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PLATFORM PRICE PARITY CLAUSES AND CONSUMER OBFUSCATION

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Platform Price Parity Clauses and Consumer Obfuscation*

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Abstract

Several antitrust authorities have investigated platform price parity clauses around the world. I analyze the impact of these clauses when platforms design a search environment for sellers and buyers to interact. In a model where platforms choose the unitary search cost faced by consumers, I show when it is profitable for platforms to obfuscate consumers through high search costs. Then, I show that price parity clauses, when exogenously given, can increase or reduce obfuscation, prices, and consumer surplus. Finally, when price parity clauses are endogenous, they are only observed in equilibrium if they hurt consumers.

Keywords: platforms, obfuscation, consumer search, price parity clauses.

JEL Classifications: D83, L42, L81.

1. Introduction

In many online markets, platforms act as marketplaces in which sellers offer their products to consumers. For example, firms sell products through Amazon and eBay, software developers display their applications at Apple's App Store and Google

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Play, people offer accommodations using Airbnb, and hotels offer rooms through online travel agents. In order to create a marketplace, these platforms define a set of rules regulating trade between consumers and sellers. These rules include fees charged to sellers and buyers, shipping and returning policies, liability rules, privacy requirements, among others. Platforms also design an environment in which consumers and sellers interact. For example, they design how information about products is shown to consumers, the order in which sellers are displayed, the location of advertised products, and so forth. All of these decisions are linked to each other, and in this article, I investigate the interaction between two of them, namely whether to impose price parity clauses (PPCs) and the design of a search environment for consumers to browse product's relevant information. The main focus of this analysis is to understand better the implications of PPCs on platform competition and consumer welfare.

Platform price parity clauses are restrictions imposed by platforms under which sellers cannot charge a lower price or offer better conditions on their alternative distribution channels. These clauses were investigated and challenged by regulators and antitrust authorities worldwide under the argument that they reduce competition between platforms, leading to higher fees charged to sellers and higher prices to consumers. For example, if Amazon imposes a PPC, it would be difficult for a rival platform, such as eBay, to induce lower prices in their marketplaces because Amazon's PPC would prohibit sellers present in both platforms to charge a lower price on eBay. In consequence, platform competition is softened, and equilibrium prices are higher. For this reason, these clauses were banned in several countries, such as Austria, Belgium, France, and Italy, and some platforms have removed them in response to these investigations. The most relevant antitrust investigations included Expedia and Booking.com[1], Amazon[2] and Apple's e-books market.[3]

The use of these clauses comes from an important characteristic of these platforms, which is that sellers set final prices to consumers in what is called the agency model.[4] As sellers control final prices, platforms would use these clauses to prevent opportunistic behavior by consumers and sellers, in which consumers use the platform to choose their preferred products and then buy them at alternative distribution channels at a lower price. At the same time, many of these platforms

[1]In 2015, several European authorities forced Expedia and Booking to remove some of their PPCs.

[2]Amazon removed these clauses in Europe after Antitrust investigations in the U.K. and Germany.

[3]The U.S. Department of Justice contested Apple's switch to the agency model in conjunction with PPCs after Apple entered the e-books market in 2010. For more details, see Foros, Kind, and Shaffer (2017).

[4]Several papers during the last few years have investigated why platforms use this business model. See for example, Johnson (2017) and Hagiu and Wright (2015).

typically charge ad-valorem fees to sellers, meaning that platforms' revenues are proportional to sellers' revenues.[5] Therefore, platforms have incentives to influence prices charged by sellers to maximize their own profits. One way to do so is through the design of the environment in which consumers search for different sellers' products' information. By making it easier or harder to search for information, platforms can influence the degree of seller competition and consequently affect the prices they charge in equilibrium. For example, by increasing consumers' search costs -by obfuscating consumers- platforms reduce the number of firms sampled by these consumers, softening seller competition and increasing equilibrium prices. The cost of doing so is the loss of sales due to these higher prices and reduced search.

Even though platforms can influence prices in different ways, I consider search design and obfuscation due to the widespread use of these practices in online markets.[6] The main reason why considering search design affects the analysis of price parity clauses is the following. Suppose there are two platforms, A and B, and A decides to make search more complicated in its marketplace, increasing the search cost faced by consumers. In response, sellers have incentives to increase prices on that platform. However, if PPCs are in place, sellers internalize that they must also increase their price in platform B, which is not optimal. Overall, sellers increase their prices in both platforms, but the price increase in platform A is lower than it would be in the absence of PPCs. This "reduced pass-through" effect decreases platforms' incentives to increase their search costs to induce higher prices. This effect goes in the opposite direction of the standard theory of harm, whereby price parity clauses make platforms' demand inelastic with respect to prices, increasing their incentives to implement higher sellers' prices. This article's main focus is to study this trade-off and analyze how incentives to set price parity clauses are affected by it.

There are several examples of how platforms obfuscate consumers in online markets. Concealing product information or making it hard to find, making the comparison between products complicated, increasing the number of clicks needed to find relevant information, increasing screen loading times, advertising cheap and low-quality products, and then steering consumers to other products, among others. An interesting example is adding non-relevant firms or products to the list shown to consumers when they search or adding firms that pay to appear in prominent positions, even if they are not the most relevant for consumers.[7] Another example

[5]The most important platforms investigated due to their price parity clauses use ad-valorem fees, including Amazon, Apple, Booking, Expedia, and other online travel agents.

