p_{hk}^{PS} > p_{hj}^{PS}$ in OTA h, given that $f_{hk}^{PS} > f_{hj}^{PS}$. However, the multi-homing hotel j charges higher prices in the platform where it competes with the rival, $p_{ij}^{PS} > p_{hj}^{PS}$, even though it pays a lower fee, $f_{hj}^{PS} > f_{ij}^{PS}$. Moreover, when α is sufficiently low, it is possible to demonstrate that $p_{hk}^{PS} > p_{ij}^{PS} (> p_{hj}^{PS})$, and hence hotel k sets a higher price than the rival that multi-homes. For relatively high values of α, we find instead that $p_{ij}^{PS} > p_{hk}^{PS} (> p_{hj}^{PS})$, meaning that the multi-homing hotel j charges the highest prices on the platform where it is alone (and in which it pays the lowest fee!). For future reference, we also notice that $(p_{ij}^{PS} - f_{ij}^{PS}) > (p_{hj}^{PS} - f_{hj}^{PS}) > (p_{hk}^{PS} - f_{hk}^{PS})$: the price margin rewards more the hotel that multi-homes.

[9] With segmentation, the fee decreases in α and β, and goes to 0 only when both parameters equal 1.

Hotels' listing decisions with unrestricted pricing. In the second stage of the game, hotels compare their profits in the three previous scenarios and decide the profit-maximizing listing strategy.

First, we study the incentives of a hotel to multi-home when the rival single-homes and find that, under Assumption 1, $\pi_j^{PS} > \pi_j^S$.[10] Apart the extreme case in which hotels are almost perfect substitute, joining a second platform is beneficial for hotels, if the rival is listed only on one. Indeed, this strategy enables the multi-homing hotel to sell more rooms, while enjoying a higher price margin on each unit than the single-homing hotel.

Second, we consider the incentives of a hotel to multi-home when the rival multi-homes as well and find that $\pi_j^{NS} > \pi_k^{PS}$. The partial segmentation scenario revealed that the single-homing hotel k not only sells a lower quantity than the multi-homing rival j, but it also pays the highest commission fee.[11] By multi-homing as well, this hotel is capable of raising its margin per room, while at the same time expanding its offer, as it is listed on both platforms.

Finally, we compare the symmetric payoffs and find that $\pi_j^{NS} > \pi_j^S$ if $\alpha < \alpha_2$ with $\alpha_1 > \alpha_2$. When α is relatively high, segmentation allows hotels to gain a bigger price margin per room: $(p_P^S - f^S) > (p_P^{NS} - f^{NS})$. Recall that, under segmentation, each hotel sells less units, as it resorts to only one OTA. However, for large values of α ($\alpha \geq \alpha_2$) hotels prefer to sacrifice quantity in exchange for obtaining a higher unitary price margin. Notice that α_2 is increasing in β because the price margin per unit is positively affected by the degree of OTAs' substitutability when both hotels multi-home, whereas the opposite occurs when they both single-home, as we explained before.

To sum up, our analysis reveals that:

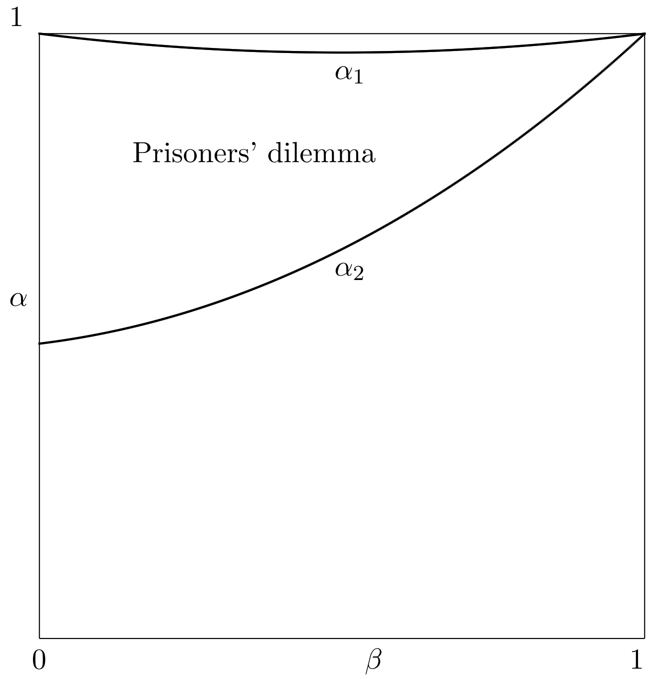
Proposition 1. *With unrestricted pricing, under Assumption 1, both hotels decide to be listed on both OTAs, and no segmentation occurs.*

Proposition 1 highlights some important findings. In the absence of price restrictions, hotels decide to be listed on both platforms to obtain consumers from both OTAs and to enjoy a higher price margin. However, for a relatively high degree of hotel substitutability ($\alpha > \alpha_2$), multi-homing is still a dominant strategy, but hotels would obtain a larger profit by single-homing. As a result, hotels are trapped in a prisoners' dilemma. Segmentation would indeed reduce the competitive pressure, and hotels would gain by selling through one OTA each, thereby obtaining larger price margins. In this region, however, hotels fail to coordinate as they both have an incentive to multi-home when the rival single-homes. The results of Proposition 1 are graphically represented in Figure 1, where we also show the threshold value α_1.

[10] More precisely, $\pi_j^{PS} > \pi_j^S$ when $\alpha < \alpha_1$.

[11] In fact, the OTA exploits the fact that it is the only way for this hotel to reach out to consumers. Interestingly, $(p_{hk}^{PS} - f_{hk}^{PS})$ does not depend on β, as hotel k sells only through OTA h.

Figure 1: Hotels' choices in the absence of PPCs



3.2 Price Parity Clauses

When OTAs apply PPCs, they oblige client hotels to charge the lowest retail price on their platform in order to avoid showrooming, *i.e.*, $p_{ij} \leq \min\{p_{hj}, p_{Dj}\}$. If both platforms impose PPCs, then it must be that $p_{ij} = p_{hj} = p_{Dj} = p_j$. Under our assumption of symmetric OTAs, the distinction between *wide* and *narrow* PPCs becomes therefore immaterial, and for this reason we simply use the terminology PPCs.

The first interesting result of this case is the following:[12]

Lemma 4. *The adoption of PPCs induces hotels to shut down their direct channels.*

There are two reasons for this result. First, when selling directly, hotels are forced to reduce their uniform price in order to be more competitive on the direct channel. However, this affects the price margin they obtain by selling through the OTAs. Second, the imposition of weak inequalities leading to uniform prices raises the commission fees, as OTAs penalize hotels for selling directly. As a result, with PPCs, hotels prefer to stop selling directly. This result confirms the intuition that hotels reduce the number of offers in their direct channel when contractual price restrictions are enforced. This is a well documented situation in the lodging sector. For example, Bundeskartellamt (2013, p. 33) argues that with contractual price restrictions, small and medium sized hotels that are hard to find without a platform use their websites merely as an advertising site rather than as an additional sales channel which substitutes the platform.[13]

We next replicate the analysis of the previous section to examine hotels' optimal pricing and listing decisions when PPCs are enforced. All proofs are in Appendix B.

[12]The proof of Lemma 4 results from combining the proofs of Lemmas 5-7.

[13]Bundeskartellamt (2013). Decree in Accordance with Section 32 (1) of the Act Against Restraints of Competition (HRS).

No Segmentation (NS*). Lemma 5 presents the equilibrium prices, commission fees, hotels' and OTAs' profits, when both hotels decide to be listed on both OTAs.

Lemma 5. *With PPCs, when both hotels are listed on the two OTAs, their (unique) retail prices are:*

$$p^{NS^*} = \frac{5-3\alpha}{3(2-\alpha)}.$$

Each OTA sets a commission fee equal to:

$$f^{NS^*} = \frac{2}{3}.$$

Hotels' and OTAs' profits are:

$$\begin{aligned} \pi_j^{NS^*} &= \frac{2(1-\alpha)}{9(1+\alpha)(2-\alpha)^2(1+\beta)}, \quad \textit{with} \quad j = 1, 2; \\ \pi_i^{NS^*} &= \frac{4}{9(1+\alpha)(2-\alpha)(1+\beta)}, \quad \textit{with} \quad i = A, B. \end{aligned}$$

Under PPCs, hotels use their unique retail price to maximize profits in the two platforms. The equilibrium price p^{NS^*} is decreasing in α, whereas it does not depend on β. The commission fee is instead independent of both parameters. This implies that OTAs always charge a positive fee, even if they are highly substitutable. Intuitively, if the two hotels are listed on both OTAs and induced *ex ante* to post the same price, then the fee is not affected by the intensity of market competition. It is immediate to prove that $f^{NS^*} > f^{NS}$, which implies OTAs increase their fees relative to the case of unrestricted pricing and multi-homing. We also obtain that $p^{NS^*} > p_P^{NS}$ and $(p^{NS^*} - f^{NS^*}) < (p^{NS} - f^{NS})$, thus confirming that PPCs do not only increase retail prices, but also reduce hotels' price margin when they multi-home. This, together with the fact that direct channels are no longer used, explains why hotels are worse-off under PPCs: $\pi_j^{NS^*} < \pi_j^{NS}$.

