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# Platform Price Parity Clauses and Segmentation

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## **Platform Price Parity Clauses and Segmentation**

**Abstract:** We investigate how the adoption of price parity clauses (PPCs) by established platforms affects the listing decisions of suppliers. PPCs have been widely adopted by online travel agencies (OTAs) to force client hotels not to charge lower prices in alternative sales channels. We find that OTAs adopt PPCs when they are perceived as highly substitutable, and in order to prevent showrooming. PPCs allow OTAs to charge hotels higher commission fees. However, hotels can respond by delisting themselves from some OTAs. Hence, our analysis reveals that the removal of PPCs enables more hotels to resort to OTAs. This is beneficial for consumers, as prices decrease in absence of PPCs.

JEL Codes: D40, L42, L81.

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## 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 OTAs to compare prices, and then book their rooms directly from the listed hotel. In spite of this, antitrust authorities in several countries are concerned that the adoption of 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 hotels from charging lower prices when selling directly with respect to the contracted OTAs. Narrow PPCs should avoid showrooming while at the same time increase competition among OTAs.

In the EU, PPCs have been scrutinized by various National Competition Authorities (NCAs). In 2015, in the UK, the Office of Fair Trading investigated *Booking.com*, *Expedia*, and *IHG* (Intercontinental Hotels Group) on the related issue of preferential agreements. In Germany, the Bundeskartellamt (the German competition authority) prohibited *HRS* in 2013 (Hotel Reservation Service) and *Booking.com* in 2015 from using any type of PPCs. In April 2015, the French, Italian and Swedish NCAs compelled *Booking.com* to commit to switch from wide to narrow PPCs. The commitment came into effect in July 2015 throughout the EU. *Expedia*, the second biggest OTA in the EU market, soon after voluntarily committed to move from wide to narrow PPCs. In August 2015, the French government imposed a law prohibiting all types of PPCs. A similar ban was adopted in Austria in 2016, Italy in 2017, and Belgium 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.<sup>1</sup> Similar initiatives however were not taken in other countries, 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.<sup>2</sup> In most major markets OTAs continue to apply wide PPCs, notwithstanding the fact that leading scholars such as Baker and Scott Morton (2018) recently stressed that antitrust enforcement against this practice should become a priority also

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<sup>1</sup>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](http://ec.europa.eu/competition/ecn/hotel_monitoring_report_en.pdf).

<sup>2</sup>In September 2017, a motion was passed in both houses of the Swiss parliament to eliminate rate parity agreements. The government must draft a law to implement the proposal by 2019. In Turkey, *Booking.com* was temporarily blocked in 2017 by the court in a dispute with local travel agents. PPCs have also been recently investigated in Japan and Singapore.

in the US.

A growing body of literature, both theoretical and empirical, has investigated the economic effects of adopting price parity clauses, and the potential consequences associated to their removal (see, among others, Edelman and Wright, 2015; Boik and Corts, 2016; Johnson, 2017; Hunold *et al.*, 2018; Mantovani *et al.*, 2017). 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 a uniform price may mitigate competition across OTAs, which can charge a higher commission fee to client hotels. In response, hotels may find it profitable to delist from some OTAs, leading to market segmentation. These findings are in line with the empirical evidence provided by Hunold *et al.* (2018), which use the German case to show that hotels increased their participation to multiple OTAs when PPCs were prohibited. They also find that prices decreased without PPCs, especially in the direct channels, which were increasingly used by hotels. Similar results were also reported by the authors for the cases of France and Austria, when PPCs were prohibited. The aim of this paper is to develop a theoretical framework that not only complements the empirical findings by Hunold *et al.* (2018), but also sheds light on this issue by providing additional results.

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 about their existence otherwise. OTAs allow hotels to expand their customer base but charge them a fee to be listed. We assume there are two symmetric OTAs providing the same type of service to client hotels. However, they are perceived by customers as horizontally differentiated in terms of the booking experience. Hotels decide whether to contract only one OTA, or both. This decision crucially depends on the contractual restrictions imposed by OTAs, which can apply PPCs. The main contribution of the paper is to determine under which conditions the imposition of PPCs in the retail price can induce hotels to limit the number of OTAs in which they decide to be listed. In spite of the relevance of PPCs for market segmentation, this is an aspect that has not been previously addressed by the current theoretical literature.

Our paper starts by considering the benchmark case in which hotels are free to set their prices in all the sales channels that they decide to use. In such a case, we assume that a fraction of consumers prefer to book their hotel room directly rather than through the preferred OTA. This is meant to capture the so-called "showrooming" effect that occurs when consumers use the platform mainly to verify the availability of products and prices online, and then buy directly from the seller if it offers a lower price. We confirm the intuitive result that hotels charge a lower retail price to those consumers who book through the direct channel, and avoid paying the commission fee to the OTA. Interestingly, hotels almost always end up being listed on the two OTAs (multi-homing), because this allows to attract more consumers. Only when the degree of product substitutability between hotels is very high, they delist from one of the two OTAs (single-homing). In so doing, they increase their perceived differentiation and are able to raise the price margin per room sold through the OTA (difference between the price on the platform and the commission fee), although they sell less rooms in total.

Then, we investigate what happens when OTAs decide to impose PPCs. We assume that showrooming disappears when the price is the same across all sales channels. Moreover, we limit our attention to the case of wide PPCs, which implies that hotels are forced to set a uniform retail price across all the sales channels in which they are active. 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 can smooth out the impact of this measure by delisting from one OTA. Single-homing increases competition across OTAs, which are then forced to lower their commissions fees. This increases the price margin for hotels, without necessarily sacrificing quantity. Hence, hotels always prefer segmentation when PPCs are applied. We confirm this result also in 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 demonstrate that OTAs always apply PPCs when showrooming is particularly intense, *i.e.* when there is a consistent portion of consumers who buy directly from the hotels. Nonetheless, OTAs resort to PPCs also when showrooming is limited, if the degree of substitutability between OTAs is sufficiently high. In this case, by adopting PPCs, OTAs induce hotels to single-home. This reduces the competitive pressure and enables OTAs to set higher commission fees than under unrestricted pricing. In contrast, when the two OTAs are perceived as sufficiently differentiated, they refrain from adopting PPCs as they prefer to avoid single-homing on the hotels side. Indeed, in this case multi-homing increases consumption, thereby compensating for the lower commission fee and the occurrence of showrooming. Finally, PPCs are adopted also when hotels are perceived as highly substitutable. Hotels would single-home anyway, even in the absence of price restrictions, and therefore OTAs gain by imposing PPCs, as this allows them to eliminate showrooming without sacrificing demand. In fact, our analysis reveals that commission fees are the same in case of single-homing, independently of PPCs.

In the last part of our paper we analyze the economic effect of PPCs in terms of industry profits and consumers. When showrooming is particularly relevant, 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 damages hotels if they are sufficiently differentiated, as they would have preferred competing in multiple platforms. On the contrary, hotels gain if they are perceived as very substitutable, given that by single-homing they can increase the price margin on the platform, without losing much demand in comparison to multi-homing. When showrooming is less intense, nothing changes in terms of hotel profitability when OTAs adopt PPCs. On the contrary, if OTAs opt for unconstrained pricing, 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 perceived as highly substitutable, whereas OTAs are not. The competitive pressure among hotels is intense, and they would have benefitted from the segmentation induced by PPCs, even though commission fees would have increased. OTAs prefer no segmentation instead, given that they are sufficiently differentiated to afford more than one seller on their platforms.

Regarding consumers, it is relatively easy to show that they are always damaged by PPCs. Indeed, platform prices increase following the surge in the commission fees caused by these contractual price restrictions. Moreover, in accordance with our assumption, under PPCs showrooming disappears. Hence, both those consumers who would have booked through the platform, and those who would have used the hotel's direct channel, end up losing out with PPCs. Specifically, direct prices increase more than platform prices. The removal of PPCs would therefore contribute to explain why overall prices decline, particularly in hotels' websites and direct channels, as empirically showed by Hunold *et al.* (2018) and Ennis *et al.* (2018).

To sum up, our simplified model of the lodging sector highlights the importance of PPCs for market segmentation and price dynamics on different sales channels. Our analysis shows 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, in turn, reduces the commission fees levied on client hotels, which translates into a lower retail prices for end customers. Our analysis also reveals that there exist cases in which PPCs are not detrimental to the hotels' interests, especially when the competitive pressure among hotels is intense.

Our findings 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 also be used to 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 the recent works of Edelman and Wright (2015), Boik and Corts (2016), Johnson (2017), and Wang and Wright (2017), among others.

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, which can be used by those consumers who have some prior knowledge about the sellers. 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 (2017) 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 Schinken (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.

Our paper is closely related to the model developed by Johansen and Vergé (2017), where

there are two OTAs, several sellers, and consumers that are 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 that the commissions are offered secretly. As a consequence, each supplier does not observe the commissions of its rivals. They adopt the “contract equilibrium” approach developed by Crémer and Riordan (1987) and Horn and Wolinsky (1988), and find scenarios in which price parity clauses benefit consumers, and may even lead to Pareto superior outcomes in which hotels do also gain. Differently from their model, we consider a group of hotel seekers that visit the OTAs in order to discover the availability of hotels on a specific location. Once they know about the existence of the hotels, consumers can directly make their reservations from the hotels’ websites. We assume that commission fees are observed by all sellers, and therefore we allow hotels to single-home. This is an important aspect of our model, as we show that PPCs may induce segmentation, thereby reducing the hotel offers on each OTA.

Our paper also 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 alia*, focus on cross-group externalities between agents on both sides. On the contrary, we explicitly consider 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 homogenous platforms.<sup>3</sup> They show that single-homing may relax seller competition on each platform. Indeed, in the case of agglomeration, consumers are informed about all prices that sellers charge in the platform. If competition between sellers is sufficiently severe, they choose to be active on different platforms to relax competition, leading to market segmentation.