[6]Other ways to influence sellers' competition include the auctioning of prominent positions in the platform's search engine (Athey and Ellison, 2011 and Chen and He, 2011), advertising products, or selling their own products while competing with independent sellers.

[7]See Mamadehussene (2020), Eliaz and Spiegler (2011).

that has attracted the interest of researchers and regulators is the use of partitioned and drip pricing,[8] under which the total price is divided into several subcategories, such as shipping fees, service fees, or credit card surcharges. For example, some platforms use drip pricing relative to some of the fees they charge to consumers. In fact, Airbnb[9] in Europe and Viagogo in the U.K. have faced regulatory pressure regarding the use of this practice. Platforms may also allow sellers to use drip pricing, which I also interpret as a form of obfuscation, as platforms could design an environment where drip pricing is not possible, thus reducing obfuscation. A case that brought the regulators' attention in the United States is the use of "resort fees" by hotels when posting their rooms in online travel agents. These are per-room and per-night mandatory fees charged by some hotels and are usually disclosed separately from the room rate. Sullivan (2017) argues that these separate resort fees are "*likely to harm consumers by increasing the search costs and cognitive costs of finding and choosing hotel accommodations*".[10] In this article, I interpret obfuscation as increased search costs for rational consumers, and I do not consider the effects of obfuscation practices arising from consumers' behavioral biases. Johnen and Somogyi (2021) study shrouding by platforms with naive consumers, in a closely related article. Other articles interpreting obfuscation as increased search costs (for non-platform firms) are Ellison and Wolitsky (2012), Wilson (2010), and Petrikaite (2018).

To investigate the implications of PPCs in this context, I develop a theoretical model in which two horizontally differentiated platforms create marketplaces for consumers and sellers to interact. While a relevant part of the price parity clauses literature focuses on sellers' direct channels, I focus on platform competition and assume that sellers do not have direct channels.[11] These platforms charge an exogenously given ad-valorem fee to sellers, they design a search environment

[8]Drip pricing is a particular case of partitioned pricing under which the different categories composing the price are shown after in the search process.

[9]Airbnb committed to present the total price of bookings, including service and cleaning charges, increasing the transparency in its marketplace. See https://ec.europa.eu/commission/presscorner/detail/en/IP_18_5809

[10]See "Economic analysis of hotel resort fees" by Mary Sullivan from the Federal Trade Commission, January 2017. Quote from Executive Summary p36.

[11]In fact, there are two types PPCs, called wide and narrow PPCs. Under wide PPCs, sellers cannot charge a lower price in any other channel, such as other platforms and their direct channel, while narrow PPCs restrict sellers only relative to their direct channel. This distinction is not relevant for this model as there is no direct channel and the focus is on platform competition. In the conclusions section, I discuss the potential impact of this assumption in the model.

for consumers, and must decide whether to impose PPCs or not.[12] The search environment, which can be more or less complicated, is represented by the unitary search cost faced by consumers, which the platform can choose at no cost.

A large number of horizontally differentiated sellers join both platforms as long as they make non-negative profits. Consumers are uninformed about each seller's price and their specific valuation for that sellers' product and must search randomly and sequentially, as in Wolinsky (1986). Consumers observe each platforms' search cost and have rational expectations about equilibrium prices before deciding which platform to join. Therefore, if a platform induces higher prices through higher search costs, it loses demand due to the higher expected prices and also directly due to the higher search cost. I characterize the symmetric bottleneck equilibrium in which all sellers are active in both platforms in order to reach as many consumers as possible while consumers join and search only from their preferred platform. This kind of "bottleneck" equilibrium is representative of many of these markets, as platforms are differentiated on the consumers' side and homogeneous on the sellers' side, as discussed by Armstrong and Wright (2007).

The main results of the model are as follows. First, in the benchmark case without PPCs, I show that platforms have incentives to obfuscate consumers by increasing unitary search costs, provided that the degree of platform competition is not too strong. By doing so, platforms reduce seller competition, inducing a higher equilibrium price charged to consumers while losing relatively little demand due to the weak level of platform competition. Then, platforms extract part of these higher prices through the ad-valorem fee. This result in itself extends the literature of obfuscation by platforms and intermediaries.

Second, I analyze the case when PPCs are exogenously given on both platforms. I show that equilibrium search costs and prices in each platform may be higher or lower as a result of these clauses. The intuition of this result is the following. The well-known criticism of PPCs is that they restrict platform competition. As consumers expect the same price in both platforms, platforms' demands become inelastic with respect to expected equilibrium prices, in what I denote as the "inelastic demand" effect. Therefore, platforms can induce higher prices, thereby hurting consumers. However, I show that PPCs reduce the ability of a platform to influence

[12] For example, Apple has used a fixed ad-valorem fee of 30% for all sellers in every market they serve for many years, and just recently, they decided to decrease it to 15% for small sellers due to regulatory pressure. Moreover, after the removal of PPCs in the online travel agents market in several countries in Europe, the European Commission found that these fees did not change after the removal of these restrictions. See "Report on the monitoring exercise carried out in the online hotel booking sector by E.U. competition authorities in 2016", written by the Belgian, Czech, French, German, Hungarian, Irish, Italian, Dutch, Swedish and U.K. national competition authorities and D.G. Competition. Available at https://ec.europa.eu/competition/ecn/hotel_monitoring_report_en.pdf.

sellers' prices, as these clauses make sellers internalize that a price increase must also occur on the other platform. This reduced pass-through effect reduces the incentives of platforms to increase prices through higher obfuscation. Which effect dominates depends on the curvature of the consumers' distribution of match values, as this shape influences the relative importance of both effects in equilibrium. This result provides a new mechanism under which PPCs could lower prices and benefit consumers when PPCs are exogenously imposed.