Segmentation (S*). Consider now the case in which the two hotels are listed on just one OTA each (segmentation) and that OTAs impose PPCs. This yields:

Lemma 6. *When each hotel is listed on a different OTA, retail prices are:*

$$p^{S^*} = \frac{2(1-\alpha\beta)(3-\alpha^2\beta^2)}{(2-\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]}.$$

Each OTA sets the commission fee:

$$f^{S^*} = \frac{(1-\alpha\beta)(2+\alpha\beta)}{4-\alpha\beta(1+2\alpha\beta)}.$$

Hotels' and OTAs' profits are:

$$\pi_j^{S^*} = \frac{(1-\alpha\beta)(2-\alpha^2\beta^2)^2}{(2-\alpha\beta)^2(1+\alpha\beta)(4-\alpha\beta-2\alpha^2\beta^2)^2}, \quad \textit{with} \quad j=1,2;$$
$$\pi_i^{S^*} = \frac{(2-\alpha^2\beta^2)(2-\alpha\beta-\alpha^2\beta^2)}{(2+\alpha\beta-\alpha^2\beta^2)(4-\alpha\beta-2\alpha^2\beta^2)^2}, \quad \textit{with} \quad i=A,B.$$

First, notice that $p^{S^*} = p_P^S$ and $f^{S^*} = f^S$: fees and prices are exactly the same as in Lemma 2. Hence, the commission fee is again negatively affected by both α and β. Of particular interest for our analysis, under PPCs segmentation increases platform competition and this contributes to reduce the commission fee in comparison to no segmentation, *i.e.*, $f^{S^*} < f^{NS^*}$. Moreover, we find that $(p^{S^*} - f^{S^*}) > (p^{NS^*} - f^{NS^*})$ which implies that the price margin when both firms single-home is always higher than when they both multi-home.[14]

Partial Segmentation (PS*). We finally analyze the case in which hotel j is listed on both OTAs, while hotel k is only active on OTA h by assumption. Lemma 7 illustrates the equilibrium prices and commission fees. Hotels' profits are $\pi_j^{PS^*}$ and $\pi_k^{PS^*}$, whereas OTAs' profits are $\pi_i^{PS^*}$ and $\pi_h^{PS^*}$. Their expressions are very long and are confined to Appendix B.

Lemma 7. *When hotel j is listed on both OTAs, while hotel k only on OTA h, their retail prices are:*

$$p_j^{PS^*} = \frac{40-\alpha[4(1+\beta)+\alpha(34-46\beta+4\alpha\beta(1+\beta)-\alpha^2(1-\beta)(7-13\beta)]}{3[2-\alpha^2(1-\beta)][8-\alpha^2(3-5\beta)]};$$
$$p_k^{PS^*} = \frac{3-\alpha^2(2-\beta)}{2[2-\alpha^2(1-\beta)]}.$$

OTAs set the following commission fees:

$$f_{ij}^{PS^*} = \frac{\left\{4[1-\alpha^2(1-\beta)]+\alpha^4(1-\beta)^2+2\alpha(1+\beta)(1+\alpha^2\beta)\right\}[8-\alpha^2(5-3\beta)]}{3(1-\alpha^2)[2-\alpha^2(1-\beta)][8-\alpha^2(3-5\beta)]};$$
$$f_{kj}^{PS^*} = \frac{16[2-\alpha^2(1-\beta)]^2-\alpha(1+\beta)[40-\alpha^2(27-13\beta)]}{6[2-\alpha^2(1-\beta)][8-\alpha^2(3-5\beta)]};$$
$$f_{kh}^{PS^*} = \frac{1}{15}\left[2(2+\alpha)-\frac{5(1-\alpha^2)}{2-\alpha^2(1-\beta)}+\frac{4(12+\alpha)(1-\alpha^2)}{8-\alpha^2(3-5\beta)}\right].$$

With partial segmentation, $f_{ij}^{PS^*} > \max\{f_{hk}^{PS}, f_{hj}^{PS}\}$. Accordingly, we find that $(p_j^{PS^*} - f_{ij}^{PS^*}) < \max\{(p_j^{PS^*} - f_{kj}^{PS^*}), (p_k^{PS^*} - f_{kh}^{PS^*})\}$. Differently from the case of unrestricted prices, with PPCs and partial segmentation the multi-homing hotel ends up paying the highest fee in the OTA where it is the only seller, and it receives the lowest price margin when selling through this sales channel. The ranking of the fees justifies the fact that the multi-homing firm is charging a higher price than the single-homing one: $p_j^{PS^*} > p_k^{PS^*}$. Surprisingly, under PPCs we also find that $q_{ij}^{PS^*} + q_{kj}^{PS^*} < q_{kh}^{PS^*}$ when α and/or β are high enough.[15] In other words,

[14] It is also possible to show that $p^{S^*} > p^{NS^*}$ when α is relatively high, provided β is not excessive.

[15] Equilibrium expressions for $q_{ij}^{PS^*}$, $q_{kj}^{PS^*}$, and $q_{kh}^{PS^*}$ are in Appendix B, Proof of Lemma 7.

in such a parametric region, the price difference $(p_j^{PS^*} - p_k^{PS^*})$ enlarges to the point that the number of rooms sold by hotel j on both OTAs is *lower* than those sold by hotel k on OTA h.

Hotels' listing decisions with PPCs. The results of lemmas (4)-(6) enable us to investigate hotels' optimal listing strategy with PPCs, which is decided in the second stage of the game.

We first consider the incentives of a hotel to multi-home when the rival single-homes. It is immediate to verify that $\pi_j^{S^*} > \pi_j^{PS^*}$: single-homing is always preferred when the rival does the same. A comparison between partial segmentation with segmentation reveals that $(p_j^{PS^*} - f_{ij}^{PS^*}) < (p^{S^*} - f^{S^*})$. Hence, in the presence of a single-homing rival, the decision to be listed on both platforms reduces the price margin in the OTA where the seller is the only active firm. This is not compensated by an increase in the quantity sold through this channel, in which the hotels then suffers a profit loss. Moreover, total quantity does not sufficiently increase to compensate such a loss, and it may even decrease in the presence of high *intra*-brand and/or *inter*-brand competition. It follows that hotels simultaneously decide to single-home, resulting in segmentation.

We next investigate the situation where a seller faces a rival which is listed in both OTAs. Also in this case the seller decides to single-home, as $\pi_k^{PS^*} > \pi_j^{NS^*}$. Indeed, there is a substantial profit gain from the unique sales channel being active, as not only the price margin increases in comparison to no segmentation, $(p_k^{PS^*} - f_{kh}^{PS^*}) > (p^{NS^*} - f^{NS^*})$, but also more rooms can be sold through the OTA, as $q_k^{PS^*} > q^{NS^*}$. This profit gain always compensates the sales missed in the other OTA. Moreover, as we stressed in the case of partial segmentation (Lemma 7), selling through only one OTA may even increase aggregate quantity in comparison to using both OTAs; this occurs when α and/or β are large enough. Single-homing is therefore a dominant strategy, confirming the decision of both hotels to single-home.

Finally, we compare segmentation with no segmentation, and confirm that $\pi_j^{S^*} > \pi_j^{NS^*}$. As already explained, the price margin increases under segmentation: $(p^{S^*} - f^{S^*}) > (p^{NS^*} - f^{NS^*})$. In addition, total quantities do not always shrink. This occurs when α and/or β are sufficiently high, in which case $q^{S^*} > 2q^{NS^*}$. As a result, hotels sell more rooms and obtain more profits with single-homing than with multi-homing.

The following proposition summarizes the hotels' listing decisions with PPCs.

Proposition 2. *When both OTAs adopt PPCs, each hotel decides to be listed on a different OTA, and segmentation occurs.*

Clearly, hotels lose out under multi-homing when OTAs enforce PPCs. First, they are induced to shut down their direct sales channels. Second, they have to charge relatively high prices in order to compensate for the increase in the commission fees, thereby losing consumers on the remaining sales channel. As a response, they both decide to be listed on one OTA each, thus increasing platform competition which lowers the fees. With segmentation, hotels can charge a higher price margin per room, although this implies using only one sales channel. This, however, does not necessarily shrink total demand. When the degree of competition across both hotels and OTAs is sufficiently fierce, hotels may end up selling more with single-homing.

3.3 Partial Application of Price Parity Clauses

For the sake of completion, we examine hotels' pricing and listing decisions when only OTA i applies PPCs to its client hotels. As this case does not provide additional insights to our analysis, we relegate the detailed analysis to Appendix C, in which we prove that:

Proposition 3. *When only one OTA adopts PPCs, each hotel decides to be listed on a different OTA, and segmentation occurs.*

Intuitively, even in the presence of only one platform that imposes price restrictions, multi-homing damages hotels as it leads to higher commission fees and lower price margins. Indeed, the OTA that adopts PPCs can increase its fee when it hosts multiple sellers, inducing the rival to do the same (by strategic complementarity), although the latter cannot raise its fee by the same amount. Hotels may smooth out the negative effect driven by the surge in the commission fee by simultaneously opting to single-home, as we already know from Subsection 3.2. Indeed, under segmentation the commission fees do not change at equilibrium, independently of the adoption of PPCs by one or both OTAs.

4 The OTAs' contractual arrangements

The previous sections have shown that hotels' optimal listing strategies depend on the OTAs' decision about whether or not to adopt PPCs. We next examine the OTAs' incentives to implement this contractual arrangement in the first stage of the game. To this aim, we compare OTAs' profits when they apply PPCs and when they do not. Recall that, in the absence of PPCs, hotels find it profitable to use both platforms to reach out to customers. In the presence of at least one OTA that applies PPCs, hotels only use one platform. Proposition 4 shows under which conditions OTAs adopt PPCs. The proof of this result is provided in Appendix D.