A few number of 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.<sup>4</sup> Consistently with our results, they obtain that the abolition of PPCs in Germany at the end of 2015, although not changing the commission rates, encouraged hotels to increase not only the use of different OTAs but also to post rooms on their 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. Ennis *et al.* (2018) use a dataset of proprietary hotel-level data for 2014 and 2016, for different hotels both in the EU and around the world. They show that the switch from wide to narrow price parities caused a price decrease on direct channels with respect to OTAs in the EU, especially for more expensive hotels. Cazaubiel *et al.* (2018) obtain a dataset from two major hotel chains in Scandinavia with prices, volumes and sales channels between 2012 and 2016. They aim to estimate the degree of substitution between *Booking.com* and *Expedia*, and

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<sup>3</sup> 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.

<sup>4</sup> A recent European Commission monitoring report (2017) considers similar data as Hunold *et al.* (2018) and analyzes the impact of removing PPCs in different European countries.

hotels' own websites, by considering a boycott against Expedia led by hotels between 2012 and 2014. Finally, Mantovani *et al.* (2017) collected data of listed prices on Booking.com in the period 2014-16 for tourism regions that belong to France, Italy, and Spain. They compare prices before and after the most relevant EU antitrust decisions and find that prices on *Booking.com* dropped between 2014 and 2015, but then bounced back between 2015 and 2016. They argue that the price reduction is mainly due to the effect of antitrust interventions, whereas the following price increase is driven by a combination of demand surge and innovative managerial techniques adopted by leading OTAs.

Our theoretical contribution is particularly related to the empirical analysis carried out by Hunold *et al.* (2018). We believe that our findings do not simply complement theirs, but are part of a larger picture in which different approaches are necessary to shed some light on the private and social desirability of new forms of vertical price restrictions such as PPCs.

The rest of the paper is organized as follows. The next section presents the basic model. Section 3 considers the hotels' decision regarding how many OTAs to use. Section 4 investigates the OTAs' decision regarding the adoption of PPCs. Section 5 highlights the economic effects of adopting PPCs. Section 6 discusses the assumptions of our model and provides some formal extensions to confirm the robustness of our results. Section 7 concludes.

## 2 The basic model

We develop a model where two horizontally differentiated sellers (1 and 2) can be listed in one or two horizontally differentiated platforms (A and B). We refer to hotels and OTAs as representative examples of sellers and platforms. OTAs are the only way for hotels to inform consumers about their presence in the market. Hotels must pay a listing fee when consumers buy their products through the OTAs.<sup>5</sup> However, they are allowed to sell directly to those consumers who decide to by-pass the OTAs' sales channel.

There is a unit mass of consumers and their inverse demand functions when they respectively book their rooms through the OTAs or directly through the hotel direct channels are given by:

$$\begin{aligned} p_{ij} &= 1 - [q_{ij} + \alpha q_{ik} + \beta(q_{hj} + \alpha q_{hk})], \\ p_{Dj} &= 1 - (q_{Dj} + \alpha q_{DK}), \end{aligned} \tag{1}$$

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  $j$  in its website. 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  $\alpha$  (resp.  $\beta$ ) means that hotels (resp. OTAs) are perceived as close substitutes, and *vice versa*.

Initially, consumers are unaware of the hotels' offers and browse through OTAs. They observe which hotels are eventually available on each platform and select the combination hotel-

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<sup>5</sup>As it is common in the literature, we assume that sellers consider the competing platforms as homogeneous while consumers have preferences for one over the others (see Armstrong and Wright, 2007).

OTA according to their preferences. In the absence of PPCs, there is a fraction  $\gamma$  of consumers that, after visiting the OTAs, decide to book directly from the hotel websites.<sup>6</sup> The remaining fraction  $(1 - \gamma)$  represents instead those consumers who decide to book through the platform. Parameter  $\gamma$  captures therefore the intensity of "showrooming". We are implicitly assuming that there are some consumers who are willing to bear some additional search cost and/or to give up additional services provided by the OTAs when the direct sales channel offers a cheaper price than the platform.<sup>7</sup> As a consequence, the adoption of PPCs implies that showrooming disappears, *i.e.*  $\gamma = 0$ , and the hotel's inverse demand is simply given by  $p_{ij}$ .<sup>8</sup> Indeed, PPCs force hotels to guarantee the best prices to the OTAs, which implies that  $p_{ij} = p_{hj} \leq p_{Dj}$ .<sup>9</sup> In this case, consumers do not receive any additional gain when reserving the rooms directly from the hotels and they always book a room through the OTAs.

Hotels decide whether to be listed in one or in two OTAs. Absent PPCs, hotel  $j$ 's profit when it multi-homes (no segmentation) and when it single-homes by showcasing its rooms only in OTA  $i$  (segmentation) are, respectively, given by:

$$\pi_j = \gamma[p_{Dj} q_{Dj}] + (1 - \gamma)[(p_{ij} - f_{ij})q_{ij} + (p_{hj} - f_{hj})q_{hj}], \quad (2)$$

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

where  $f_{ij}$  is the commission fee hotel  $j$  pays to platform  $i$ .<sup>10</sup> For simplicity, we also assume that the cost hotels bear for directly offering their booking services is equal to zero. When OTAs apply PPCs, hotels sell their rooms through the OTAs only, and their profits can be simply obtained by assuming  $\gamma = 0$  in (2)-(3).

The profits of the OTAs also depend on the number of hotels that are listed in their websites. Without PPCs, OTA  $i$ 's profits when it lists the two hotels and when it only lists hotel  $j$  are respectively given by:

$$\pi_i = (1 - \gamma)[f_{ij} q_{ij} + f_{ik} q_{ik}]; \quad (4)$$

$$\pi_i = (1 - \gamma)[f_{ij} q_{ij}]. \quad (5)$$

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<sup>6</sup>Notice that our demand system differs from Johansen and Vergé (2017) as we assume that only inter-brand competition matters when consumers decide to buy directly.

<sup>7</sup>Booking.com recently undertook significant structural changes that improved the quality of its services. For example, it introduced complementary features to enhance the customer experience (Mantovani *et al.*, 2017).

<sup>8</sup>We set  $\gamma = 0$  to simplify our computations with PPCs. However, our main results still hold when  $\gamma > 0$ , provided such a value is not too high. Additional discussion on this relevant point will be provided in Section 6.

<sup>9</sup>Under *narrow* price parity clauses, platform  $i$  only forces each supplier to charge a lower price on its platform than on the hotel's website, *i.e.*  $p_{ij} \leq p_{Dj}$ . Since both platforms impose narrow price parity clauses, we must have that  $p_{Dj} = \max\{p_{ij}, p_{hj}\}$ . *Wide* and *narrow* price parity clauses coincide in our model.

<sup>10</sup>In general, the fee corresponds to a fraction of the revenues generated by the hotel through the platform. However, revenue-sharing rules make the analysis intractable and for this reason we adopt a simpler per-unit commission. Additional discussion is provided in Section 6, where we suggest that our qualitative results hold also in presence of revenue-sharing.

In the presence of PPCs there is no showrooming and OTA  $i$ 's profit functions result from inserting  $\gamma = 0$  in (4)-(5).

The timing of the model is as follows. In *Stage 1*, the OTAs decide whether to impose PPCs or not. We will show that under the assumption of symmetric OTAs the imposition of PPCs imply that the prices hotels post in their direct channel and those set in the OTAs will be the same. On the contrary, without PPCs hotels are free to set different prices in their sales channels. In *Stage 2*, hotels simultaneously decide whether to be listed in both OTAs (no segmentation) or only in one (segmentation). In *Stage 3*, OTAs simultaneously set the linear commission fees for hotels, taking into account the previous steps of the game. Finally, in *Stage 4* hotels simultaneously set the prices in all channels in which they are active, and in *Stage 5* consumers choose from which channel to book the room and profits are realized. We proceed by backward induction and look for Subgame Perfect Nash Equilibria of the game. In case of multiple equilibria, we use Pareto dominance as the refinement criterion. Notice that our timing differs from Johansen and Vergé (2017), who consider equilibria in which all hotels are active on all channels. As previously explained, they look for contract equilibria in which OTAs compute the acceptable commission that renders the supplier indifferent between being listed and exit the platform. Our aim is different, as we want to explicitly consider the possibility to delist from one of the two OTAs.

### 3 The hotels' listing decision

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 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.

#### 3.1 The benchmark case: unrestricted pricing

This section considers the benchmark case in which hotels can freely set the retail prices both on their websites and on the OTAs in which they are listed. As explained in the previous section, we assume that, if direct prices are lower, a fraction  $\gamma$  of consumers use the OTAs to find their preferred hotel, but then book directly from the hotel's website. We want to know whether in this situation hotels prefer to be listed on both OTAs or just on one of them. In order to address this question, we calculate hotels' profits in all possible scenarios: No Segmentation ( $NS$ ), in which both hotels multi-home and are therefore listed in both OTAs; Segmentation ( $S$ ), in which each hotel is listed in a different OTA; Partial Segmentation ( $PF$ ), where only one hotel is listed on both OTAs, whereas the other only on one.<sup>11</sup>

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<sup>11</sup>In our model, OTAs are the only way for hotels to inform consumers about their existence. As a consequence, they never have an incentive to delist from both OTAs. In an alternative version of the model, we instead assumed that OTAs were not necessary for hotels to become visible. Calculations

The equilibrium of the model is determined by backward induction. In the last stage of the game, consumers make their choices and direct demands are derived as functions of the retail prices. In Stage 4, hotels set the retail prices for their website and for the OTAs in order to maximize their profits. These prices depend on the commission fees set by the OTAs in Stage 3. Finally, in Stage 2 hotels compare their profits in the different scenarios and decide their listing strategy. All the computations and proofs of main lemmas and propositions are shown 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:*

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

*Both OTAs set the commission fee*

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

*Hotels' and OTAs' profits are respectively:*

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

Lemma 1 shows that without PPCs the retail prices set by the hotels in their direct channels only depend on the degree of product differentiation between them. In particular, as  $\alpha$  increases hotels become more similar and the competitive pressure reduces their prices. Platform prices are also negatively affected by  $\alpha$ , although to a lower degree than direct prices. In addition, they decrease when  $\beta$  increases, *i.e.*, when platforms are perceived as less differentiated. Also 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  $\beta \rightarrow 1$ , as the commission fee goes to zero as the two OTAs become perfect substitutes.