Finally, I extend the model by allowing platforms to choose whether to impose PPCs or not. In the game's unique equilibrium, I show that either both platforms set PPCs or neither platform does. When the curvature of the distribution of match values is such that PPCs lead to higher obfuscation and prices, meaning the inelastic demand effect dominates, imposing a PPC is a (weakly) dominant strategy for both platforms. This high price equilibrium, relative to the case without PPCs, is easily sustained by each platform PPC. If the rival would deviate by not imposing a PPC and implementing lower prices, the first platform PPC would still bind for every seller in the market, making this deviation never profitable. Therefore, when PPCs are observed in the endogenous game, it is always the case where they lead to higher prices, a result that supports regulatory bans on these restrictions.

However, I also show that, in the unique equilibrium of the game, platforms may decide not to impose PPCs. This happens when the curvature of the distribution is such that PPCs lead to lower obfuscation and prices due to the pass-through effect dominating the demand effect. Starting from this relatively high price equilibrium, in comparison to the case with PPCs, platforms do not have incentives to impose PPCs. If a platform sets a PPC to implement even higher prices, the reduced pass-through effect is too strong, and this deviation would hurt that platform. If a platform sets a PPC to implement lower prices, this PPC would not be binding, therefore not restricting sellers in practice because prices in that platform would be lower than in the rival platform. Hence, this deviation is not profitable either. Overall, this result provides an explanation why in many markets, PPCs are not observed, even if they have been argued to benefit platforms.

Literature review

This article contributes to different strands of economic literature:

Platform price parity clauses: Wang and Wright (2020) study a model where platforms offer lower (exogenous) search costs to consumers than direct channels. Therefore, it may be optimal for consumers to search on the platform and then switch and buy from sellers' direct channels at lower prices (showrooming). They show that PPCs often harm consumers unless platforms become not viable. While their focus is on the relationship between PPCs and sellers' direct distribution channels, my work focuses on platforms' search design and PPCs and their implications on platform competition.

Johansen and Vergé (2017) study an environment with secret contracts between platforms and sellers, in which sellers' listing decisions might limit platforms' ability to raise fees. In this model, when PPCs are imposed, platforms cannot excessively increase their fees because sellers might stop selling on that platform. They show that PPCs might benefit platforms, suppliers, and consumers when interbrand competition is sufficiently strong. In contrast, I assume that platforms' fees are publicly displayed. Edelman and Wright (2015) study "price coherence" in a model where platforms can invest in benefits to consumers. They show that price coherence leads to higher retail prices, excessive intermediary adoption, and over-investment in benefits to buyers. These effects generate a reduction in consumer surplus and sometimes in total welfare.

Boik and Corts (2016), on their part, find that prices are always higher under PPCs, but it might be that this effect is so strong that even platforms are worse in equilibrium. Calzada, Manna, and Mantovani (2021) focus on the online travel agents market and analyze segmentation issues. Hotels can choose to delist from a platform and sell directly through their own distribution channels. In their model, online travel agents set PPCs when showrooming is intense or when substitutability between them is high. When PPCs are imposed, hotels choose to single-home and sell their products only in one online travel agent. The main differences between these papers and mine are that I focus on a setting with no direct channel and where platforms indirectly affect competition through an additional competitive variable, and that I use a fixed ad-valorem fee instead of a linear fee. Johnson (2017) and Foros, Jarle Kind, and Shaffer (2017) study the impact of PPCs in the decision of upstream and downstream firms to adopt the agency model. Their focus is mainly related to the effects of the agency model on final prices and welfare relative to the traditional wholesale model and when this model is adopted.

Obfuscation in oligopolies: This paper is also related to the literature on obfuscation, mainly through search models in non-platform firms. For example, Petrikaite (2018) studies how a multi-product monopolist may find it optimal to increase the search cost for one of its products. Ellison and Wolitzky (2012) and Wilson (2010), under different search models, also show conditions under which obfuscation is profitable by an oligopolist.[13]

[13] Teh (2020) studies a more general framework of platforms' choice of non-price variables where a variable that increases seller competition and consumers' valuation, as a lower search cost does in my model, is one of the specific cases. While his interest is on the different possible fee structures, he obtains a similar obfuscation result for a monopoly platform. I extend the notion of obfuscation in a search design environment to two competing platforms.