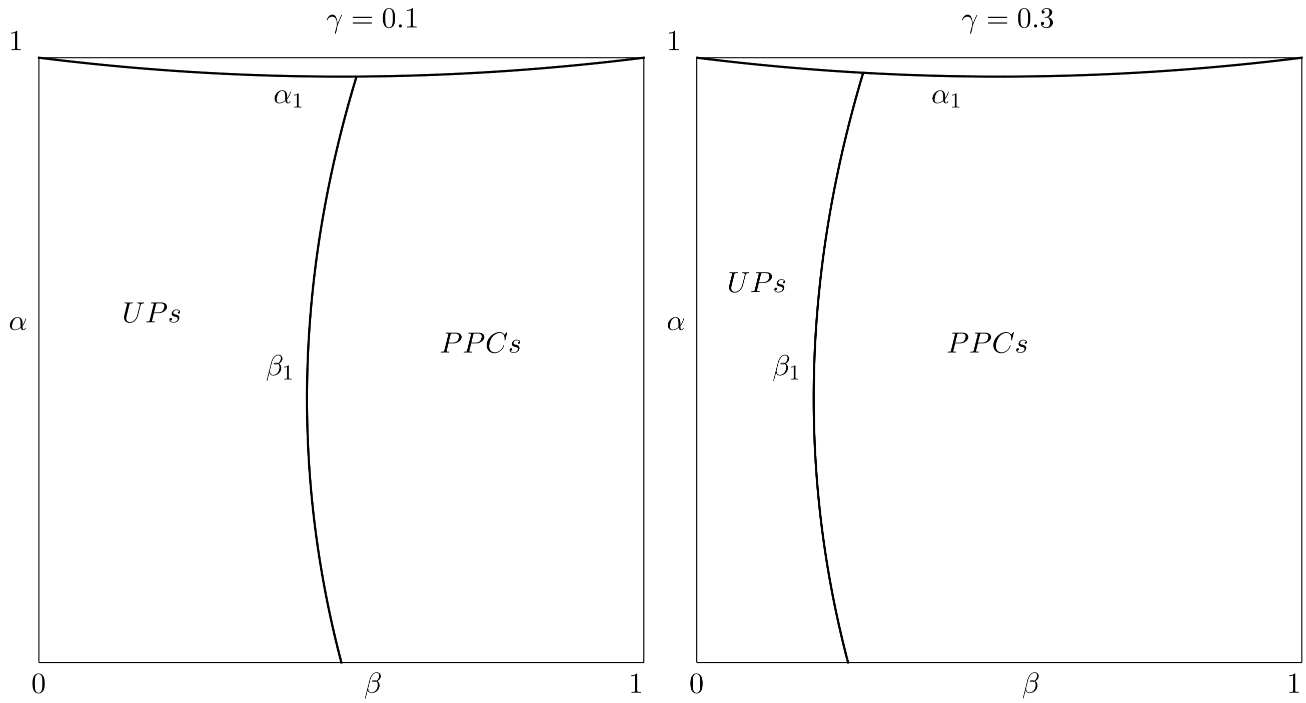
Proposition 4. *OTAs' decision about whether or not to adopt PPCs is the following:*

- *When $\gamma > \gamma_1$, both OTAs adopt PPCs; as a result, hotels choose to single-home and OTAs obtain $\pi_i^{S^*}$.*
- *When $\gamma \leq \gamma_1$, there are two cases:*
  - *(i) if $\beta > \beta_1$, both OTAs adopt PPCs, hotels choose to single-home, and OTAs obtain $\pi_i^{S^*}$;*
  - *(ii) if $\beta \leq \beta_1$, both OTAs leave prices unconstrained, hotels choose to multi-home, and OTAs obtain π_i^{NS}.*

Proposition 4 shows that OTAs adopt PPCs when showrooming is particularly relevant ($\gamma > \gamma_1$). Interestingly, PPCs are also applied in the absence of showrooming. Indeed, for low values of γ (and even when $\gamma = 0$), OTAs may find it profitable to apply these price restrictions when the degree of competition between them is sufficiently high ($\beta > \beta_1$). The reason is that OTAs face a trade-off when $\gamma \leq \gamma_1$. If they both apply PPCs, showrooming disappears but hotels decide to single-home, hence total quantity sold through the OTAs shrinks. On the contrary, if they both leave prices unconstrained, hotels multi-home, there is showrooming, and OTAs charge a commission fee that is lower than with PPCs ($f^{NS} < f^S = f^{S^*}$) and decreasing in β. Taking this into account, when the degree of *intra*-brand substitutability becomes sufficiently strong ($\beta > \beta_1$), OTAs adopt PPCs, as this eliminates showrooming and allows them to charge a higher commission fee.[16] Notice that in this case OTAs sacrifice quantity, since hotels respond to PPC by single-homing. Clearly, the larger is the relevance of showrooming, the lower the value of β_1 above which PPCs are adopted.

Figure 2 graphically represents two cases in which $\gamma \leq \gamma_1$, respectively $\gamma = 0.1$ (left panel) and $\gamma = 0.3$ (right panel). The threshold value β_1 decreases in γ, and it becomes negative (hence, not relevant for our analysis) when $\gamma > \gamma_1$. The parametric region where hotels' prices are unconstrained is indicated with UPs, whereas $PPCs$ indicates the presence of price parity clauses imposed by OTAs.

Figure 2: The OTAs' decision

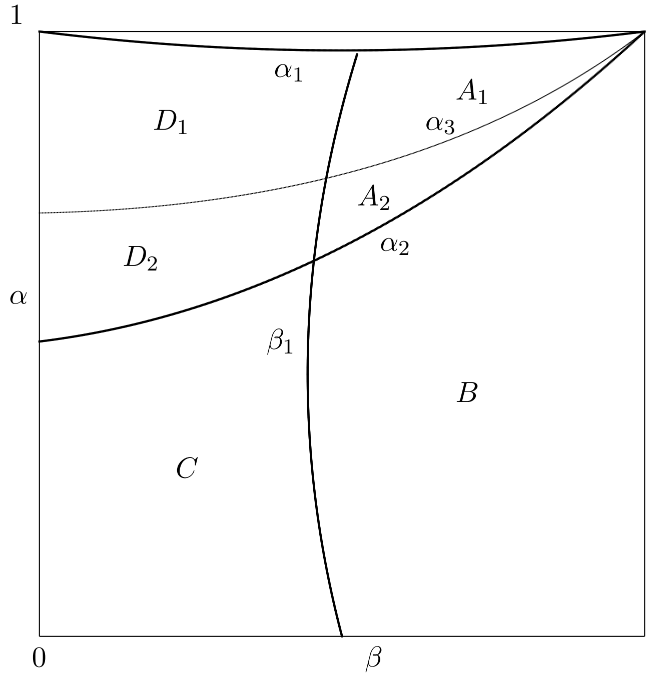


5 The economic effects of price parity clauses

Armed with this equilibrium characterization regarding OTAs' contractual decisions and hotels' responses, we analyze the economic effects of imposing PPCs. In particular, we focus on the consequences for hotels and consumers by considering the most interesting case in which $\gamma \leq \gamma_1$. In Figure 3 we set $\gamma = 0.1$ to graphically represent the areas of interest. Recall from Figure 2 that when γ increases, the threshold value β_1 diminishes becoming negative when $\gamma > \gamma_1$. This implies that regions C and D shrink when showrooming is progressively more relevant (until disappearing when $\gamma > \gamma_1$), whereas areas A and B expand.

[16] f^{S^*} is less affected than f^{NS} by a rise in β. As a result, the difference $f^{S^*} - f^{NS}$ increases in β.

Figure 3: The economic effects of PPCs



Let us examine the different regions. We start with A and B, where $\beta > \beta_1$ and, respectively, $\alpha > \alpha_2$ and $\alpha \leq \alpha_2$. OTAs apply PPCs and hotels choose to single-home (Proposition 2) to lower commission fees, even though they reduce the active sales channels. In region A, hotels would have opted for multi-homing in the absence of PPCs, ending up in a prisoners' dilemma as $\pi_j^{NS} < \pi_j^S$ when $\alpha > \alpha_2$ (see Figure 1). This is not completely solved under PPCs, as hotels obtain $\pi_j^{S^*}$ instead of π_j^S. However, we find that $\pi_j^{S^*} \geq \pi_j^{NS}$ when $\alpha \geq \alpha_3$, meaning that hotels benefit from the segmentation induced by PPCs in A_1. In this subregion, hotels offer extremely similar products and, by single-homing, are able to increase their price margin without necessarily losing demand. The opposite holds in A_2 and B, where hotels offer more differentiated products. In these regions, they would have gained more without PPCs, attracting consumers from both OTAs and their own websites. Regarding consumers, they are always penalized by PPCs, given that platform prices increase ($p^{S^*} = p_P^S > p_P^{NS} > p_D^{NS}$) following the surge in the commission fees ($f^{S^*} = f^S > f^{NS}$). Moreover, showrooming disappears. Hence, both those consumers who would have booked through the platform, and those who would have booked directly through the hotels, end up losing out.

Consider now regions C and D, in which OTAs refrain from adopting PPCs and hotels respond by listing on both OTAs (Proposition 1). In region C, the OTAs' and hotels' interests coincide, and the same occurs in D_2, as $\alpha < \alpha_3$ ensures that $\pi_j^{NS} > \pi_j^{S^*}$. In contrast, in D_1 hotels would have preferred PPCs. In this subregion, OTAs leave retail prices unrestricted because they are sufficiently differentiated and they want to receive consumers from both hotels. Hotels, however, would have benefitted from the adoption of PPCs, as this facilitates the segmentation of the market, thereby reducing the competitive pressure among them. Consumers are obviously better-off without PPCs because prices are lower.