We also find that hotels' profits obviously decrease in  $\alpha$ , while they increase in  $\beta$  and  $\gamma$ . As indicated above, an increase in the degree of *intra*-brand (hotel) competition  $\alpha$  diminishes hotel's direct prices and, consequently, their profits. In contrast, an increase in the degree of *inter*-

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were more complicated, but we proved that the strategy of selling only through the direct channel was always dominated. Hence, the profit comparison boiled down to the decision between one and two OTAs. Additional calculations are available upon request.

brand (platform) competition  $\beta$  reduces commission fees. This drives down platform prices, but less in proportion to the decrease in the commission fees, which explains why hotels' profits increase in  $\beta$ . In other words, the price margin per unit sold through the OTA ( $p_P^{NS} - f^{NS}$ ) enlarges in  $\beta$ . Furthermore, hotels benefit from showrooming, which increases the portion of consumers who by-pass OTAs. Regarding platforms' profits, they are clearly decreasing in  $\beta$  and  $\gamma$ , while the impact of  $\alpha$  is ambiguous. More precisely, OTAs gain from an intensification of *intra*-brand competition when  $\alpha > 1/2$ , as in such interval demand on the OTAs increases in  $\alpha$ .

**Segmentation (S).** The next lemma 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:*

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

*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:*

$$\begin{aligned} \pi_j^S &= \frac{\gamma(1-\alpha)}{(1+\alpha)(2-\alpha)^2} + \frac{(1-\gamma)(1-\alpha\beta)(2-\alpha^2\beta^2)^2}{(1+\alpha\beta)(2-\alpha\beta)^2[4-\alpha\beta(1+2\alpha\beta)]^2}, \\ \pi_i^S &= \frac{(1-\gamma)(1-\alpha\beta)(2+\alpha\beta)(2-\alpha^2\beta^2)}{(1+\alpha\beta)(2-\alpha\beta)[4-\alpha\beta(1+2\alpha\beta)]^2}. \end{aligned}$$

By comparing Lemma 2 with Lemma 1, it is immediate to notice that the prices posted by hotels in their own direct channel do not change, *i.e.*,  $p_D^{NS} = p_D^S$ . This is because their demand functions are the same in the two cases. In contrast, the prices posted in the OTAs are higher with segmentation than without it, *i.e.*,  $p_P^S > p_P^{NS}$ . 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 to access one of the two hotels. For this reason, the commission fee is higher with segmentation ( $f^S > f^{NS}$ ), and it remains positive even if  $\beta = 1$ .<sup>12</sup>

As expected, hotels' profits increase in  $\gamma$  and decrease in  $\alpha$ . However, we now find that these profits are negatively affected by the intensity of platform competition. In contrast to the previous case, under segmentation an increase in  $\beta$  reduces the prices charged by hotels on the OTAs more than it decreases the commission fees, *i.e.* ( $p_P^{NS} - f^{NS}$ ) decreases in  $\beta$ . Finally, with segmentation the platforms' profits are negatively affected not only by  $\beta$  and  $\gamma$ , but also by  $\alpha$ , because a higher intensity of *intra*-brand competition amplifies *inter*-brand competition in the presence of only one hotel on each OTA.

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<sup>12</sup>Under segmentation, the commission fee decreases in both  $\alpha$  and  $\beta$ , and it goes to zero only when both parameters are equal to 1.

**Partial Segmentation (PS).** Finally, we 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.** *When hotel  $j$  is listed on both OTAs  $i$  and  $h$ , while hotel  $k$  is listed only on OTA  $h$ , their retail prices are:*

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

OTAs set the following commission fees:

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

Hotels' profits are  $\pi_j^{PS}$  and  $\pi_k^{PS}$ , while OTAs' profits are  $\pi_i^{PS}$  and  $\pi_h^{PS}$ . Their expressions are moved to the Appendix A as they are extremely long.

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,  $p_{ij}^{PS} > p_{hj}^{PS}$ , meaning the multi-homing hotel  $j$  charges a higher price in the platform where it competes with the rival, even though it pays a lower fee ( $f_{hj}^{PS} > f_{ij}^{PS}$ ). Moreover, when  $\alpha$  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  $\alpha$ , we find instead that  $p_{ij}^{PS} > p_{hk}^{PS} (> p_{hj}^{PS})$ , meaning that the multi-homing hotel 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 seems to reward the hotel that multi-homes.

**Hotels' listing decisions with unrestricted pricing** We now consider the second stage of the game for the case of unrestricted pricing. Hotels compare their profits in the three previous scenarios and decide the profit-maximizing listing strategy. The threshold values of  $\alpha$  which will appear in the forthcoming analysis are not reported as they are very complex.<sup>13</sup> However, we will provide a graphical representation at the end of this subsection.

First, we study the incentives of a hotel to multi-home when the rival single-homes. To this purpose, we compare  $\pi_j^{PS}$  with  $\pi_j^S$  and find that  $\pi_j^{PS} > \pi_j^S$  if  $\alpha < \alpha_1$ . *A priori*, one may expect

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<sup>13</sup>These values are available upon request, together with additional calculations and graphical representations.

that joining a second platform is always beneficial, 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. However, when  $\alpha$  is relatively high, we find that  $(p_P^S - f^S) > (p_{ij}^{PS} - f_{ij}^{PS})$ , meaning that the unitary profit margin is higher under segmentation when hotels are perceived as highly substitutable. For very high values of  $\alpha$ , hotels may prefer to gain more on each unit of output than expanding sales through multi-homing. In such a case, the simultaneous decision of both hotels to single-home is a Nash equilibrium, which results in segmentation.

Second, we consider the incentives of a seller to multi-home when the rival multi-homes as well. It is straightforward to find that  $\pi_j^{NS} > \pi_k^{PS}$ . Clearly, 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 fee.<sup>14</sup> This explains why hotel  $k$  has the smallest price margin. By multi-homing as well, this hotel is capable of raising its margin per room, while at the same time expanding the number of rooms being booked, as it lists on two platforms. As a consequence, both hotels decide to multi-home, and no segmentation is a Nash equilibrium of the game.

Finally, we compare the symmetric payoffs that emerge in cases of segmentation vis-à-vis no segmentation. Interestingly, we obtain that  $\pi_j^{NS} > \pi_j^S$  if  $\alpha < \alpha_2$ . In fact, it is possible to demonstrate that, when  $\alpha$  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, when  $\alpha$  becomes sufficiently large, hotels prefer to sacrifice quantity in exchange for obtaining a bigger unitary price margin. Notice that  $\alpha_2$  is increasing in  $\beta$  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 highlighted along this subsection.

To sum up, our analysis reveals that:

**Proposition 1.** *With unrestricted pricing, hotels' listing strategy is the following:*

1. *When  $\alpha \in (0, \alpha_2]$ , there is a unique symmetric Nash equilibrium in which both hotels decide to be listed on both OTAs; no segmentation occurs and hotels obtain the highest payoff.*
2. *When  $\alpha \in (\alpha_2, \alpha_1]$ , there is again a unique symmetric Nash equilibrium in which both hotels decide to be listed on both OTAs; no segmentation occurs but hotels are trapped in a prisoners' dilemma as they would obtain a higher payoff by being listed on one OTA each.*
3. *When  $\alpha \in (\alpha_1, 0]$ , there are two Nash equilibria in which either both hotels are listed on both OTAs (no segmentation), or each hotel is listed in only one OTA (segmentation). We assume that hotels coordinate on the Pareto dominant solution and segmentation occurs.*

Proposition 1 highlights some important findings. When hotels are sufficiently differentiated ( $\alpha \leq \alpha_1$ ), there is a unique symmetric Nash equilibrium where both firms decide to be listed

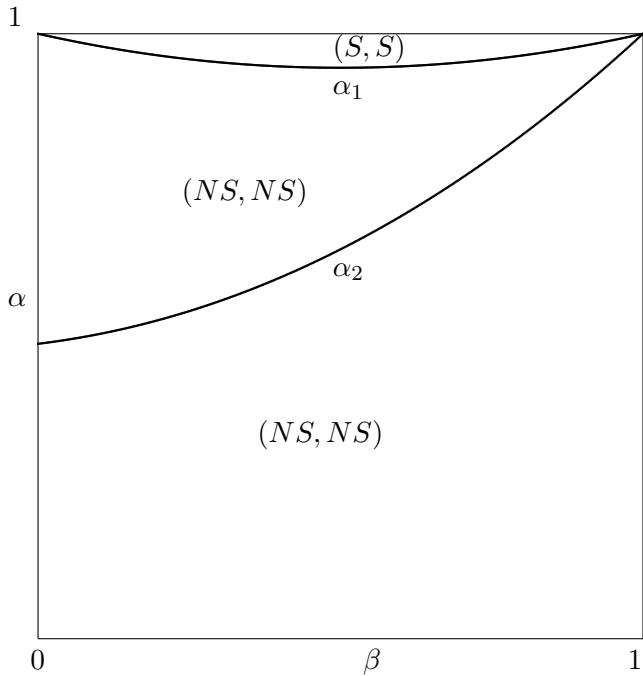
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<sup>14</sup>In fact, the OTA exploits the fact that it is the only way for this hotel to reach out to consumers. Interestingly,  $(p_{hk}^{PS} - f_{hk}^{PS})$  does not depend on  $\beta$ , as hotel  $k$  sells only through OTA  $h$ .

on both platforms. For an intermediate degree of hotel substitutability ( $\alpha \in (\alpha_2, \alpha_1]$ ), multi-homing is still a dominant strategy, but hotels would obtain a larger profit by single-homing. Segmentation would indeed reduce the competitive pressure among hotels, which would gain by sacrificing quantity and selling through one OTA each, in which they would nonetheless enhance the price margin. In this region, however, hotels fail to coordinate, as they have an incentive to multi-home when the rival single-homes, as we previously explained. This happens for very high values of  $\alpha$  ( $\alpha > \alpha_1$ ), as both hotels realize that it is preferable to single-home when the rival does the same. *Intra*-brand competition is severe and segmentation enables hotels to smooth out a competitive pressure that would be exacerbated by selling through both platforms.