Obfuscation practices have also been studied relative to consumers' naiveté and biases when making decisions. For example, Huck and Wallace (2015) show, through experimental evidence, that the way prices are shown or "framed" may have detrimental effects on consumers' search process. In this experiment, just by adding two clicks to find out the total price of the product, consumers end up paying higher prices, and their consumer surplus is reduced by 22%.[14] More recently, Blake et al. (2021), through a large field experiment, show how drip pricing makes comparison difficult for consumers, increasing the price they pay on StubHub.com.

Obfuscation by intermediaries: Johnen and Somogyi (2021) study how platforms can shroud or unshroud additional fees to naive consumers. By shrouding additional fees, naive consumers wrongly believe that products are cheap, increasing their perceived surplus. However, sophisticated consumers incur in costly efforts to avoid such fees. The authors show that cross-group externalities increase the incentives to shroud, because higher perceived surplus by buyers bring more buyers to the platform, which in turn bring more sellers, and so on. Casner (2020) studies platforms' decision to admit some low-quality sellers and the relationship between this form of obfuscation and the platform's recommendation system. The obfuscation trade-off is similar, but he focuses on incentives from low-quality firms to imitate high-quality sellers and the platform's recommendation system's profitability. Relatedly, Eliaz and Spiegler (2011) explain how a search engine chooses a pool of sellers to show when a consumer submits a query, and the engine's revenue is on a per-click basis. They also find that it may be optimal for the engine to contaminate the search pool with non-relevant firms for consumers.

Hagiu and Jullien (2011, 2014) study the incentives of an information intermediary that collects per-click fees to divert search. The intermediary has superior information about that match between a consumer and a firm. They derive conditions under which the intermediary guides the consumer to search their less preferred firm first. Teh and Wright (2018) also consider a case where an intermediary has higher information on the match between consumers and firms. However, its revenue comes from sellers paying a commission conditional on consumers purchasing the product. The intermediary provides a ranking of firms for consumers. In equilibrium, even if the recommendation is not distorted, competition between sellers

[14]There is an extensive body of empirical research reaching similar results. For example, Hossain and Morgan (2006) use data from eBay and show that increasing the shipping fee relative to the base price increases the number of bidders and the revenue for firms selling through this website. Also, Brown et al. (2010) conduct a field experiment using the Yahoo Taiwan and the eBay Ireland platforms and find that increasing shipping fees can boost revenues if these fees are shrouded. A relevant example is the case of taxes that are sometimes shown separately and later on in the purchasing process. Chetty et al. (2009) show, while studying the salience of taxes in a supermarket, that taxes included in posted prices have more significant effects on consumer demand than the ones added at the register in the end. Greenleaf et al. (2016) provide a survey of this literature.

to offer higher commissions to the intermediary increases final prices, and consumer surplus is lower.[15]

The rest of the article is organized as follows. In Section 2, I describe the model, its main assumptions and derive some preliminary results already studied in the search literature. In Section 3, I analyze the platforms' optimal decisions when PPCs are not imposed. Then, in section 4, I analyze the platforms' decisions when PPCs are exogenously imposed and when PPCs are an endogenous decision variable for each platform. Finally, in Section 5, I conclude.

2. The model

Consider a market where a continuum of consumers has unit demand for a single good produced by a continuum of sellers. I normalize the measures of both consumers and sellers to one. Consumers and sellers can only interact through two competing platforms acting as marketplaces, called A and B, meaning that their outside option is equal to zero.

Consumers. The value of a seller's product is idiosyncratic to consumers, and they must engage in a costly search process to learn both this match value and the price of a given seller. The surplus of buying from seller j, net of search costs, is $\epsilon_{ij} - p_{jk}$, where ϵ_{ij} is the match utility of consumer i derived from seller j (the same in both platforms) and p_{jk} is the price of seller j on platform $k \in \{A, B\}$. The distribution of ϵ_{ij} is independent across consumers and sellers and has a smooth, positive everywhere and log-concave density function g on the interval $[0, \overline{v}]$, with cumulative distribution function G.

Each time consumers sample a seller in platform k, they face a search cost s_k, which they observe before joining that platform.[16] These search costs represent the cost of time spent or the cognitive effort involved in sampling a given seller. After searching a seller, consumers learn the price and their valuation for that product, represented by a random draw of the distribution g. Consumers' search process is with perfect recall and no replacement, meaning they can always come back to a previously sampled firm and purchase that product. Once consumers buy a product, they leave the market. I assume the search process is random, meaning that sellers are sampled in no particular order. Consumers hold passive beliefs about

[15] Other papers focusing on obfuscation by intermediaries that give recommendations to consumers are Inderst and Ottaviani (2012a, 2012b), Murooka (2013), and de Cornière and Taylor (2019). Our work extends and complements this literature by showing how obfuscation, through increased search costs, might be optimal in the agency model.

[16] If consumers anticipate instead of observing the search costs, then platforms would deviate by increasing the search costs once consumers have joined their marketplace, leading to a Diamond paradox like equilibrium with maximum search costs.

equilibrium prices when observing a price deviation from the equilibrium path.[17]

Consumers also have a heterogeneous fixed cost of joining each platform denoted by t_A and t_B. I assume that half of the consumers have $t_A = 0$ and t_B distributed uniformly on $[0, t]$, while the other half has $t_B = 0$ and t_A following the same distribution. This assumption represents a situation where half of the consumers are familiar with one of the platforms and face a fixed cost if they decide to join the other platform and vice versa. The fixed cost may represent the cost of learning how to use the platform, creating an account, linking payment methods, etc. Therefore, the parameter t is a measure of platform differentiation or market power because a higher value of t makes consumers, on average, more reluctant to visit one of the platforms.