The main results of this section can be summarized in the following proposition, whose proof directly follows from our previous analysis:

Proposition 5. *The adoption of PPCs never benefits consumers, whereas the potential gains for hotels are confined to cases in which their degree of substitutability is very high.*

To sum up, our analysis has shown that the adoption of PPCs leads hotels to single-home in order to increase platforms' competition, thereby driving down commission fees. In this scenario, hotels also prefer to close their direct channels to increase their price margins, especially when they are very similar. Taking this into account, we expect that the removal of these contractual agreements will induce hotels to multi-home, lowering platform prices because of a reduction in the commission fee. Furthermore, the prohibition of PPCs incentivizes hotels to use more their direct channels, which generates showrooming that negatively affects OTAs but benefits consumers.

6 Conclusions

The paper has investigated the effect of price parity clauses imposed by platforms on the suppliers' pricing and listing decisions. To this aim, we have formally studied a model in which OTAs showcase the available hotels to uninformed consumers, who then decide whether to reserve a room through the OTA or directly from the hotel.

The first contribution of our paper has been to determine under which conditions the imposition of PPCs by OTAs can induce market segmentation. We have shown that OTAs adopt these restrictive clauses when showrooming is relevant, and when they want to smooth out the competitive pressure in platform market. PPCs allow OTAs to set higher commission fees, but hotels can respond by delisting from some platforms. For this reason, OTAs may decide to leave price unconstrained when they are perceived as sufficiently differentiated.

The second contribution of our analysis has been to investigate the economic effects of PPCs. We have shown that these price restrictions are responsible for an increase in hotel prices and for the reduction in the number of hotels listed on the platforms. In addition, PPCs induce hotels to shut down their direct sales channels. This scenario may have relevant consequences on consumer welfare and on the quality of the service offered by hotels.

Our results are consistent with the recent empirical research on the effects of prohibiting PPCs in Germany in 2015, examined by Hunold et al. (2018), who have shown that this measure was followed by a decrease in hotel prices (especially in direct channels) and by an increase in the number of sales channels used by hotels. In a similar vein, Mantovani et al. (2019) have found that prices on *Booking.com* declined after the EU antitrust decisions against PPCs. However, our analysis does not only provide a theoretical underpinning of these empirical results. We also uncover interesting scenarios in which the prohibition of PPCs would damage hotels as well. Ultimately, we have confirmed that removing these price restrictions always benefit consumers, who enjoy lower prices on the platform, or can afford to buy directly from the hotel at a cheaper price.

The policy prescriptions of our model rest on some modelling assumptions. We introduced Assumption 1 to simplify the exposition of our results and to focus on the what we believe are novel mechanisms and/or results. In spite of this, it is interesting to explain that when hotels' degree of substitutability is very high (α close to 1), hotels choose single-homing also in the absence of PPCs to reduce the competitive pressure, although this means selling fewer rooms and paying a higher commission fee. They also prefer to cease their direct channel and to use the OTAs as a differentiation mechanism.[17] It is an empirical question to determine how important this situation can be, and whether hotels can indeed use the complementary services offered by OTAs to gain market power.

Our paper has considered that OTAs are the only mechanism available for hotels to attract consumers. The model could be extended to consider a market in which there is a fraction of informed consumers, who directly browse the hotels' websites to make their reservations, and a group of uninformed hotel seekers, who use OTAs to gather information. The main finding of our paper is that with PPCs hotels can decide to delist from one OTA to gain market power and to reduce the commission fees. We expect this result will be maintained in this more complex framework, even if hotels' interest in delisting from one OTA will depend on their brand reputation and awareness. Another possible extension of our paper could be to consider the use of a revenue sharing scheme between hotels and platforms. The adoption of PPCs should also reduce competition between OTAs allowing them to obtain a larger share of the revenues. In this context, it would be interesting to characterize in which situation hotels can delist from one OTA to recover their bargaining power. Finally, we believe it is worth investigating competition between asymmetric platforms. By doing so, the distinction between wide and narrow PPCs might become relevant and we could study how the switch from wide to narrow PPCs affects prices, commission fees, and consequently social welfare. We leave this and other appealing extensions for future research.

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[17] In this small parametric region, OTAs are indifferent between adopting PPCs or not, and consumers are indifferent as well. In Appendix A (Proof of Proposition 1) and Appendix D (Proof of Propositions 4 and 5) we provide exhaustive calculations for the whole parametric range of α.

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Appendix A: The benchmark case

Proof of Lemma 1

When both hotels are listed in the two platforms, their direct demand functions are:

$$q_{ij} = \frac{1}{(1+\alpha)(1+\beta)} + \frac{\beta(p_{hj} - \alpha p_{hk}) - (p_{ij} - \alpha p_{ik})}{(1-\alpha^2)(1-\beta^2)}; \quad q_{Dj} = \frac{1}{1+\alpha} - \frac{p_{Dj} - \alpha p_{Dk}}{(1-\alpha^2)}.$$

In stage 4 of the game, hotels set the prices announced in the OTAs and in their own web sites. Substituting the above quantities into the hotels' profit function in equation (3) and deriving with respect to p_{ij} and p_{Dj}, we obtain the retail prices as a function of the commission fees:

$$p_{ij} = \frac{1-\alpha}{2-\alpha} + \frac{f_{ij} + f_{hj}}{(2-\alpha)(2+\alpha)} + \frac{\alpha(f_{ik} + f_{hk})}{(2-\alpha)(2+\alpha)}; \qquad p_{Dj} = \frac{1-\alpha}{2-\alpha}.$$

In stage 3, taking into account the previous prices and that hotels are listed on both platforms, the OTAs choose commission fees to maximize profits in equation (5). This yields $f^{NS} = \frac{1-\beta}{2-\beta}$. Equilibrium quantities are:

$$q_P^{NS} = \frac{1}{(2-\alpha)(2-\beta)(1+\alpha)(1+\beta)}, \quad q_D^{NS} = \frac{1}{2+\alpha(1-\alpha)}.$$

By substituting commission fees into prices and then into hotels' and platforms' profits, we obtain the equilibrium values reported in Lemma 1. It is important to show that:

$$\frac{\partial \pi_j^{NS}}{\partial \gamma} = \frac{(1-\alpha)[2-\beta^2(3-\beta)]}{(1+\alpha)(2-\alpha)^2(1+\beta)(2-\beta)^2} > 0 \quad \text{for any} \quad \alpha, \beta \in (0,1).$$

This implies that hotels always find it profitable to also sell through their own web sites. □

Proof of Lemma 2

When hotels are listed on different platforms, their direct demand functions are:

$$q_{ij} = \frac{1}{(1+\alpha)(1+\beta)} - \frac{p_{ij} + \alpha\beta p_{hk}}{(1-\alpha^2)(1-\beta^2)}; \quad q_{Dj} = \frac{1}{1+\alpha} - \frac{p_{Dj} - \alpha p_{Dk}}{(1-\alpha^2)}.$$

In stage 4, hotels set the prices announced in the OTAs and in their own direct sales channel. Substituting the above quantities into the hotels' profits in equation (4) and deriving with respect to p_{ij} and p_{Dj}, we obtain the retail prices as a function of the commission fees:

$$p_{ij} = \frac{1-\alpha\beta}{2-\alpha\beta} + \frac{2f_{ij} + \alpha\beta f_{hk}}{(2-\alpha\beta)(2+\alpha\beta)}; \quad p_{Dj} = \frac{1-\alpha}{2-\alpha}.$$

In stage 3, platforms choose commission fees to maximize their profits in equation (6), yielding $f^S = \frac{(1-\alpha\beta)(2+\alpha\beta)}{4-\alpha\beta(1+2\alpha\beta)}$. Equilibrium quantities are:

$$q_P^S = \frac{1}{(1+\alpha)(1+\beta)} - \frac{2(1+\alpha\beta)(1-\alpha\beta)(3-\alpha^2\beta^2)}{(1-\alpha^2)(1-\beta^2)(2-\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]}, \quad q_D^S = \frac{1}{2+\alpha(1-\alpha)}.$$

Substituting f^S into the retail prices and then into the hotels' and OTAs' profit functions, we obtain the equilibrium values which appear in Lemma 2. Interestingly, we find that

$$\frac{\partial \pi_j^S}{\partial \gamma} = \frac{(1-\alpha)}{(1+\alpha)(2-\alpha)^2} - \frac{(1-\alpha\beta)(2-\alpha^2\beta^2)^2}{(1+\alpha\beta)(2-\alpha\beta)^2[4-\alpha\beta(1+2\alpha\beta)]^2} < 0 \quad \text{when} \quad \alpha > \widehat{\alpha}.$$

The expression of $\widehat{\alpha}$ is not reported, as it is extremely long, but a graphical representation is provided in Figure A. In such a case, hotels prefer to shut down their direct channel as the presence of a percentage γ of consumers who showroom reduces their profits. □

Proof of Lemma 3

Suppose hotel j is active on both platforms i and h, while hotel k is active only on platform h. Also recall that a fraction of consumers γ can directly reserve their rooms from the hotels' web site. The hotels' demand functions are therefore given by:

$$\begin{aligned} q_{ij} =& \frac{1}{1+\beta} - \frac{p_{ij}-\beta p_{hj}}{1-\beta^2}; \quad q_{hk} = \frac{1}{1+\alpha} - \frac{p_{hk}-\alpha p_{hj}}{1-\alpha^2}; \quad q_{Dj} = \frac{1}{1+\alpha} - \frac{p_{D_j}-\alpha p_{Dk}}{1-\alpha^2}; \\ q_{hj} =& \frac{1-\alpha\beta}{(1+\alpha)(1+\beta)} + \frac{\beta p_{ij}}{1-\beta^2} + \frac{\alpha p_{hk}}{1-\alpha^2} + \frac{(1-\alpha^2\beta^2)p_{hj}}{(1-\alpha^2)(1-\beta^2)}. \end{aligned}$$