The results of Proposition 1 are graphically represented in Figure 1. It is worth noting that the parametric region in which segmentation is an equilibrium is very limited and it requires a very high degree of substitutability between the two hotels.

**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.

We then replicate the analysis of the previous section to examine the hotels' optimal listing decision when PPCs are enforced. In accordance with our assumption, consumers weakly prefer using the OTA to complete the booking process when prices set on and off the platform are the same. Hence, under PPCs showrooming disappears, *i.e.*  $\gamma = 0$ .

**No Segmentation ( $NS^*$ ).** The next lemma presents the equilibrium prices, commission fees, hotels' and OTAs' profits, when both hotels decide to be listed on the two OTAs.

**Lemma 4.** *With PPCs, when both hotels are listed in 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:*

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

With PPCs hotels use their unique retail price to maximize profits in the two platforms. The equilibrium price  $p^{NS^*}$  is decreasing in the degree of hotel competition  $\alpha$ , whereas it does not depend on the degree of platform substitutability  $\beta$ . The commission fee is independent of both  $\alpha$  and  $\beta$ , meaning that OTAs always charge a positive fee, even if they are perceived by consumers as highly substitutable. Intuitively, if the two hotels are listed on both OTAs and induced *ex-ante* to post the same price in both of them, the commission fee is not affected by the intensity of competition on the OTAs market. What is remarkable is that it does not depend on the degree of hotel differentiation either. It is immediate to prove that  $f^{NS^*} > f^{NS}$ , which implies the OTA increases its commission fee with respect to the case of unrestricted pricing and multi-homing. This also explains why  $p^{NS^*} > p_P^{NS}$ .<sup>15</sup> However, it can be easily verified that  $(p^{NS^*} - f^{NS^*}) < (p^{NS} - f^{NS})$ , thus confirming that PPCs reduce hotels' price margin when they both multi-home. This explains why hotels are worse-off under PPCs:  $\pi_j^{NS} > \pi_j^{NS^*}$ .

Regarding OTAs, we find that  $\pi_i^{NS^*} > \pi_i^{NS}$  when  $\beta > 1/2$ . In absence of price restrictions, hotels sell more rooms through the platform as prices are lower. From the OTAs' perspectives, this compensates for a lower commission fee charged to hotels. However,  $f^{NS}$  decreases in  $\beta$ , whereas  $f^{NS^*}$  does not. Hence, for a sufficient high value of  $\beta$ , OTAs prefer to receive a comparatively high commission rate per room being sold, even though this means selling less rooms.

**Segmentation ( $S^*$ ).** Consider now the case in which the two hotels are listed in just one OTA each (segmentation) and that OTAs impose PPCs on client hotels. This situation yields the following equilibrium prices, commission fees, and firms' profits:

**Lemma 5.** *When each hotel is listed on a different OTA, the retail prices are:*

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

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<sup>15</sup> As a result,  $q^{NS} > q^{NS^*}$ ; the equilibrium expressions for quantities are reported in Appendix A.

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:

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

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  $\alpha$  and  $\beta$ . 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  $(p^{S^*} - f^{S^*}) > (p^{NS^*} - f^{NS^*})$ : the price margin when both firms single-home is always higher than when they both multi-home.<sup>16</sup>

Turning to OTAs, they usually end up losing profits when hotels single-home, given that they can charge a lower commission fee, and they host only one hotel each. However, there exists a parametric region in which  $\pi_i^{S^*} < \pi_i^{NS^*}$ ; this occurs when  $\beta$  is very high, and it is explained by the fact that the increase in quantity (despite rooms are sold only in one OTA) overcomes the negative effect induced by a lower commission fee.

**Partial Segmentation ( $PS^*$ ).** We finally analyze the case in which hotel  $j$  is listed on both OTAs, while hotel  $k$  is only active in one OTA (OTA  $h$  by assumption). Lemma 6 illustrates the equilibrium prices and commission fees.

**Lemma 6.** *When hotel  $j$  is listed on both OTAs, while hotel  $k$  only on OTA  $h$ , the retail prices are:*

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

OTAs set the following commission fees:

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

Hotels' profits are  $\pi_j^{PS^*}$  and  $\pi_k^{PS^*}$ , while OTAs' profits are  $\pi_i^{PS^*}$  and  $\pi_h^{PS^*}$ . Their expressions

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<sup>16</sup>It is also possible to show that  $p^{S^*} > p^{NS^*}$  when  $\alpha$  is relatively high, provided  $\beta$  is not excessive.

are very long and they are confined to the Appendix.

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  $\alpha$  and/or  $\beta$  are high enough.<sup>17</sup> In such a parametric region, the price difference  $(p_j^{PS^*} - p_k^{PS^*})$  enlarges and the number of rooms sold by hotel  $j$  in both platform is lower than those sold by hotel  $k$  on platform  $h$ .

**Hotels' listing decisions with PPCs.** The results of the three previous lemmas enable us to investigate the hotels' optimal listing strategy in presence of PPCs, which is decided in the second stage of the game. Also here there are threshold values of  $\alpha$  and  $\beta$  that are omitted from the main text for brevity.

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 the case of partial segmentation with that of segmentation reveals that  $(p_j^{PS^*} - f_{ij}^{PS^*}) < (p^{S^*} - f^{S^*})$ , meaning that, in the presence of a single-homing rival, the decision to be listed in both platforms reduces the price margin in the OTA where the seller is the only active firm. This is not compensated by a (possible) increase in quantity, and therefore there is a profit loss in such sales channel. Moreover, total quantity does not sufficiently increase to compensate such a loss, and it may even decrease in the presence of sufficiently high degrees of *intra*-brand and/or *inter*-brand competition. It follows that the simultaneous decision to single-home is always a Nash equilibrium, 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, and  $\pi_k^{PS^*} > \pi_j^{NS^*}$ . *In primis*, 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 is always higher than potential missed sales in the other OTA. As before, we find that selling through only one channel may even increase aggregate quantity in comparison to using both OTAs; this occurs, again, when  $\alpha$  and/or  $\beta$  are large enough. It then follows that single-homing is a dominant strategy, and therefore the decision of both hotels to be listed on one OTA each is the unique Nash equilibrium of the game.

Finally, we compare segmentation with no segmentation, and confirm that  $\pi_j^{S^*} > \pi_j^{NS^*}$ . As already explained when analyzing segmentation with PPCs, the price margin increases under segmentation:  $(p^{S^*} - f^{S^*}) > (p^{NS^*} - f^{NS^*})$ . In addition, total quantities do not always shrink

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<sup>17</sup>Equilibrium expressions for  $q_{ij}^{PS^*}$ ,  $q_{kj}^{PS^*}$ , and  $q_{kh}^{PS^*}$  are reported in Appendix A, Proof of Lemma 6. The additional threshold values of  $\alpha$  and/or  $\beta$  above which  $q_{ij}^{PS^*} + q_{kj}^{PS^*} < q_{kh}^{PS^*}$  holds can be provided upon request.

under segmentation (see Appendix A). In particular, when  $\alpha$  and/or  $\beta$  are sufficiently high we obtain that  $q^{S^*} > 2q^{NS^*}$ , meaning that each hotel sells more by using only one OTA than in the case where both hotels sell through two OTAs each. This explains why profits are higher under segmentation.

The result is summarized in the following proposition.

**Proposition 2.** *When both OTAs adopt PPCs, there is a unique Nash equilibrium in which each hotel is listed on a different OTA; segmentation occurs and hotels obtain the highest payoff.*

Proposition 2 confirms that hotels lose out under multi-homing when OTAs enforce PPCs. Indeed, they are forced to charge relatively high prices in order to compensate for the increase in the commission fees, thereby losing consumers on each sales channel. As a response, they both decide to be listed in one OTA each. This increases platform competition and reduces the commission fee. Hotels gain as they can charge a higher price margin per room being sold, although this implies resorting to only one sales channel. This, however, does not necessarily shrinks total demand, as we discussed above. In fact, when the degree of competition both across hotels and OTAs is sufficiently fierce, hotels end up selling more in one OTA than in both OTAs. In fact, under segmentation the commission fee decreases in both  $\alpha$  and/or  $\beta$ , allowing hotels to reduce the price and therefore receiving more room requests. On the contrary, the commission fee is not affected by the intensity of market competition under the combination of PPCs and no segmentation, and hotels may end up losing demand especially when competition among OTAs exacerbates.

### 3.3 Partial Application of Price Parity Clauses

For the sake of completion, this section examines hotels pricing and listing decisions when only OTA  $i$  applies PPCs to its client hotels. We replicate the analysis of the previous sections to study whether hotels prefer to be listed on both OTAs or just on one of them.