Platforms. The platforms are horizontally differentiated and mediate transactions at zero cost. They have two decision variables. First, they design a search environment characterized by the unitary search cost s_k faced by consumers when searching for sellers in their marketplaces. There is a minimum and exogenous level of search cost $\underline{s}$ that can be chosen by the platforms, meaning that even if they create the simplest search environment possible, consumers still face a small cost to sample each seller.[18] Second, they decide whether to impose a PPC or not. If they set a PPC, sellers joining that platform cannot charge a lower price on the other platform. On top of these two decision variables, each platform charges a publicly displayed, symmetric, and exogenously given ad-valorem fee τ to all sellers, defined as a percentage of the price charged by sellers to consumers.

Sellers. The sellers are horizontally differentiated and produce at zero marginal cost. Horizontal differentiation comes from the fact that each consumer obtains a different draw from the distribution of match values when visiting each seller, but there are no systematic advantages for any sellers' product. Sellers join both platforms and simultaneously set prices after observing the unitary search costs s_k, the price parity policy set by both platforms, and the level of the exogenous ad-valorem fee τ.

Equilibrium concept: I focus on a symmetric Perfect Bayesian Equilibrium in which sellers join both platforms and consumers search and buy in only one, usually referred to as a bottleneck equilibrium. If consumers single-home, sellers have incentives to join both platforms to access as many consumers as possible. If sellers multi-home, consumers will only join and search on their preferred platform as they can find every product in that marketplace. I disregard less interesting

[17]This means that observing a price deviation from a seller does not change consumers' expectations about prices charged by unsampled sellers.

[18]The model could be solved ignoring this assumption. The main insights would not be affected. This assumption helps to make exposition simpler by ignoring the case where search costs are negligible, and the model becomes the one studied by Perloff and Salop (1985).

equilibria where only one or none of the platforms is active because of pessimistic expectations on both sides of the market.[19]

Timing: at stage 1, platforms simultaneously design their search environment by choosing s_k and decide whether to impose a PPC or not. At stage 2, sellers observe the platforms' choices, join both platforms, and simultaneously set prices. Finally, at stage 3, consumers choose which platform to join, and they randomly search for their preferred product.

Preliminaries

In this section, I briefly recapitulate some known results from the search literature that are instrumental in understanding the analysis that follows. The derivation of all of the following results are found in Wolinsky (1986) and Anderson and Renault (1999).

Consumers' behavior: consumers' behavior is characterized by whether they decide to participate in a platform, and which platform to join, along with their search and purchasing behavior once they are on a platform.

Once on a platform, as is known from Kohn and Shavell (1974) and Weitzman (1979), optimal consumer search is characterized by a stationary stopping rule, based on a constant reservation value that I denote as a, that depends on the search cost s. This reservation value a is given by the unique solution to

$$\int_{a}^{\overline{v}} (x - a)dG(x) = s. \tag{1}$$

Every time consumers sample a seller, say seller j, it is optimal for them to stop and purchase that product if $\epsilon_{ij} - p_j > a - p^*$, where p^* is the expected equilibrium price of the other sellers. If they purchase the product, they leave the market. If not, they go on and sample the next seller and follow the same decision rule. Equation (1) derives the reservation value a such that the incremental benefit of one additional search is equal to the unitary search cost. Given that there is a continuum of sellers in each platform, consumers never return and buy from a previously sampled seller and never switch platforms.

Before joining either platform, consumers decide whether to participate in the market and which platform to join. This decision is based on consumers' expected consumer surplus of joining each platform k, which is a function of their reservation

[19] For example, if consumers expect no sellers to join a given platform, they will not join and search in that platform. At the same time, sellers will not join that platform because they expect no consumers searching in that marketplace.

values, and is given by

$$\phi_k = \underbrace{\frac{\int_{a_k}^{\overline{v}} x dG(x)}{1-G(a_k)}}_{\text{Expected match value}} - \underbrace{\frac{s_k}{1-G(a_k)}}_{\text{Expected search cost}} - \underbrace{(p_k^*(s_k)+t_k)}_{\text{Expected price and fixed cost}} . \quad (2)$$

This expression is derived as follows. Given that there is a continuum of sellers in each platform, consumers eventually find a suitable product. Therefore, their expected match value, given their myopic search rule, is $\mathbb{E}[\epsilon_{ij}|\epsilon_{ij} \geq a_k]$. With respect to the expected search costs, in a symmetric price equilibrium, a consumer stops and buys in a given seller with probability $1-G(a_k)$, and keeps searching with probability $G(a_k)$. Therefore, the expected search cost is given by $\sum_{l=0}^{\infty} G^l(a_k)s_k = \frac{s_k}{1-G(a_k)}$.[20]

After some manipulations, (2) can be rewritten only as a function of a_k. Integrating by parts the first term and using (1), equation (2) can be rewritten as

$$\phi_k = a_k(s_k) - p_k^*(s_k) - t_k, \quad (3)$$

where we observe that the difference between the expected match value and the expected search cost simplify to a_k. Consumers join the platform yielding the highest expected consumer surplus based on the observed search cost, expected prices, and idiosyncratic fixed cost, as long as this value is non-negative.