In stage 4, each hotel sets the prices on the platforms and on their direct sales channels. Substituting the above demand functions into the hotels' profits and deriving with respect to prices, we obtain the following retail prices:

$$\begin{aligned} p_{Dj} =& \frac{1-\alpha}{2-\alpha}; \quad p_{ij} = \frac{1}{2}\left(\frac{2-\alpha-\alpha\beta}{2-\alpha}\right) + \frac{f_{ij}}{2} + \frac{\alpha\beta f_{hk}}{4-\alpha^2} + \frac{\alpha^2\beta f_{hj}}{2(4-\alpha^2)}; \\ p_{hj} =& \frac{1-\alpha}{2-\alpha} + \frac{2f_{hj}+\alpha f_{hk}}{4-\alpha^2}; \quad p_{hk} = \frac{1-\alpha}{2-\alpha} + \frac{2f_{hk}+\alpha f_{hj}}{4-\alpha^2}. \end{aligned}$$

In stage 3, platforms choose commission fees to maximize their profits and we obtain f_{ij}^{PS}, f_{hj}^{PS}, and f_{hk}^{PS}. Using these fees, we find equilibrium retail prices p_D^{PS}, p_{ij}^{PS}, p_{hj}^{PS}, and p_{hk}^{PS}. We can then get the hotels' and OTAs' equilibrium profits, which are written in a compact form as:

$$\begin{aligned} \pi_j^{PS} &= \frac{\gamma(1-\alpha)}{(1+\alpha)(2-\alpha)^2} + (1-\gamma)\left[(p_{ij}^{PS}-f_{ij}^{PS})q_{ij}^{PS} + (p_{hj}^{PS}-f_{hj}^{PS})q_{hj}^{PS}\right]; \\ \pi_k^{PS} &= \frac{\gamma(1-\alpha)}{(1+\alpha)(2-\alpha)^2} + (1-\gamma)(p_{hk}^{PS}-f_{hk}^{PS})q_{hk}^{PS}; \\ \pi_i^{PS} &= (1-\gamma)f_{ij}^{PS}q_{ij}^{PS}; \quad \pi_h^{PS} = (1-\gamma)(f_{hj}^{PS}q_{hj}^{PS} + f_{hk}^{PS}q_{hk}^{PS}); \end{aligned}$$

where

$$\begin{aligned} q_{ij}^{PS} &= \frac{4+\beta(2-\alpha^2\beta)}{2(1+\beta)[8-\beta^2(2+3\alpha^2)]}; \quad q_{hk}^{PS} = \frac{1}{2(2-\alpha)(1+\alpha)}; \\ q_{hj}^{PS} &= \frac{8+\beta\left\{4-2\alpha+2\alpha^2+\alpha\beta-4\alpha^2\beta+\beta^2[1-\alpha(2-\alpha+\alpha^2)]\right\}}{2(1+\alpha)(2-\alpha)(1+\beta)[8-\beta^2(2+3\alpha^2)]}. \end{aligned}$$

Finally, we find that

$$\frac{\partial \pi_j^{PS}}{\partial \gamma} = \frac{1-\alpha}{(1+\alpha)(2-\alpha)^2} - \left[\frac{1}{2}\left(\frac{2-\alpha-\alpha\beta}{2-\alpha}\right) - \frac{f_{ij}^{PS}}{2} + \frac{\alpha\beta f_{hk}^{PS}}{4-\alpha^2} + \frac{\alpha^2\beta f_{hj}^{PS}}{2\left(4-\alpha^2\right)}\right] q_{ij}^{PS} + \\ - \left[\frac{1-\alpha}{2-\alpha} + \frac{\alpha(f_{hk}^{PS}+f_{hj}^{PS})-2f_{hj}^{PS}}{4-\alpha^2}\right] q_{hj}^{PS} < 0 \quad \text{when} \quad \alpha > \widetilde{\alpha},$$

while

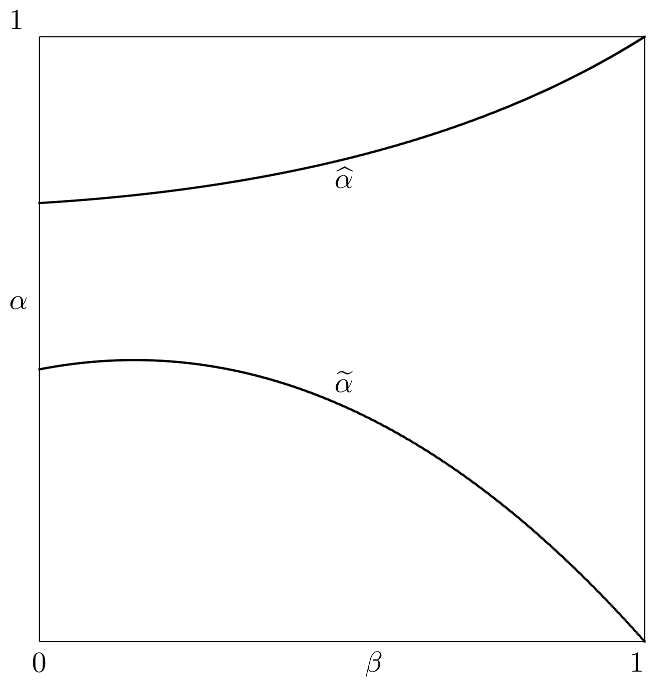
$$\frac{\partial \pi_k^{PS}}{\partial \gamma} = \frac{(1-\alpha)}{(1+\alpha)(2-\alpha)^2} + \left[\frac{(2-\alpha)^2 f_{hk}^{PS} + \alpha f_{hj}^{PS}}{4-\alpha^2}\right] q_{hk}^{PS} > 0 \quad \text{for any} \quad \alpha, \beta \in (0,1).$$

The expression of $\widetilde{\alpha}$ is very long and, for this reason, we only provide a graphical representation in Figure A. □

Proof of Proposition 1

We show that when $\alpha < \alpha_1$, it is a dominant strategy for both hotels to multi-home. To this aim, we first compare the hotels' profits when both hotels multi-home with those obtained when a hotel deviates by being active only on one OTA, finding that $\pi_j^{NS} > \pi_k^{PS}$ for any value of the parameters. We then consider the comparison between π_j^{PS} and π_j^{S}. We already know that $\partial\pi_j^{S}/\partial\gamma < 0$ when $\alpha > \widehat{\alpha}$, and that $\partial\pi_j^{PS}/\partial\gamma < 0$ when $\alpha > \widetilde{\alpha}$. Figure A represents the threshold values of α.

Figure A: Hotels' choices about direct channels



When $\alpha < \widetilde{\alpha}$, we find that it always holds that $\pi_j^{PS} > \pi_j^S$. Second, when $\alpha \in (\widetilde{\alpha}, \widehat{\alpha})$, we know that hotel j would shut down the direct channel in the asymmetric case where it is the only one that multi-homes. Specifically, in the parametric region under consideration we obtain that $\pi_j^{PS}\Big|_{\gamma=0} > \pi_j^S$. Finally, when $\alpha \in (\widehat{\alpha}, 1)$, hotels decide to sell only through the contracted OTA, and we find that $\pi_j^{PS}\Big|_{\gamma=0} > \pi_j^S\Big|_{\gamma=0}$ if $\alpha < \alpha_1$, where $\alpha_1 > \widehat{\alpha}$, as one can see by comparing Figure A with Figure 1. As a result, when $\alpha < \alpha_1$, there exists a unique Nash equilibrium in pure strategies in which hotels are active on both OTAs. In contrast, when $\alpha > \alpha_1$, two solutions are possible: one in which both hotels segment the market and one in which both of them multi-home. By comparing the hotels' profits in these two solutions, we find that $\pi_i^S > \pi_i^{NS}$. □

Appendix B: Price parity clauses

Proof of Lemma 5

Suppose that $\gamma = 0$. When hotels are listed on both platforms, they set the prices considering the following demand function:

$$q_{ij} = \frac{1}{(1+\alpha)(1+\beta)} - \frac{(1-\beta)(p_j - \alpha p_k)}{(1-\alpha^2)(1-\beta^2)}.$$

Substituting the above quantity into the hotels' profits and deriving with respect to p_j, we obtain the following retail prices as a function of commission fees:

$$p_j = \frac{1-\alpha}{2-\alpha} + \frac{f_{ij} + f_{hj}}{(2-\alpha)(2+\alpha)} + \frac{\alpha(f_{ik} + f_{hk})}{(2-\alpha)(2+\alpha)}.$$

In stage 3, platforms choose commission fees to maximize their profits: $f^{NS^*} = \frac{2}{3}$. As a result, symmetric prices are $p_j^{NS^*} = \frac{5-3\alpha}{3(2-\alpha)}$. Equilibrium quantities are given by:

$$q_j^{NS^*} = \frac{1}{3(2-\alpha)(1+\alpha)(1+\beta)}.$$

By substituting quantities, prices, and commission fees into hotels' and platforms' profits, we get the results in Lemma 5.