**No Segmentation (NS\*\*).** When both hotels decide to multi-home, the equilibrium prices, commission fees, and industry profits (hotels and OTAs) are exactly 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. We refer to Lemma 4 for the equilibrium expressions and the analysis of this case.

**Segmentation (S\*\*).** Consider now the case in which each hotel is listed in a different platform and only one OTA adopts PPCs. Without loss of generality, we consider the case in which hotel  $j$  is listed in 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 in 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 7.** When each hotel is listed on a different OTA, but only OTA  $i$  applies PPCs to hotel  $j$ , the retail prices are:

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

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:

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

while platforms' profits are:

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

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 7 with Lemma 5. 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  $\gamma$ . 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 in both OTAs, while hotel  $k$  is active only in 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).

In Appendix A we only present the equilibrium solutions for commission fees, prices, and

profits in the first case.<sup>18</sup> However, as all these expressions are very long and do not provide additional insights to our analysis, we decided to move them to the appendix. As in the case where both OTAs adopt PPCs, we find that the 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  $\pi_k^{PS^{**}}$ .

**Hotels' listing decisions with partial PPCs.** Finally, 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. It then follows that:

**Proposition 3.** *When only one OTA adopts PPCs, there is a unique Nash equilibrium in which each hotel is listed on a different OTA; segmentation occurs and hotels obtain the highest payoff.*

Similarly to the case in which both OTAs adopt PPCs, hotels prefer to be listed in just one OTA. 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. In fact, 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. For this objective, we compare OTAs' profits when they apply PPCs and when they do not. Recall that, in the

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<sup>18</sup>The second case is instead available upon request.

absence of PPCs, the hotels find it profitable to use both platforms to reach out to customers when  $\alpha \leq \alpha_1$ ; otherwise, they use only one platform each when  $\alpha > \alpha_1$ . In the presence of at least one OTA that applies PPCs, segmentation always occurs. Another result from the previous section that is useful to determine the OTAs' optimal policy is that under segmentation OTAs always set the same commission fee ( $f^{S**} = f^{S*} = f^S$ ).<sup>19</sup>

The next proposition shows under what conditions the OTAs will decide to impose PPCs:

**Proposition 4.** *OTAs' decision to apply PPCs is the following:*

- When  $\gamma > \gamma_1$  and/or  $\alpha > \alpha_1$ , there is a unique Nash equilibrium in which both OTAs adopt PPCs. Hotels choose to single-home and OTAs obtain  $\pi_i^{S*}$ . The resulting equilibrium is Pareto dominant.
- When  $\gamma \leq \gamma_1$  and  $\alpha \leq \alpha_1$ , there are two cases: (i) if  $\beta > \beta_1$ , there is a unique Nash equilibrium in which both OTAs adopt PPCs and obtain  $\pi_i^{S*}$  as hotels are induced to single-home; (ii) if  $\beta \leq \beta_1$ , there are two Nash equilibria given: either both OTAs adopt PPCs, or they both leave prices unconstrained. The latter solution is Pareto dominant, and we assume that OTAs coordinate on unconstrained pricing. As a consequence, hotels choose to multi-home and OTAs obtain  $\pi_i^{NS}$ .

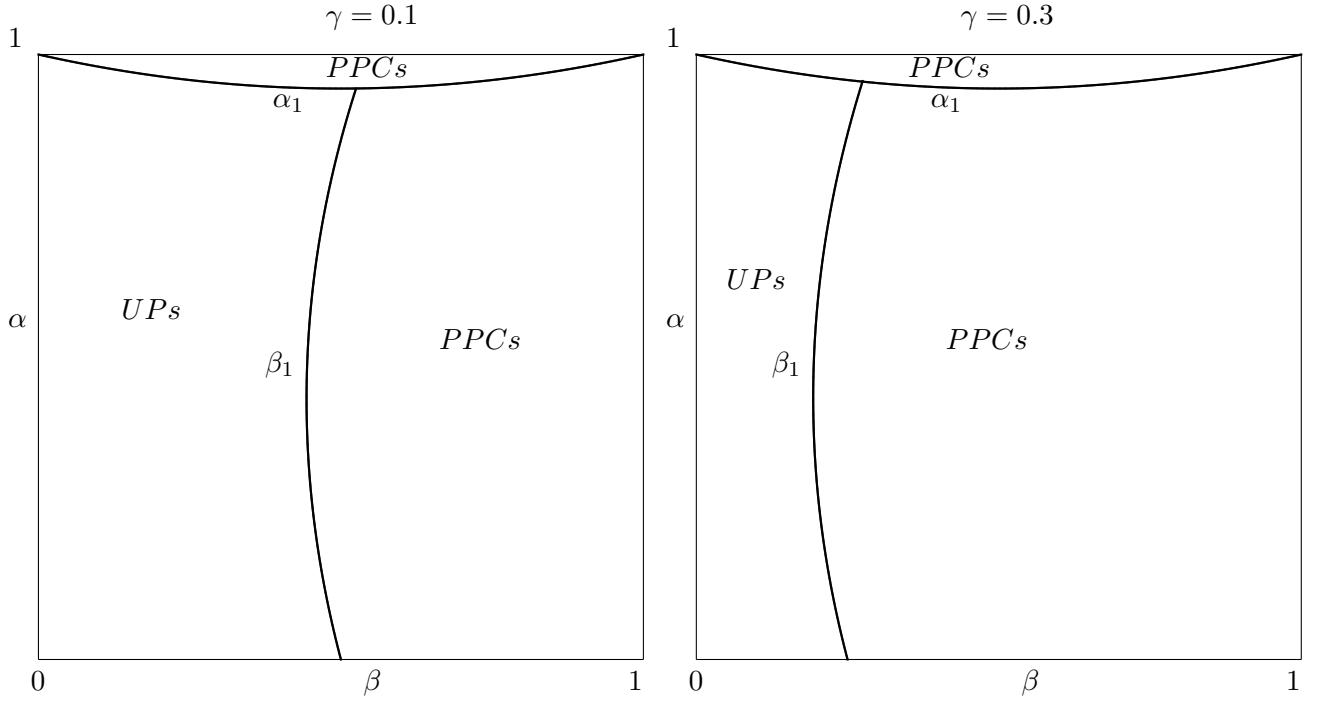
The proof of Proposition 4 and the specific threshold values for the parameters of interest are provided in Appendix A. Figure 2 graphically represent the case in which  $\gamma \leq \gamma_1$  for both the case of  $\gamma = 0.1$  (left panel) and  $\gamma = 0.3$  (right panel). The threshold value  $\beta_1$  decreases in  $\gamma$ , 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.

*In primis*, Proposition 4 shows that OTAs obviously decide to use PPCs when showrooming is sufficiently relevant. Interestingly, PPCs are also adopted in the absence of showrooming. Indeed, for low values of  $\gamma$  (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 ( $\beta > \beta_1$ ) and/or when hotels compete very aggressively as they are almost perfect substitutes ( $\alpha > \alpha_1$ ). The two cases deserve separate attention.

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<sup>19</sup>This is also due to one of the main assumptions of our model, *i.e.*, that showrooming disappears when OTAs apply PPCs. However, our main results do not change if we remove this assumption, as we will specify in Section 6.

**Figure 2: The OTAs' decision**



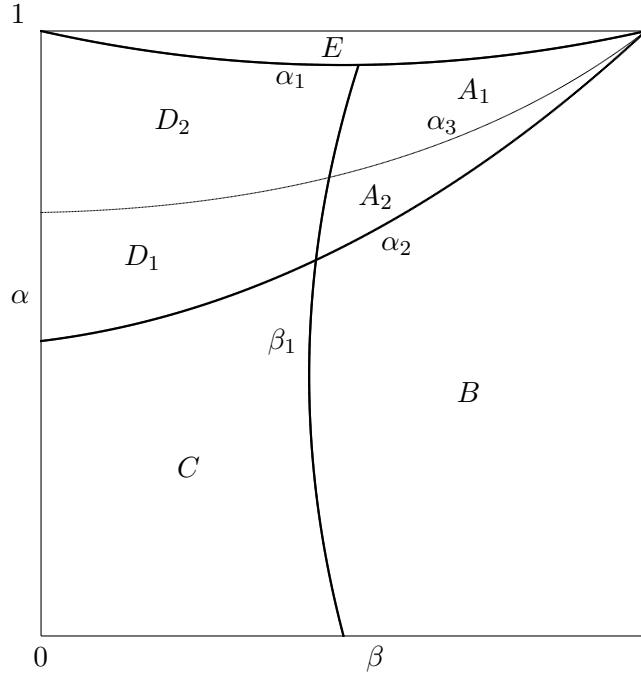
On the one hand, when *inter-brand* substitution is very strong ( $\alpha > \alpha_1$ ), OTAs prefer to apply PPCs. Segmentation would occur in any case, as hotels decide to single-home even in the absence of PPCs. Since the commission fee is always the same under segmentation ( $f^{S**} = f^{S*} = f^S$ ), it is then clear that OTAs gain by adopting PPCs as they can eliminate showrooming without sacrificing demand. In fact,  $\pi_i^{S*} = \pi_i^{S**} > \pi_i^S = \pi_h^{S**} = (1 - \gamma)\pi_i^{S*}$ , as we know from the previous analysis.