Sellers' pricing: Denote D_k as the number of consumers joining platform k, or platform k's demand. This value is fixed from a seller's perspective, as consumers make participation decisions based on observed search costs and expected equilibrium prices. A given seller's demand in platform k, is derived as follows. In a symmetric price equilibrium between sellers, the probability of a consumer buying from any given sampled seller is $1 - G(a_k)$. Therefore, the expected number of consumers sampling any seller in their second search round is $G(a_k)D_k$, in their third search round is $G^2(a_k)D_k$, and so on.[21] Now, suppose seller j deviates from the symmetric equilibrium. A consumer sampling seller j buys its product if and only if $\epsilon_{ij} - p_{jk} \geq a_k - p_k^*$, where p_k^* is the equilibrium price in platform k. Therefore, seller j's demand in platform k is given by

$$\sum_{l=0}^{\infty}[G^l(a)][1 - G(p_{jk} + a_k - p_k^*)]D_k = \frac{1 - G(p_{jk} + a_k - p_k^*)}{1 - G(a_k)} D_k. \quad (4)$$

[20] The probability of searching one time is $1 - G(a_k)$, two times is $G(a_k)(1 - G(a_k))$, three times is $G^2(a_k)(1 - G(a_k))$, and so forth. Summing these terms to infinity is equal to $\sum_{l=0}^{\infty} G^l(a_k)s_k = \frac{s_k}{1-G(a_k)}$.

[21] In the first round, each seller is sampled by D_k consumers, given the normalization of the number of sellers and consumers.

Therefore, seller j's profit function is given by

$$\Pi_j = \Pi_{jA} + \Pi_{jB}, \tag{5}$$

where

$$\Pi_{jk} = (1-\tau)p_{jk}\frac{[1-G(p_{jk}+a_k-p_k^*)]}{1-G(a_k)}D_k, \tag{6}$$

is the seller's profit in platform k. In absence of PPCs, the price that every seller sets in each platform is independent of each other, as the price set in one platform does not affect the seller's demand on the other platform. Taking the first-order conditions for a symmetric price equilibrium in each platform leads to

$$p_k^* = \frac{1-G(a_k)}{g(a_k)}. \tag{7}$$

For given reservation values a_k, this is the unique symmetric price equilibrium of the sellers' pricing stage in platform k for a given a_k, under the assumption that g is log-concave.

Define $\lambda(a) \equiv \frac{1-G(a)}{g(a)}$ as the Mills ratio of the distribution g. Therefore, the equilibrium price in platform k is equal to $\lambda(a_k)$. Given that g is log-concave, the equilibrium price is decreasing in a_k or, equivalently, increasing in s_k. The intuition is that a higher search cost makes consumers more reluctant to search more products, meaning it is optimal for them to search less, or having a lower reservation value. Thus, consumers are willing to accept worse match values and, on average, their search process leads to them finding worse products. Given that consumers search less and compare fewer sellers, they can charge higher prices, explaining why a higher search cost leads to a higher equilibrium price. Overall, consumers expected consumer surplus is lower.

3. Consumer obfuscation

In this section, I characterize the symmetric bottleneck equilibrium of the game in the benchmark case where platforms cannot impose PPCs. I explain why and when platforms obfuscate in equilibrium, meaning that they design a search environment with a unitary search cost higher than the minimum exogenous level $\underline{s}$. For technical simplicity, given the inverse and one-to-one relationship between s_k and a_k, I characterize the search environment design decision from stage 1 of the game as the platforms' choice of reservation values.

To start the analysis, I describe the platforms' feasible set for reservation values. Define $\underline{a}$ as the unique value of a such that $\underline{a} = \lambda(\underline{a})$.[22] Given the expression for

[22]It is unique due to the log-concavity of the distribution of match values.

the expected consumer surplus, $\phi(a_k) = a_k - \lambda_k(a_k) - t_k$, and given that $a_k - \lambda_k(a_k)$ is strictly increasing in a_k, any a_k lower than $\underline{a}$ would leave consumers with negative expected consumer surplus, even if their fixed cost is 0. Therefore, platforms never set a reservation value $a_k < \underline{a}$. Also, the minimum search cost $\underline{s}$ generates a maximum possible reservation value $\overline{a}$, given by equation (1) evaluated at $\underline{s}$. Hence, platforms' feasible set for reservation values is $[\underline{a}, \overline{a}]$. This set is non-empty as long as the value of $\underline{s}$ is not too high.

To ensure the existence and uniqueness of the symmetric bottleneck equilibrium, I make the following assumption:

Assumption 1: The Mills ratio $\lambda(a)$ is log-concave, meaning that $\lambda(a)\lambda''(a) - \lambda'^2(a) \leq 0, \quad \forall a \in [\underline{a}, \overline{a}]$.