We show *ex-post* that γ must be equal to 0. If this is not the case, equilibrium prices do not change ($\widehat{p^{NS^*}} = p^{NS^*}$) but the (symmetric) commission fee increases with respect to the baseline model:

$$\widehat{f^{NS^*}} = \frac{2-\gamma(1-\beta)}{3(1-\gamma)} > f^{NS^*}.$$

As a consequence, price margins diminish, and remain positive only when γ is not too high, given that $\widehat{f^{NS^*}}$ is increasing in γ. Equilibrium profits for hotels and OTAs are as follows:

$$\begin{aligned}\widehat{\pi_j^{NS^*}} &= \frac{[2-\gamma(1-\beta)](1-\alpha)}{9(1+\alpha)(2-\alpha)^2(1+\beta)}, \quad \text{with} \quad j=1,2;\\ \widehat{\pi_i^{NS^*}} &= \frac{2[2-\gamma(1-\beta)]}{9(1+\alpha)(2-\alpha)(1+\beta)}, \quad \text{with} \quad i=A,B.\end{aligned}$$

It is straightforward to verify that $\widehat{\pi_j^{NS^*}} < \pi_j^{NS^*}$ and $\widehat{\pi_i^{NS^*}} < \pi_i^{NS^*}$, given that the surge in the commission fee outweighs the sales through the direct channel for hotels, thereby reducing both hotels' and OTAs' profits. In this case, hotels eliminate the direct channel. □

Proof of Lemma 6

Suppose that $\gamma = 0$. Hotels are listed on different platforms and set their price considering the following demand function:

$$q_{ij} = \frac{1}{1+\alpha\beta} - \frac{p_j - \alpha\beta p_k}{(1+\alpha\beta)(1-\alpha\beta)}.$$

Substituting quantities into the hotels' profits and deriving with respect to p_j, we obtain the retail prices as a function of the commission fees:

$$p_j = \frac{1-\alpha\beta}{2-\alpha\beta} + \frac{2f_{ij} + \alpha\beta f_{hk}}{(2-\alpha\beta)(2+\alpha\beta)}.$$

In stage 3, platforms choose commission fees to maximize their profits, which yields $f^{S^*} = \frac{(1-\alpha\beta)(2+\alpha\beta)}{4-\alpha\beta(1+2\alpha\beta)}$. Equilibrium quantities are given by:

$$q_j^{S^*} = \frac{2-\alpha^2\beta^2}{(2-\alpha\beta)(1+\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]}.$$

By substituting quantities, prices, and commission fees into hotels' and platforms' profits, we get the results in Lemma 6.

Also in this case, we show *ex post* that γ must be equal to 0. If this is not the case, symmetric equilibrium prices and commission fees are respectively given by:

$$\widehat{p^{S^*}} = \frac{(1-\alpha\beta)\left\{2(1-\alpha^2)(3-\alpha^2\beta^2) - \alpha\gamma(1-\alpha^2)(1-\beta)[2-\alpha^2\beta^2+4\alpha^3\beta^2-\alpha(12+7\beta)] + \gamma^2\cdot\Phi\right\}}{\{(1-\alpha^2)(2-\alpha\beta) - \alpha\gamma(1-\beta)[1+\alpha^2\beta-2\alpha(1+\beta)]\}\cdot\Psi},$$

$$\widehat{f^{S^*}} = \frac{(1-\alpha\beta)\left\{(1-\alpha^2)(2+\alpha\beta) + \alpha\gamma(1-\beta)[1+\alpha^2\beta+2\alpha(1+\beta)][1-\alpha^2(1-\gamma+\gamma\beta^2)]\right\}}{(1-\gamma)(1-\alpha^2)\left\{(1-\alpha^2)(4-\alpha\beta-2\alpha^2\beta^2) - \alpha\gamma(1-\beta)[1-2\alpha^3\beta^2+2\alpha(2+\beta)-\alpha^2\beta(1+2\beta)]\right\}},$$

where:

$$\begin{aligned}\Phi &= \alpha^2(1-\beta^2)[1-\alpha^3\beta^2+2\alpha^4\beta^2+\alpha(2+\beta)-\alpha^2(6+7\beta+4\beta^2)],\\ \Psi &= \left\{(1-\alpha^2)(4-\alpha\beta-2\alpha^2\beta^2)+\gamma\alpha(1-\beta)[1-2\alpha^3\beta^2+2\alpha(2+\beta)+\alpha^2(6+7\beta+4\beta^2)]\right\}.\end{aligned}$$

The expressions for equilibrium profits $\widehat{\pi_j^{S*}}$ and $\widehat{\pi_i^{S*}}$ are extremely long and therefore we write them in a compact form as:

$$\widehat{\pi_j^{S*}} = \gamma\widehat{p^{S*}} \cdot \widehat{q_{Dj}^{S*}} + (1-\gamma)(\widehat{p^{S*}} - \widehat{f^{S*}}) \cdot \widehat{q_{Pj}^{S*}}, \qquad \widehat{\pi_i^{S*}} = (1-\gamma)\widehat{f^{S*}} \cdot \widehat{q_{Pj}^{S*}},$$

where:

$$\begin{aligned}
\widehat{q_{Dj}^{S*}} &= \widehat{q_{Pj}^{S*}} = \frac{\{1-\alpha^2[1-\gamma(1-\beta)]\}\,\{2+\alpha^4\beta^4[1-\gamma(1-\beta)]-\alpha^2[2+\beta^2-\gamma(2-\beta-\beta^2)]\}}{\{(1+\alpha\beta)[(1-\alpha^2)(2-\alpha\beta)-\alpha\gamma(1-\beta)(1-2\alpha-2\alpha\beta+\alpha^2\beta)]\cdot\Omega\}},\\
\Omega &= [(1-\alpha)(1+\alpha)(4-\alpha\beta-2\alpha^2\beta^2-\alpha\gamma+\alpha\beta\gamma(1-\alpha(4-2\beta+\alpha\beta+2\alpha^2\beta(1+\alpha))))].
\end{aligned}$$

First, we notice that $\widehat{f^{S*}} > f^S$, meaning that the commission fee increases with respect to the case of unrestricted prices. We also obtain that $\widehat{f^{S*}} < \widehat{f^{NS*}}$ when γ is sufficiently low. However, $\widehat{\pi_j^{S*}}$ is positive for relatively low values of γ, and therefore it is possible to show that for the parametric region in which $\widehat{\pi_j^{S*}} > 0$ then $\widehat{f^{S*}} < \widehat{f^{NS*}}$ (when $\widehat{\pi_j^{S*}} < 0$, hotels would obviously prefer to multi-home). Finally, we find that $\widehat{\pi_j^{S*}}$ is decreasing in γ, which implies that hotels find it profitable to shut down their direct channel. □

Proof of Lemma 7

Suppose that supplier j is active on both platforms, while supplier k is active only on one. In stage 4, hotels set the prices, considering the demands:

$$\begin{aligned}
q_{ij} &= \frac{1-p_j}{1+\alpha\beta},\ q_{hj} = \frac{1-\alpha-\alpha\beta(1-\alpha)}{(1-\alpha^2)(1+\beta)} - \frac{(1+\alpha^2\beta)p_j}{(1-\alpha^2)(1+\beta)} + \frac{\alpha p_k}{(1-\alpha^2)};\\
q_{hk} &= \frac{1}{1+\alpha} - \frac{p_j-\alpha p_k}{(1-\alpha^2)}.
\end{aligned}$$

Substituting quantities into the hotels' profits and deriving with respect to p_j and p_k yields:

$$\begin{aligned}
p_j &= \frac{(1-\alpha)[4+3\alpha(3-\beta)]}{8-\alpha^2(5-3\beta)} + \frac{2(1-\alpha^2)f_{ij}+\alpha(1+\beta)f_{hj}+2(1+\alpha^2\beta)f_{hk}}{8-\alpha^2(5-3\beta)},\\
p_k &= \frac{(1-\alpha)[4+2\alpha-\alpha^2(1+\beta)]}{8-\alpha^2(5-3\beta)} + \frac{\alpha(1+\alpha^2\beta)f_{hj}}{8-\alpha^2(5-3\beta)} + \frac{\alpha(1-\alpha^2)f_{ij}+2[2-(1-\beta)\alpha^2 f_{hk}}{8-\alpha^2(5-3\beta)}.
\end{aligned}$$

In stage 3, platforms choose commission fees to maximize their profits. They are reported in Lemma 7, together with equilibrium prices. We substitute the equilibrium prices and commission fees respectively in the hotels' and platforms' profits, and obtain:

$$
\begin{aligned}
\pi_j^{PS*} &= \frac{1}{900}\left\{\frac{1050(1-\alpha^2)}{[2-\alpha^2(1-\beta)]^2}+\frac{25(49+18\alpha)}{[2-\alpha^2(1-\beta)]^2}-\frac{131+2(73-8\alpha)\alpha}{1-\alpha^2}\right\} \\
&\quad +\frac{1}{900}\left\{\frac{50}{1+\beta}-\frac{16(12+\alpha^2)(1-\alpha^2)}{[8-\alpha^2(3-5\beta)]^2}-\frac{2(12+\alpha)(236+13\alpha)}{8-\alpha^2(3-5\beta)}\right\}, \\
\pi_k^{PS*} &= \frac{1}{900}\left[7-4\alpha+\frac{25(1-\alpha^2)}{2-\alpha^2(1-\beta)}-\frac{8(1-\alpha^2)(12+\alpha)}{8-\alpha^2(3-5\beta)}\right] \\
&\quad \cdot\left[\frac{7-4\alpha}{1-\alpha^2}+\frac{25(1-\alpha^2)}{2-\alpha^2(1-\beta)}+\frac{8(12+\alpha)}{8-\alpha^2(3-5\beta)}\right], \\
\pi_i^{PS*} &= \frac{2\left\{[2-\alpha^2(1-\beta)]^2+2\alpha(1+\beta)(1+\alpha^2\beta)\right\}^2[8-\alpha^2(5-3\beta)]}{9(1-\alpha^2)(1+\beta)[2-\alpha^2(1-\beta)]^2[8-\alpha^2(3-5\beta)]}, \\
\pi_h^{PS*} &= \left\{\frac{16[2-\alpha^2(1-\beta)]^2-\alpha(1+\beta)[40-\alpha^2(27-13\beta)]}{6[2-\alpha^2(1-\beta)][8-\alpha^2(3-5\beta)]}\right\}\cdot q_{hj}^{PS*} \\
&\quad +\frac{1}{15}\left[2(2+\alpha)-\frac{5(1-\alpha^2)}{2-\alpha^2(1-\beta)}+\frac{4(12+\alpha)(1-\alpha^2)}{8-\alpha^2(3-5\beta)}\right]\cdot q_{hk}^{PS*},
\end{aligned}
$$

where:

$$
\begin{aligned}
q_{hj}^{PS*} &= \frac{1}{30}\left[\frac{5}{1+\beta}+\frac{3\alpha(12+\alpha)}{8-\alpha^2(3-5\beta)}-\frac{5\alpha}{2-\alpha^2(1-\beta)}-\frac{\alpha(7-4\alpha)}{1-\alpha^2}\right], \\
q_{hk}^{PS*} &= \frac{1}{30}\left[\frac{7-4\alpha}{1-\alpha^2}+\frac{25}{2-\alpha^2(1-\beta)}-\frac{8(12+\alpha)}{8-\alpha^2(3-5\beta)}\right].
\end{aligned}
$$