On the other hand, when both  $\gamma$  and  $\alpha$  are sufficiently low ( $\gamma \leq \gamma_1$  and  $\alpha \leq \alpha_1$ ), the OTAs face a trade-off. 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 refrain from adopting PPCs, hotels multi-home and more rooms are available in the platforms, but some consumers buy directly from the hotels. OTAs may then decide to tolerate a certain degree of showrooming in exchange for the larger number of bookings they receive when all hotels are listed on both OTAs. In such a case, however, the commission fee is lower than with PPCs ( $f^{NS} < f^S = f^{S*}$ ), and it decreases in  $\beta$ . Taking this into account, when the degree of *intra-brand* substitutability becomes sufficiently strong ( $\beta > \beta_1$ ), OTAs prefer to impose PPCs, as this does not only eliminates showrooming, but it also allows them to charge a commission fee ( $f^{S*}$ ) that is independent of  $\beta$ . OTAs gain as the tariff difference ( $f^{S*} - f^{NS}$ ) increases in  $\beta$ , but they sacrifice quantity, since hotels respond by single-homing. Clearly, the higher the initial level of the showrooming problem, the lower the value of  $\beta_1$  above which PPCs are adopted, as one can see in Figure 2.

## 5 The economic effects of price parity clauses

Armed with this equilibrium characterization regarding the OTAs' pricing strategies, and the hotels' response to such strategies, we can now analyze the economic effects of imposing PPCs, and their possible removal thereof. In particular, we focus on the consequences for hotels and consumers. For ease of exposition, we consider the case in which  $\gamma \leq \gamma_1$  and use Figure 3 to graphically identify the areas of interest. When  $\gamma$  increases, we already know that threshold value  $\beta_1$  tends to diminish until it becomes negative when  $\gamma > \gamma_1$ . This implies that Areas  $C$  and  $D$  shrink when showrooming becomes progressively more relevant (until they disappear when  $\gamma > \gamma_1$ ), whereas areas  $A$  and  $B$  expand. Area  $E$ , on the contrary, does not depend on  $\gamma$ .

**Figure 3: The economic effects of PPCs**



Let us examine the different areas. We start with  $A$  and  $B$ , where  $\beta > \beta_1$  and  $\alpha \in (\alpha_2, \alpha_1)$  and  $\alpha \in (0, \alpha_2)$ , respectively. In these regions, OTAs apply PPCs. As a result, hotels choose to single-home (Prop. 2) in order to pay a lower commission fee, even though they reduce the number of active sales channels. In area  $A$ , hotels would have opted for multi-homing in the absence of price restrictions, ending up in a prisoner's dilemma when as  $\pi_j^{NS} < \pi_j^S$  when  $\alpha > \alpha_2$  (Prop. 1). This dilemma is not completely solved by PPCs, as hotels obtain  $\pi_j^{S^*}$  instead of  $\pi_j^S$ . However,  $\pi_j^{S^*} \geq \pi_j^{NS}$  when  $\alpha \geq \alpha_3$ , and therefore they benefit from the segmentation equilibrium induced by PPCs in subregion  $A_1$ .<sup>20</sup> Hotels are perceived as extremely similar, and by single-homing they can increase the price margin on the platform, without necessarily losing

<sup>20</sup>Moreover, there exists an area where  $\pi_j^{S^*} > \pi_j^S$ , and the imposition of PPCs enables hotels to reach the highest payoff. We will provide more comments while investigating area  $E$ . For the sake of completion, the precise ranking of the involved profits is as follows: (i) when  $\alpha \in (0, \alpha_2]$ :  $\pi_j^{S^*} < \pi_j^S \leq \pi_j^{NS}$ ; (ii) when  $\alpha \in (\alpha_2, \alpha_3]$ :  $\pi_j^{S^*} \leq \pi_j^{NS} < \pi_j^S$ ; (iii) when  $\alpha \in (\alpha_3, \alpha_4]$ :  $\pi_j^{NS} < \pi_j^{S^*} \leq \pi_j^S$ ; (iv) when  $\alpha \in (\alpha_4, 0)$ :  $\pi_j^{NS} < \pi_j^S < \pi_j^{S^*}$ . The threshold value  $\alpha_4$  is not reported in Figure 3, but we found that  $\alpha_4 \in (\alpha_3, \alpha_1)$ .

demand in comparison to multi-homing. The opposite holds in subregion  $A_2$  and also in region  $B$ , where hotels end up losing profits by the price restrictions imposed by OTAs:  $\pi_j^{S^*} < \pi_j^{NS}$ . This is due to the fact that commission fees increase under PPCs and hotels lose their freedom to price discriminate in a parametric region in which they are sufficiently differentiated to afford competing in multiple platforms. Regarding consumers, they are always penalized by the imposition of PPCs, given that platform prices increase ( $p^{S^*} = p_P^S > p_P^{NS} > p_D^{NS}$ ) following the surge in the commission fees ( $t^{S^*} = t^S > t^{NS}$ ). Moreover, showrooming disappears. Hence, both those consumers who would have booked through the platform, and those who would have used the hotel's direct channel, end up losing out with PPCs. Specifically, direct prices increase more than platform prices.

Consider now areas  $C$  and  $D$ , which are characterized by the fact that OTAs refrain from adopting PPCs and hotels respond by listing on both platforms (Prop. 1). In area  $C$ , the interests of OTAs and hotels coincide, and the same occurs also in area  $D_1$ , as  $\alpha < \alpha_3$  ensures that  $\pi_j^{NS} > \pi_j^{S^*}$ . In these parametric regions hotels are still trapped in a prisoner's dilemma, but their profits are still higher than those of segmentation caused by PPCs. The situation differs in region  $D_2$ , in which  $\pi_j^{S^*} > \pi_j^{NS}$  (as  $\alpha \geq \alpha_3$ ). In this region, OTAs leave prices unconstrained, but hotels would have benefitted from the segmentation induced by PPCs. However, it is not in the interest of OTAs to attract only one hotel, given that showrooming is not very relevant, and their platforms are sufficiently differentiated to afford more than one seller. Regarding consumers, as OTAs refrain from adopting PPCs, they are better-off than in the presence of such restrictive clauses.

Finally, we focus on area  $E$ , where  $\alpha > \alpha_1$ . Here hotels would single-home with or without PPCs (Prop. 1-3). Even in the absence of price restrictions, they realize that their degree of substitutability is so high that multi-homing would be detrimental by squeezing the profit margin on each platform. However, OTAs adopt PPCs to avoid showrooming, and this turns out to be profit-enhancing for the hotels as well, given that  $\pi_j^{S^*} > \pi_j^S$  when  $\alpha$  is high. This result seems counterintuitive, given that the price margin is not affected by the OTAs' contractual arrangement ( $p^{S^*} - t^{S^*} = p^S - t^S$ ), and that without PPCs hotels can also sell directly. However, the profit margin of direct selling sharply decreases in  $\alpha$  when the degree of hotel substitutability is particularly high. Under unconstrained prices, showrooming diverts a fraction of consumers from the OTA to the direct channel, which is not very profitable for hotels due to their extremely high degree of substitutability. As a consequence, hotels are better off with PPCs, as they avoid showrooming and can set higher retail prices on selected OTA. Turning to consumers, although platform prices do not change ( $p^{S^*} = p_P^S$ ), the elimination of showrooming brought by PPCs damages those consumers who would have by-passed the platform (they end up paying  $p^{S^*} > p_D^{NS}$ ).

The previous discussion can be summarized in the following proposition.

**Proposition 5.** *The adoption of PPCs unambiguously damages consumers, whereas the potential gains for hotels are confined to cases in which their degree of substitutability is very high.*

Regarding the consequence in terms of the hotels' listing decisions, our analysis reveals that the adoption of PPCs crucially affects the decision of hotels to single-home, thereby reducing

the competitive pressure in the platform. Hence, the removal of these contractual agreements would allow hotels to multi-home, thereby driving down platform prices because of a drop in the commission fee. Moreover, hotels would also be able to sell directly for a cheaper price to those consumers willing to give up the services provided by the OTA.

To sum up, our analysis reveals that, in most of the cases, prohibiting PPCs favours multi-homing, thus reducing the commission fees charged by OTAs. This allows hotels to increase their profits while at the same time charging a lower price both on the platform and in the direct channel, thereby benefitting consumers as well.

## 6 Discussion of our assumptions

The analysis carried out in this paper rests on some assumptions that may cast some doubts on the validity of our results in a more general context. The purpose of this section is therefore to demonstrate that our main findings continue to hold when we remove some of these assumptions. We provide a brief description of each relevant robustness check that we carried out, and refer the reader to Appendix B for additional mathematical details.

We considered the case in which OTAs are necessary for hotels to inform consumers about their existence, and assumed that a fraction  $\gamma$  of clients book their rooms directly from the hotel when prices across sales channels are different. Alternatively, we could have interpreted parameter  $\gamma$  as the fraction of consumers that buy directly because they are already informed about the hotel. This, however, does not modify our findings, as it is relatively easy to show that the potential choice of not contracting any OTA is always dominated, independently of  $\gamma$ . Hence, our interpretation of  $\gamma$  renders the analysis less dispersive as it enables us to focus on the hotels' decision between single-homing and multi-homing.

We also assumed that showrooming totally disappears when OTAs adopt PPCs ( $\gamma = 0$ ). When removing this assumption, we demonstrate in the appendix that all our main results still hold, although it becomes extremely cumbersome to find specific threshold values for the parameters of interest. The only significant change is given by the fact that the commission fees under PPCs are higher than before, and increasing in  $\gamma$ . This also implies that OTAs do not charge the same fees under segmentation across the different scenarios (for instance, we find that  $f^{S^*} > f^S$ ). As showrooming remains constant under PPCs, OTAs penalize hotels in proportion to the fraction of consumers that by-pass the platform. However, for sufficiently high values of  $\gamma$ , not only the price margin (and eventually also the equilibrium profits in case of segmentation) but also equilibrium quantities for the case of partial segmentation may become negative, thereby imposing an upper bound to parameter  $\gamma$ . To sum up, although we may lose something in terms of richness of results especially for the commission fees, assuming  $\gamma = 0$  under PPCs allows us to dramatically simplify the calculations for the cases in which at least one OTA applies these price restrictions.