This assumption means that the Mills ratio is not too convex in the relevant support for the platforms' choice of reservation values. This assumption is satisfied by any distribution with constant curvature, such as the Generalized Pareto Distribution (GPD). It also holds the Power Function distribution and some parametrizations of the Beta distribution. Moreover, I provide a result in the Appendix (see Lemma 2), showing that right-hand truncations of log-concave distribution functions generate log-concave Mills ratios, as long as the truncation point is not too high, therefore satisfying assumption 1.

To derive platforms' demands, note that consumers expect the continuum of sellers to be active in each platform, so they rationally anticipate that joining a platform will lead to a purchase with probability one in that platform. Therefore, they will join platform A, rather than platform B, if and only if $\phi_A(a_A) \geq \phi_B(a_B)$ or, equivalently, if $(a_A - p_A^* - t_A \geq a_B - p_B^* - t_B)$. Consider first the case where $a_A \geq a_B$. Then, all consumers that have $t_A = 0$ go to platform A. Consumers with $t_B = 0$ also buy from A as long as $(t_A \leq a_A - a_B + p_B^* - p_A^*)$. Therefore platform A's demand is equal to[23]

$$D_A(a_A, a_B) = \frac{1}{2} + \frac{a_A - a_B}{2t} + \frac{p_B^*(a_B) - p_A^*(a_A)}{2t}. \tag{8}$$

The same expression is obtained for D_A when $a_B > a_A$. Therefore, D_A is given by expression (8). The demand for platform B is derived following the same steps.

The reservation value a_A has two effects on demand, analogous to its effects on expected consumer surplus. First, it affects the expected match value, net of

[23]We have

$$D_A(a_A|a_A \geq a_B) = \underbrace{\frac{1}{2}}_{\text{Consumers with } t_A = 0} + \underbrace{\frac{1}{2}\Pr(t_A \leq a_A - a_B + p_B^* - p_A^*)}_{\text{Consumers with } t_B = 0},$$

search costs, that consumers find in a given platform. Second, it affects the equilibrium price in that platform. Both effects go in the same direction, meaning that an increase in a_A strictly increases platform A's demand (and strictly decreases platform B's demand). The fact that increasing obfuscation decreases consumers' participation in a platform is consistent with some empirical evidence showing that consumers value transparency. Seim et al. (2017) show that price transparency increases consumers' demand in the driving schools market in Portugal. Ershov (2021) shows that reductions in consumers' discovery costs in the Android app store increase downloads and sales.[24]

At $t = 1$, a given platform's maximization problem, say platform A, is given by

$$\max_{a_A} \Pi_A(a_A, a_B) = \tau p_A^*(a_A) D_A(a_A, a_B). \tag{9}$$

The first-order condition with respect to a_A is given by

$$\frac{\partial p_A^*}{\partial a_A} D_A + \frac{(1 - \frac{\partial p_A^*}{\partial a_A})}{2t} p_A^* = 0. \tag{10}$$

Remembering that $p_A^*(a) = \lambda(a)$, the symmetric equilibrium reservation value a^* implicitly solves

$$\lambda(a^*) = -\frac{t\lambda'(a^*)}{(1 - \lambda'(a^*))}. \tag{11}$$

The following proposition characterizes the unique symmetric bottleneck equilibrium of the game:

Proposition 1. *Suppose assumption 1 holds. Then, for any $t > 0$, there exists a unique symmetric bottleneck equilibrium. Moreover, there exist values $\underline{t}$ and $\bar{t}$, with $\underline{t} < \bar{t}$, such that the equilibrium reservation value (search cost) is given by*

- *If $t < \underline{t}$, then $a^* = \bar{a}$. (corner solution)*
- *If $\underline{t} \leq t \leq \bar{t}$, then $a^* \in [\underline{a}, \bar{a}]$, given by the solution of (11). (interior solution)*
- *If $\bar{t} < t$, then $a^* = \underline{a}$. (corner solution)*

The equilibrium reservation value is weakly decreasing in t and the equilibrium search cost is weakly increasing in t (strictly if the solution is interior).

Proof. See Appendix. □

Proposition 1 shows how obfuscation can be a useful tool to increase sellers' prices and therefore profits for platforms. The main economic trade-off highlighted

[24] Also, Totzek and Jurgensen (2021) find that drip pricing lowers consumers' perceived price fairness, and find that drip pricing increases attention to total price, increasing consumers focus on the perceived loss of a transaction and decreasing attention to product characteristics. As a conclusion they recommend firms to have an early total price disclosure.

by proposition 1 is as follows. If a platform decreases its reservation value, or equivalently, increases its search cost, competition between sellers is reduced, and the equilibrium price increases, while part of this price increase is captured through the ad-valorem fee. The cost of doing so is a loss of demand due to this higher price and also due to a lower expected consumer surplus because of lower match values. When differentiation between platforms is not too low, the equilibrium reservation value is lower than $\overline{a}$, and the equilibrium search cost is higher than $\underline{s}$, a result that I interpret as platform obfuscation.

In this symmetric bottleneck equilibrium, all consumers join the platform where they face zero fixed cost. Therefore, consumer surplus is proportional to the equilibrium reservation value, as a higher reservation value lowers the equilibrium price and increases the match value that consumers obtain on average. Thus, increased competition between platforms, given by a lower value of t, increases consumer surplus. Platforms profits, on the contrary, decrease if t is lower, and so do sellers' profits. Overall, platform competition is effective in reducing platforms' obfuscation practices and it benefits consumers.