□

Proof of Proposition 2

We show that when OTAs adopt PPCs, it is always a dominant strategy for both hotels to segment the market. To this aim, we first compare hotels' profits when a hotel multi-homes, while its rival single-homes, finding that $\pi_j^{S*} > \pi_j^{PS*}$ for any value of the parameters. We then compare the hotels' profits when both of them are listed on the two OTAs with those obtained when a hotel decides to deviate by single-homing and we find that $\pi_j^{NS*} < \pi_k^{PS*}$ for any value of the parameters. The intuition for this result is provided in the text. □

Appendix C: Partial application of Price Parity Clauses

No Segmentation (NS**)

When both hotels multi-home, equilibrium prices, commission fees, and industry profits are the same as those obtained with no segmentation when both OTAs apply PPCs. The reason is that with multi-homing prices on the OTA that does not adopt PPCs are the same as those on the OTA that does. Indeed, with multi-homing, the prices charged on the OTA that leaves prices unconstrained would be lower than in the OTA that imposes PPCs. This, however, contradicts the principle supporting wide PPCs. We then have to impose that prices are equal at the onset of the game. We refer to Lemma 5 for the equilibrium expressions and the analysis of this case.

Segmentation ($\mathbf{S}^{**}$)

Consider now the case in which each hotel is listed on a different platform and only one OTA adopts PPCs. Without loss of generality, we consider the case in which hotel j is listed on OTA i, which applies these price restrictions. Following our assumption that PPCs eliminate showrooming, we now consider that $\gamma = 0$ for hotel j, which sells its rooms only through OTA i. On the contrary, hotel k sets two different prices, one on the OTA h and the other for those consumers who prefer to buy directly. The next lemma shows the equilibrium prices, commission fees, and the hotels' and OTAs' profits.

Lemma 8. *When each hotel is listed on a different OTA, but only OTA i applies PPCs to hotel j, the retail prices are:*

$$p_{D_k}^{S^{**}} = \frac{8-2\alpha-\alpha\beta[6+\alpha\beta(3-\alpha-2\alpha\beta)]}{2(2-\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]},\ p^{S^{**}} = \frac{2(1-\alpha\beta)(3-\alpha^2\beta^2)}{(2-\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]}.$$

Each OTA sets a commission fee:

$$f^{S^{**}} = \frac{(1-\alpha\beta)(2+\alpha\beta)}{4-\alpha\beta(1+2\alpha\beta)}.$$

Hotels' profits are:

$$\begin{aligned}
\pi_j^{S^{**}} &= \frac{(1-\alpha\beta)(2+\alpha\beta)(2-\alpha^2\beta^2)}{(1+\alpha\beta)(2-\alpha\beta)[2(1-\alpha\beta)(2+\alpha\beta)+\alpha\beta]^2},\\
\pi_k^{S^{**}} &= \frac{\gamma\left\{8-\alpha[2+6\beta+6\alpha\beta^2(3-\alpha-2\alpha\beta)]\right\}^2}{4(1-\alpha^2)(2-\alpha\beta)^2[4-\alpha\beta(1+2\alpha\beta)]^2} + (1-\gamma)\pi_j^{S^{**}},
\end{aligned}$$

while platforms' profits are:

$$\pi_i^{S^{**}} = \frac{(2-\alpha^2\beta^2)(2-\alpha\beta-\alpha^2\beta^2)}{(2+\alpha\beta-\alpha^2\beta^2)(4-\alpha\beta-2\alpha^2\beta^2)^2}, \quad \pi_h^{S^{**}} = (1-\gamma)\pi_i^{S^{**}}.$$

Proof. Under the partial application of price parity clauses, OTA i adopts PPCs, while OTA h does not. If suppliers decide to be listed on different platforms (segmentation), their demand functions are:

$$q_{ij} = \frac{1}{(1+\alpha)(1+\beta)} - \frac{p_{ij}+\alpha\beta p_{hk}}{(1-\alpha^2)(1-\beta^2)}; \quad q_{Dj} = \frac{1}{1+\alpha} - \frac{p_{Dj}-\alpha p_{Dk}}{(1-\alpha^2)}.$$

Since OTA i adopts PPCs, hotel j sets the same price on its website and on OTA i, *i.e.*, $p_{ij} = p_{Dj}$. Moreover, consumers know that the price is the same in the two channels and book the hotel j's room through OTA i. In other words, there is no showrooming on OTA i. Conversely, OTA h does not adopt PPCs, hotel k can set a different retail price on its website and on OTA h. This implies that hotel k also sells its services through its website to a fraction γ of consumers. Hotels' profits can be written as:

$$\pi_j = (p_{ij}-f_{ij})q_{ij}; \quad \pi_k = \gamma(p_{Dk}\, q_{Dk}) + (1-\gamma)(p_{hk}-f_{hk})q_{hk}.$$

Substituting the above quantities into the hotels' profits and deriving with respect to p_{ij}, p_{hk}, p_{Dk}, we obtain the retail prices as a function of the commission fees. In stage 3, platforms choose commission fees to maximize their profits and we obtain $f^{PS^{**}}$, which enable us to first find equilibrium prices and then the equilibrium profits of hotels and platforms, as reported in Lemma 8. Equilibrium quantities sold through the OTAs are equal to $q_j^{S^*}$, given that platform prices and commission fee are the same as in the case of both OTAs adopting PPCs. However, now hotel k also sells through its own sales channel, obtaining an equilibrium quantity equal to:

$$q_{Dk}^{S^*} = \frac{\alpha\left\{2+\beta[6+\alpha\beta(3-\alpha-\alpha\beta)\right\}-8}{(2-\alpha\beta)(1+\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]}.$$

□

First of all, notice that $f^{S^{**}} = f^{S^*} = f^S$: when both hotels single-home, equilibrium fees do not change, independently of price restrictions imposed by at least one OTA. This implies also that platform prices are the same: $p^{S^{**}} = p^{S^*}$. For this reason, we also obtain that $\pi_j^{S^{**}} = \pi_j^{S^*}$ and $\pi_i^{S^{**}} = \pi_i^{S^*}$, as one can immediately verify by comparing Lemma 8 with Lemma 6. Therefore, the equilibrium profits for the hotel that is forced to respect PPCs, and consequently for the OTAs that applies these price constraints, do not change under segmentation with respect to Subsection 3.2. On the contrary, equilibrium profits increase for the hotel that is free to set different prices in its sales channels. In particular, hotel k now offers a different price in its direct channel, in which it charges $p_{D_k}^{S^{**}} < p^{S^{**}}$. Its profits are therefore higher than those of hotel j ($\pi_k^{S^{**}} > \pi_j^{S^{**}}$), and this profit difference enlarges with the intensity of showrooming γ. Finally, the profits for OTA h are lower than OTA i, because the former is affected by showrooming as it does not adopt PPCs.

Partial Segmentation (PS**)

We finally analyze the case in which hotel j is listed on both OTAs, while hotel k is active only on one OTA. As before, we assume that OTA h does not apply PPCs, while OTA i does. Under partial segmentation, we have to distinguish between two cases:

1. hotel k is listed on OTA h (that does not impose PPCs);
2. hotel k is listed on OTA i (that adopts PPCs).

We only present the equilibrium solutions for commission fees, prices, and profits in the first case.[18] Demand functions are:

$$\begin{aligned} q_{ij} &= \frac{1-p_{ij}-\beta(1-p_{hj})}{1-\beta^2},\ q_{hk} = \frac{1-p_{hk}-\alpha(1-p_{hj})}{1-\alpha^2},\ q_{Dj} = \frac{1}{1+\alpha} - \frac{p_{Dj}-\alpha p_{Dk}}{(1-\alpha^2)}, \\ q_{hj} &= \frac{1-p_{hj}-\alpha(1-p_{hk})-\beta(1-\alpha^2)(1-p_{ij})+\alpha\beta[1-p_{hk}-\alpha(1-p_{hj})]}{(1-\beta^2)(1-\alpha^2)}. \end{aligned}$$

As we assume that hotel k is listed only on the OTA that does not impose PPCs (OTA h), then it can set different prices on its sales channels. Hotel j, on the contrary, offers its rooms in both

[18] The second case is instead available upon request.