## 7 Conclusions

The aim of this paper was to investigate the effect of price restrictions on the decision of suppliers to single-home and use only one platform or to multi-home and list their products on more than one platform. In particular, we have formally studied the impact of PPCs on market segmentation and final prices for end customers by taking as a reference the vertical relations between hotels and OTAs. We have considered 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 was to determine under which conditions the imposition of PPCs by the 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 react to this situation 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 was to investigate the economic effects of the use of the 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. This situation may have relevant consequences on the quality of the service offered by hotels and the relative consumption of this service. Our findings are consistent with the recent empirical research analyzing the effects of the abolition of 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 a increase in multi-homing by hotels. However, our paper does not simply provide a theoretical underpinning of their empirical results, given that we uncover interesting situations 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 prices.

The policy prescriptions of our model rest on some modelling assumptions. We have assumed that OTAs allow hotels to reach consumers that otherwise would have not known about their existence. Other interpretations are still plausible and do not change our results, as we argued in the discussion of our main assumptions. We have also assumed that showrooming disappears in the presence of price parity clauses, and that the commission fee paid by the hotels to the platforms is a simple per-unit commission fee. We have relaxed these assumptions and demonstrated that our main findings still hold.

In our model, the commission fee paid by the hotels to the platforms is a simple per-unit commission fee. This assumption drastically simplifies our computations and is consistent with the main theory of harm put forward by antitrust authorities in several recent cases. However, since in practice platforms often impose revenue-sharing rules on suppliers, we could extend our analysis by considering a commission that corresponds to a fraction of the revenues. Another extension that it may be worth undertaking concerns relaxing the assumption that the platforms are symmetric. By doing so, the distinction between wide and narrow PPCs becomes relevant

and we could study how the switch from wide to narrow price parities affects prices, commission fees, and consequently social welfare. We leave this and other interesting extensions for future research.

## Appendix A

**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 profits function in equation (2) and deriving with respect to  $p_{ij}$  and  $p_{Dj}$  we obtain:

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

In stage 3, taking into account the previous prices and that hotels are listed in the two platforms, the OTAs choose commission fees to maximize profits in equation (4). This yields  $f^{NS} = \frac{1-\beta}{2-\beta}$ . By substituting into prices and then into hotels' and platforms' profits, we obtain the equilibrium values reported in Lemma 1. Equilibrium quantities are:

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

and they are both increasing in  $\alpha$  when  $\alpha > 1/2$ , as it can be easily ascertained.

**Proof of Lemma 2.** When hotels are listed in 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 profits 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:

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

In stage 3, platforms choose commission fees to maximize equation (5), yielding  $f^S = \frac{(1-\alpha\beta)(2+\alpha\beta)}{4-\alpha\beta(1+2\alpha\beta)}$ . Substituting  $f^S$  into the retail prices and then into the profit functions, we obtain the equilibrium values which appear in Lemma 2.

**Proof of Lemma 3.** Suppose hotel  $j$  is active in both platforms  $i$  and  $h$ , while hotel  $k$  is active only in platform  $h$ . Also recall that a fraction of consumers  $\gamma$  can directly reserve their rooms from the hotels' sales channel. The hotels' demand functions are therefore given by:

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

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

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

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 equilibrium profits, which are written in a compact form as:

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

where

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

**Proof of Lemma 4.** Hotels are listed in both platforms and, in stage 4, set their price 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 profits and deriving with respect to  $p_j$ , we obtain

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

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 these prices and commission fees in hotels' and platforms' profits, we get the results in Lemma 4.

**Proof of Lemma 5.** Hotels are listed in 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 the above quantities into the 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  $f^{S^*} = \frac{(1-\alpha\beta)(2+\alpha\beta)}{4-\alpha\beta(1+2\alpha\beta)}$ . Then, equilibrium prices are  $p_j^{S^*}$ , and by substituting these prices and commission fees in the hotels' and platforms' profits, we get the results in Lemma 5. Equilibrium quantities are given by:

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

**Proof of Lemma 6** Suppose that supplier  $j$  is active in both platforms, while supplier  $k$  is active only in one. In stage 4, hotels set the prices, considering the demands:

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

Substituting the above quantities into the profits and deriving with respect to  $p_j$  and  $p_k$ , we obtain:

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

In stage 3, platforms choose commission fees to maximize their profits. They are reported in Lemma 3, together with equilibrium prices.

We substitute the equilibrium prices and commission fees respectively in the hotels' and

platforms' profits, and obtain:

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

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 Lemma 7.** Under the partial application of price parity clauses, OTA  $i$  adopts PPCs, while OTA  $h$  does not. If suppliers decide to be listed in 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  $\gamma$  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 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 7. 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:

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

**Partial Segmentation under Partial Application of Price Parity Clauses.** We analyze the case in which hotel  $j$  is listed on both OTAs, while hotel  $k$  is active only in one OTA. Their demand functions are:

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

Moreover, we assume that hotel  $k$  is listed on the OTA (OTA  $h$ ) that does not impose PPCs. In this case, hotel  $j$  sets the same price in all channels  $p_{ij} = p_{hj}$ , and it gives up the direct sales channel. On the contrary, hotel  $k$  can set a different price on its sales channels, i.e.  $p_{hk} \neq p_{Dk}$ , and a fraction of consumers  $\gamma$  will book from its direct channel if the price is lower. Hotels' 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 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:

$$\begin{aligned} f_{ij}^{PS^{**}} &= \frac{1}{(1 - \alpha)^2 \Gamma} \cdot \{8 - \alpha^2(5 - 3\beta)[\gamma(1 - \alpha)(8 - \alpha)(11 + \alpha - \alpha^3(3 - \beta)(1 - \beta) - 9\beta](1 + \alpha^2\beta) \\ &\quad + \alpha(1 + \beta)(\gamma + t\alpha^2\beta)^2 - 2(1 - \alpha)^2[4 - 4\alpha^2(1 - \beta) + \alpha^2(1 - \beta)^2 + 2\alpha(1 + \beta)(1 + \alpha^2\beta)]\}, \\ f_{hj}^{PS^{**}} &= \frac{1 - \gamma}{\Gamma} \cdot \{64 - 40\alpha(1 + \beta) + \alpha\gamma[16 - 4\alpha - \alpha^2(11 - 2\alpha(1 - \beta) - 5\beta](1 + \beta)(1 + \alpha^2\beta) \\ &\quad + \alpha[67\alpha + 16\alpha^2(5 - \beta)(1 - \beta) - 64(2 - \beta) - 16\alpha^3(1 - \beta)^2 + 54\beta - 13\beta^3 - \alpha^2(27 - 13\beta)]\}, \\ f_{hk}^{PS^{**}} &= \frac{\gamma}{\Gamma} \cdot \{(1 + \alpha^2\beta)[48 - 8\alpha - 32\alpha^2(2 - \beta) + 8\alpha^2(1 - \beta) - 2\alpha^4(1 - \beta)^2 + \alpha^3(3 - \beta)(7 - 5\beta)] \\ &\quad + 2(1 - \alpha)^2[24 + 8\alpha - 29\alpha^2 + 19\alpha^2\beta - 8\alpha^3(1 - \beta) + 9\alpha^4 + 2\alpha^5(1 - \beta)^2 - \alpha^2\beta(11 - 4\beta)]\}, \end{aligned}$$

where

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

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.

**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, and it is partially driven by the assumptions of our model (we suppose that PPCs eliminate showrooming), which are nonetheless motivated by the real case scenario that we analyze.

Consider the case in which  $\alpha \in (0, \alpha_1)$ . If both OTAs adopt PPCs, suppliers decide to single-home and platforms' profits are  $\pi_i^{S*}$ , as we know from Lemma 5. In contrast, if both OTAs allow hotels to set different prices in their sales channels (unconstrained pricing), no segmentation occurs and platforms' profits are  $\pi_i^{NS}$ , as we know from Lemma 1. When only one OTA adopts PPCs, it obtains  $\pi_i^{S**} = \pi_i^{S*}$ , leaving to the rival  $\pi_h^{S**} = (1-\gamma)\pi_i^{S**}$ , as from Lemma 7. 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  $\pi_i^{NS}$ , or applying PPCs, which results in  $\pi_i^{S**}$ . By comparing these profits, we find that  $\pi_i^{S**} > \pi_i^{NS}$  if  $\beta$  and/or  $\gamma$  are sufficiently small. The threshold value of  $\gamma$  is reported in the main text as it is relatively easy to write, whereas that of  $\beta$  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  $\pi_i^{NS} > \pi_i^{S**}$ .

Let us examine the case in which  $\alpha \in [\alpha_1, 1)$ . In this interval, hotels always prefer to single-home. If both OTAs adopt PPCs, platforms' profits are equal to  $\pi_i^{S*}$ , as from Lemma 5. In contrast, if both OTAs refrain from using PPCs, their profit amount to  $\pi_i^S$ , as from Lemma 2. Notice that  $\pi_i^S = (1-\gamma)\pi_i^{S*}$ ; the commission rate does not change in presence of segmentation, but OTAs suffers from showrooming when PPCs are not applied. 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 OTAs 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.

## Appendix B

**PPCs do not eliminate showrooming.** Consider the situation in which the adoption of PPCs does not eliminate showrooming. The benchmark case of unrestricted pricing is obviously unaffected and we focus on what changes for the case of full and partial adoption of PPCs.

**Price Parity Clauses.** When both hotels multi-home (no segmentation), equilibrium prices do not change ( $\widehat{p^{NS^*}} = p^{NS^*}$ ) but the (symmetric) commission fee increases with respect to the baseline model in which PPCs eliminate showrooming:

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

As a consequence, price margins diminish, and remain positive only when  $\gamma$  is not too high, given that  $\widehat{f^{NS^*}}$  is increasing in  $\gamma$ . However, hotels now also sell through their direct channels at the unique price  $\widehat{p^{NS^*}}$ . Equilibrium profits for hotels and OTAs under no segmentation are always positive and are respectively given by:

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

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, and that showrooming is not eliminated by PPCs, thereby reducing OTAs profits. In comparison to the benchmark case of unrestricted prices and no segmentation, the loss for hotels when OTAs adopt PPCs is obviously bigger, whereas OTAs still gain for sufficiently high values of  $\beta$ , as in Subsection 3.2.

When both hotels single-home (segmentation), symmetric equilibrium prices and commission fees are respectively given by:

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

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

where:

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

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:

$$\widehat{\pi}_j^{S^*} = \gamma \widehat{p}^{S^*} \cdot \widehat{q}_{Dj}^{S^*} + (1 - \gamma)(\widehat{p}^{S^*} - \widehat{f}^{S^*}) \cdot \widehat{q}_{Pj}^{S^*}, \quad \widehat{\pi}_i^{S^*} = (1 - \gamma)\widehat{f}^{S^*} \cdot \widehat{q}_{Pj}^{S^*},$$

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, it is immediate to notice that  $\widehat{f}^{S^*} \neq f^S$  (and therefore also  $\widehat{p}^{S^*} \neq p_P^S$ ): fees and prices are not the same as in Lemma 2. In particular,  $\widehat{f}^{S^*} > f^S$ , meaning that the commission fee increases with respect to the case of unrestricted prices. With respect to the scenario of no segmentation analyzed above, we obtain that  $\widehat{f}^{S^*} < \widehat{f}^{NS^*}$  only when  $\gamma$  is sufficiently low. However, we also obtain that  $\widehat{\pi}_j^{S^*}$  is positive for relatively low values of  $\gamma$ , and therefore it is possible to show that for the parametric region in which  $\widehat{\pi}_j^{S^*} > 0$  then  $\widehat{f}^{S^*} < \widehat{f}^{NS^*}$  (for all the cases in which  $\widehat{\pi}_j^{S^*} < 0$ , hotels would obviously prefer to multi-home, provided they all multi-home, as  $\widehat{\pi}_j^{NS^*} > 0$  for every admissible value of  $\gamma$ ). Turning to OTAs, we find that their profits are increasing in  $\gamma$ , because the commission fee increases in such a parameter, and it is higher than in case of no segmentation. They gain with respect to no segmentation when  $\beta$  is sufficiently high, and this is more likely to happen when  $\gamma$  increases.

In case of partial segmentation, under the assumption that hotel  $j$  is listed on both OTAs, whereas hotel  $k$  is only active in OTA  $h$ , the equilibrium expressions for commission fees, prices, and equilibrium profits for hotels and OTAs become even more cumbersome than in the previous case, and for this reason they are not reported here (they are available upon request). However, it is possible to demonstrate that  $\widehat{f}_{ij}^{PS^*} > \max\{\widehat{f}_{hk}^{PS}, \widehat{f}_{hj}^{PS}\}$ , and that  $(\widehat{p}_j^{PS^*} - \widehat{f}_{ij}^{PS^*}) < \max\{(\widehat{p}_j^{PS^*} - \widehat{f}_{kj}^{PS^*}), (\widehat{p}_k^{PS^*} - \widehat{f}_{kh}^{PS^*})\}$ . This confirms that the multi-homing hotel pays the highest fee in the OTA where it is the only seller, and it receives the lowest price margin when selling through it. However, its equilibrium quantities in such OTA are negative for relatively high values of  $\gamma$ , and this imposes an additional condition on this parameter. When respecting this condition (*i.e.*, for relatively low values of  $\gamma$ ) we confirm that equilibrium profits are positive, with  $\widehat{\pi}_j^{NS^*} < \widehat{\pi}_k^{NS^*}$ .

We now consider the hotels' decision regarding single-homing vs. multi-homing. Although algebraically complex, we are able to confirm that single-homing is always preferred when the rival does the same, *i.e.*,  $\widehat{\pi}_j^{S^*} > \widehat{\pi}_j^{PS^*}$ , and that single-homing prevails when the rival multi-homes, *i.e.*,  $\widehat{\pi}_k^{PS^*} > \widehat{\pi}_j^{NS^*}$ . Finally, we find that  $\widehat{\pi}_j^{S^*} > \widehat{\pi}_j^{NS^*}$  for relatively low values of  $\gamma$ , which

are compatible with the condition of non-negativity for equilibrium quantities in the partial segmentation scenarios. To sum up, when both OTAs adopt PPCs, there is a unique Nash equilibrium in which hotels decide to single-home and this decision is Pareto optimal. The underlying explanations for these profit comparisons are mostly the same as in Subsection 3.2., and therefore we verify that the results of Proposition 2 hold in this more general framework.

**Partial application of Price Parity Clauses.** When only OTA  $i$  applies PPCs to its client hotels and both hotels decide to multi-home, equilibrium prices, commission fees, and industry profits (hotels and OTAs) are exactly the same as those obtained with no segmentation when both OTAs apply PPCs. We refer to the previous scenario for the equilibrium expressions.

Consider now the case of segmentation in which, without loss of generality, hotel  $j$  is listed in OTA  $i$ , which applies PPCs. This hotel now sells both directly and through OTA  $i$  but must charge a unique price, whereas hotel  $k$  sets two different prices, one in OTA  $h$  and the other for those consumers who prefer to buy directly. The equilibrium expressions for commission fees, prices, and industry profits are again extremely long, and are available upon request. We find that  $\widehat{f_i^{S^{**}}} > \widehat{f_k^{S^{**}}}$ , and therefore the OTA that imposes PPCs charges a higher fee than the rival. Moreover, our analysis reveals that  $\widehat{p_{D_k}^{S^{**}}} < \widehat{p_j^{S^{**}}} < \widehat{p_{P_k}^{S^{**}}}$ . This represents a novelty in comparison to Subsection 3.3, and confirms that equilibrium fees and prices now change when both hotels single-home, depending on the price restrictions imposed by at least one OTA. Regarding equilibrium fees, for example, we obtain that  $\widehat{f_i^{S^{**}}} > \widehat{f^{S^*}} > f^S$  and  $\widehat{f_k^{S^{**}}} < f^S < \widehat{f^{S^*}}$ . It is then evident that the OTA that does not impose PPCs ends up losing with respect to the rival, and this clearly explains that no OTA would refrain from using these price restrictions when the other does it. As per hotels, it is straightforward to demonstrate that  $\widehat{\pi_k^{S^{**}}} > \widehat{\pi_j^{S^{**}}}$ , as in Subsection 3.3, but the result is also driven by the difference in the commission fees.

In case of partial segmentation, we still consider case in which hotel  $j$  is listed in both OTAs, while hotel  $k$  is active only in one OTA. As before, we assume that OTA  $h$  does not apply PPCs, while OTA  $i$  does. As we already know, under partial segmentation, we have to distinguish between two cases: (i) hotel  $k$  is listed on OTA  $h$  (that does not impose PPCs); (ii) hotel  $k$  is listed on OTA  $i$  (that adopts PPCs). We solve both cases, whose equilibrium expressions are very long and do not provide additional insights to our analysis.

Finally, we compare hotels' equilibrium profits in the three scenarios and confirm that single-homing is the unique Nash equilibrium of the subgame, and that it is Pareto dominant for sufficiently low values of  $\gamma$ , which are compatible with the non-negativity of the main equilibrium expressions. As a consequence, also the results of Proposition 3 continue to hold.

**The OTAs' contractual arrangements and the economic effects of PPCs.** We start by considering the case in which  $\alpha < \alpha_1$ , which is characterized by the fact that hotels multi-home when OTAs leave prices unconstrained. We verify that the adoption of price restrictions is a dominant strategy for both platforms when  $\gamma$  is relatively high, although it cannot overcome a certain threshold value that guarantees the non-negativity of equilibrium quantities in some of the scenarios investigated above. For lower values of  $\gamma$ , then we need a relatively high value of

$\beta$  for the same result to occur, otherwise we obtain a coordination game in which there are two Nash equilibria in the principal diagonal: either both OTAs adopt PPCs, or they both leave prices unconstrained. However, we find that the latter equilibrium is Pareto dominant in this region of  $\gamma$ , and assume that both OTAs coordinate on not imposing price restrictions.

The second case that we evaluate takes into account  $\alpha \in (\alpha_1, 1)$ , and it differs from the previous one in that hotels prefer to single-home in absence of PPCs, as we know from Proposition 1. We find that OTAs always prefer to use PPCs. Even if showrooming cannot be eliminated, the adoption of these price restrictions enables OTAs to charge higher fees, as we highlighted on the previous discussion.

We then confirm that there exists a unique Nash equilibrium in which both OTAs adopt PPCs for sufficiently high values of  $\alpha$  and/or  $\gamma$ , although we must respect the conditions on  $\gamma$  for the equilibrium expressions to be economically meaningful. For lower values of  $\alpha$  and/or  $\gamma$ , this equilibrium still holds for relatively high values of  $\beta$ . Moreover, the decision of both OTAs to apply these price restrictions is Pareto dominant for values of  $\gamma$  that do not exceed the conditions on such parameter. Moreover, we demonstrate that there are two Nash equilibria for lower values of  $\alpha$  and/or  $\gamma$ , provided  $\beta$  is not too high, and we prove that OTAs coordinate on unconstrained pricing, which is Pareto dominant.

To sum up, the results of Proposition 4 continue to hold, even if it is not possible to identify clear threshold values for the parameters at stake as we have to resort to numerical simulations. This also implies that we cannot provide a precise representation of the different areas that we used in Figure 3 to represent the economic effects of imposing PPCs, and their removal thereof. However, our previous analysis and additional calculations that we carried out reveal that the also the findings of Proposition 5 extend to the case in which PPCs do not eliminate showrooming.

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