OTAs, one of which adopting wide PPCs (OTA i). If left unconstrained, also this hotel would charge different prices on the two OTAs, with the lower price being set on the OTA that does not impose PPCs. This, however, cannot be allowed under wide PPCs, and for this reason we have to impose that $p_{ij} = p_{hj}$. Furthermore, similarly to the previous cases, we can easily show that hotels give up their direct sales channel and their profits can be written as:

$$\begin{aligned} \pi_j &= (p_{ij} - f_{ij})q_{ij} + (p_{hj} - f_{hj})q_{hj}, \\ \pi_k &= \gamma(p_{Dk}\, q_{Dk}) + (1-\gamma)(p_{hk} - f_{hk})q_{hk}. \end{aligned}$$

Substituting the above quantities into the hotels' profits and deriving with respect to p_{ij}, p_{hk}, p_{Dk}, we obtain the retail prices as a function of the commission fees. In stage 3, OTAs maximize their profit *w.r.t.* the commission fees and we obtain:

$$\begin{aligned} f_{ij}^{PS^{**}} &= \frac{1}{(1-\alpha)^2\Gamma} \cdot \big\{8 - \alpha^2(5-3\beta)[\gamma(1-\alpha)(8-\alpha)(11+\alpha-\alpha^3(3-\beta)(1-\beta)-9\beta](1+\alpha^2\beta) \\ &\quad +\alpha(1+\beta)(\gamma+t\alpha^2\beta)^2 - 2(1-\alpha)^2[4-4\alpha^2(1-\beta)+\alpha^2(1-\beta)^2+2\alpha(1+\beta)(1+\alpha^2\beta)]\big\}, \end{aligned}$$

$$\begin{aligned} f_{hj}^{PS^{**}} &= \frac{1-\gamma}{\Gamma} \cdot \big\{64 - 40\alpha(1+\beta) + \alpha\gamma[16-4\alpha-\alpha^2(11-2\alpha(1-\beta)-5\beta](1+\beta)(1+\alpha^2\beta) \\ &\quad +\alpha[67\alpha+16\alpha^2(5-\beta)(1-\beta)-64(2-\beta)-16\alpha^3(1-\beta)^2+54\beta-13\beta^3-\alpha^2(27-13\beta)]\big\}, \end{aligned}$$

$$\begin{aligned} f_{hk}^{PS^{**}} &= \frac{\gamma}{\Gamma} \cdot \big\{(1+\alpha^2\beta)[48-8\alpha-32\alpha^2(2-\beta)+8\alpha^2(1-\beta)-2\alpha^4(1-\beta)^2+\alpha^3(3-\beta)(7-5\beta)] \\ &\quad +2(1-\alpha)^2[24+8\alpha-29\alpha^2+19\alpha^2\beta-8\alpha^3(1-\beta)+9\alpha^4+2\alpha^5(1-\beta)^2-\alpha^2\beta(11-4\beta)\big\}, \end{aligned}$$

where

$$\begin{aligned} \Gamma &= \big\{2t^2\alpha^2(1+\beta)(1+\alpha^2\beta)^2 - 6(1-\alpha)^2[2-\alpha^2(1-\beta)][8-\alpha^2(3-5\beta)] + \\ &\quad \gamma(1+\alpha^2\beta)[96-4\alpha^2(35-13\beta)+47\alpha^2-47\alpha^2\beta(46-3\beta)]\big\}. \end{aligned}$$

By inserting these expressions into the equilibrium prices, we get $p_{ij}^{PS^{**}}$, $p_{hk}^{PS^{**}}$, $p_{Dk}^{PS^{**}}$, which enable us to find hotel equilibrium profits $\pi_j^{PS^{**}}$and $\pi_k^{PS^{**}}$, together with OTAs' equilibrium profits $\pi_i^{PS^{**}}$and $\pi_h^{PS^{**}}$. These expressions are omitted for brevity. As in the case where both OTAs adopt PPCs, we find that by multi-homing hotel j pays the highest fee in the OTA where it is the only seller, and from which it receives the lowest price margin. We also confirm that hotel j sets a higher price than the rival, which can also offer a lower price in its direct channel. For future reference, hotels' equilibrium profits are indicated with $\pi_j^{PS^{**}}$and $\pi_k^{PS^{**}}$.

Proof of Proposition 3

We analyze the hotels' optimal listing strategy in this situation. Recall that, when both hotels multi-home, their profit is the same as in case of full adoption of PPCs, *i.e.*, $\pi_j^{NS^{**}} = \pi_j^{NS^{*}}$, $j = 1, 2$. Under segmentation, on the contrary, the hotel that is not bound by price restrictions enjoys a higher profit than the rival: $\pi_k^{S^{**}} > \pi_j^{S^{**}} = \pi_j^{S^*}$. As we previously showed that $\pi_j^{S^*} > \pi_j^{NS^*}$, it is then immediate to find that also in this case segmentation yields a higher profit for both hotels than no segmentation: $\pi_k^{S^{**}} > \pi_j^{S^{**}} = \pi_j^{S^*} > \pi_j^{NS^{**}} = \pi_j^{NS^*}$. Considering the equilibrium profits under partial segmentation, we next obtain that $\pi_k^{S^{**}} > \pi_j^{S^{**}} > \pi_j^{PS^{**}}$. This demonstrates that under segmentation no hotel has an incentive to deviate in order to become active in both platforms. Finally, we compare the hotels' profits under no segmentation with those obtained by one hotel that unilaterally decides to single-home. We find that $\pi_k^{PS^{**}} > \pi_j^{NS^{**}}$, confirming that for the deviating hotel k the profit increase in its unique sales channel more than compensate for the profit loss in the other channel. □

Appendix D: OTAs' decision

Proof of Proposition 4

First of all, it is relatively straightforward to prove that OTAs adopt PPCs when showrooming is sufficiently relevant. In particular, this occurs when $\gamma > \gamma_1$, where

$$\gamma_1 = 1 - \frac{(2-\alpha)(1+\alpha)(1+\beta)(2-\beta)^2(1-\alpha\beta)(2+\alpha\beta)(2-\alpha^2\beta^2)}{2(1-\beta)(2-\alpha\beta)(1+\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]^2}.$$

This result is intuitive as PPCs eliminate showrooming.

Consider now the case in which $\alpha \in (0, \alpha_1)$. If both OTAs adopt PPCs, suppliers decide to single-home and platforms' profits are $\pi_i^{S^*}$, in Lemma 6. In contrast, if both OTAs allow hotels to set different prices in their sales channels (unconstrained pricing), no segmentation occurs and platforms' profits are π_i^{NS}, in Lemma 1. When only one OTA adopts PPCs, it obtains $\pi_i^{S^{**}} = \pi_i^{S^*}$, leaving to the rival $\pi_h^{S^{**}} = (1-\gamma)\pi_i^{S^{**}}$, in Lemma 8. It is therefore clear that, if one OTA adopts PPCs, then the rival decides to do the same, as it can avoid showrooming at no cost (commission fees do not change under segmentation, independently of the decision of OTAs), as $\pi_i^{S^*} > \pi_h^{S^{**}} = (1-\gamma)\pi_i^{S^*}$. Therefore, there exists an equilibrium in which both OTAs adopt these price clauses. Consider now the case in which a platform decides to leave prices unconstrained. The rival faces the decision between doing the same, thereby getting π_i^{NS}, or applying PPCs, which results in $\pi_i^{S^{**}}$. By comparing these profits, we find that $\pi_i^{S^{**}} > \pi_i^{NS}$ if β and/or γ are sufficiently small. The threshold value of γ is reported in the main text as it is relatively easy to write, whereas that of β is cumbersome and therefore it is graphically represented in Figure 2. When $\pi_i^{S^{**}} > \pi_i^{NS}$, the unique equilibrium is given by the adoption of PPCs by both OTAs and this decision also brings the Pareto optimal solution. On the contrary, when $\pi_i^{S^{**}} < \pi_i^{NS}$, there are two symmetric Nash equilibria as also the decision to adopt unconstrained prices by both OTAs is a possible stable solution of the game. In this case, however, we find that unconstrained prices yields a higher payoff for OTAs, which coordinate on such a solution. Indeed, as $\pi_i^{S^{**}} = \pi_i^{S^*}$, $\pi_i^{NS} > \pi_i^{S^*}$ when $\pi_i^{NS} > \pi_i^{S^{**}}$.

Finally, let us examine the case in which $\alpha \in [\alpha_1, 1)$. In this interval, hotels always prefer to single-home and to eliminate showrooming by shutting down their direct channels. If both OTAs adopt PPCs, platforms' profits are equal to $\pi_i^{S^*}$, in Lemma 6. In contrast, if both OTAs refrain from using PPCs, their profit amount to π_i^S, in Lemma 2. Notice that $\pi_i^S = \pi_i^{S^*}$; the commission rate does not change in presence of segmentation, and showrooming is not an issue, as hotels always prefer to cease their direct sales channel when α is high.

In addition, as we specified above, when only one OTA adopts PPCs, it obtains $\pi_i^{S^{**}} = \pi_i^{S^*}$ and the rival $\pi_h^{S^{**}} = (1-\gamma)\pi_i^{S^{**}}$. It then follows that $\pi_i^S = \pi_h^{S^{**}} < \pi_i^{S^{**}} = \pi_i^{S^*}$; under segmentation, the profit does not change for the OTA that leaves prices unconstrained, independently of the strategy adopted by the rival OTA. It is then clear that: (*i*) if one OTA uses PPCs, it is in the interest of the rival to use PPCs as well; (*ii*) if an OTA does not adopt PPCs, the best response of the other is to adopt them. Therefore, the adoption of PPCs is a dominant strategy and there exists a unique equilibrium in which both OTAs resort to these contractual agreements. Moreover, OTAs obtain the highest payoff. □