As discussed before, an example of platforms' obfuscation behavior is the use of "resort fees" when hotels post their offers through online travel agents (OTAs). The result of Proposition 1 suggests that OTAs are obfuscating consumers to reduce competition between hotels and increase the price they charge to consumers, which in turn increases the OTAs' revenues collected through the ad-valorem fee. This result also suggests that the level of competition between OTAs would not be strong enough to eliminate this obfuscation practice.

It is important to discuss two important characteristics of the equilibrium. First, there is no showrooming between platforms. This would happen if one platform would set a lower search cost, but have higher prices. Then, consumers could potentially search in the platform with lower search frictions and then switch and buy from the other platform at a cheaper price. However, as the search design environment is the variable influencing equilibrium prices, and a lower search cost leads to a lower equilibrium price, consumers never switch platforms. Second, in the symmetric equilibrium, sellers never delist from one platform. The potential for delisting is important in other models of PPCs in the literature. However, as I use an ad-valorem fee and sellers do not have fixed costs, they do not delist from either platform as they cannot improve their profits in one platform by delisting from the other.[25]

Finally, I discuss the effect of the curvature of the match value distribution in

[25] Usually, the reason to delist is that different per-transaction fees used in other models affect sellers marginal cost. Therefore, a seller by delisting from a high fee firm decreases its marginal cost and can improve its profits in the other platform.

the model. For this purpose, I provide an example by assuming that the distribution of match values follows a Generalized Pareto Distribution (GPD), with a density function given by $g(x,\xi) = (1+\xi x)^{-(1+\xi)/\xi}$ and a cumulative distribution function given by $G(x,\xi) = 1-(1+\xi x)^{-1/\xi}$. This distribution has a linear Mills ratio equal to $\lambda(x,\xi) = 1+\xi x$. The log-concavity assumption on the distribution of match values g implies that $\xi < 0$, meaning that the Mills ratio is strictly decreasing in x.

Example 1. *If the distribution of match values follows a GPD with parameter* $\xi < 0$*, the equilibrium reservation value in an interior solution is given by*

$$a^* = \frac{\xi(1-t)-1}{\xi(1-\xi)}. \tag{12}$$

The equilibrium reservation value is increasing in ξ *in the interval* $[\underline{a}, \overline{a}]$*. Moreover,* $\underline{t} = -\frac{(1+\xi\overline{a})(1-\xi)}{\xi}$ *and* $\overline{t} = -\frac{(1+\xi\underline{a})(1-\xi)}{\xi}$*.*

The intuition is that if the curvature of the Mills ratio, given by the value of ξ, becomes smaller in absolute value, the price equilibrium in the sellers' stage is less responsive to changes in reservation values by platforms. This lower pass-through from search costs to the equilibrium prices set by sellers decreases the incentives of platforms to induce higher prices through lower reservation values (through higher obfuscation). I explain additional implications of the curvature of the distribution of match values in the next section, where I compare the result of Proposition 1 with the case where the platforms set price parity clauses.

4. Price parity clauses

This section analyzes the effects of price parity clauses on the platforms' design of a search environment and equilibrium prices. I characterize the case where price parity clauses are exogenously imposed in both platforms to understand their effects on consumer behavior, sellers' pricing, and platforms' obfuscation strategies. Then, I extend the model to allow platforms to decide whether to impose such clauses or not, allowing us to understand platforms' incentives to impose those restrictions.

Exogenous price parity clauses: Suppose first that PPCs are exogenously imposed by both platforms. In the new symmetric bottleneck equilibrium, two effects arise that influence platforms' search design decisions. First, sellers must set the same price on both platforms. Therefore, platforms' demands become independent of the equilibrium price charged by sellers. This means that demands become less elastic with respect to changes in reservation values (search costs). This demand effect decreases the level of competition between platforms and increases platforms' incentives to implement higher equilibrium prices through higher obfuscation. Second, the equilibrium price sensitivity with respect to the reservation values (search costs) is lower. This reduced pass-through effect reduces platforms' incentives to increase prices through higher obfuscation.

In this section, I explain these two effects and show how the curvature of the match values' distribution determines which one of these opposite effects dominates in equilibrium. The main result of this section is that when price parity clauses are exogenously set by both platforms, they can lead to higher or lower prices and obfuscation.

To understand the demand effect, note that consumers' participation decision and search behavior once they join a platform is the same as when PPCs are not imposed. The only difference is that they expect the same price on both platforms. Therefore, platform A's demand is given by

$$D_A(a_A) = \frac{1}{2} + \frac{a_A - a_B}{2t}. \tag{13}$$

Platform's B demand is derived analogously. Platforms' demands become less elastic to changes in reservation values, as they are now independent of the uniform equilibrium price, reducing platform competition and increasing incentives to obfuscate. However, note that demands are not completely inelastic to changes in the search environment, as reservation values also affects search behavior and expected match values.

To understand the pass-through effect, consider the sellers' new maximization problem. A given seller j's profit function is now given by

$$\Pi_j = (1-\tau)p_j \left[D_A \frac{1 - G(a_A + p_j - p_p^*)}{1 - G(a_A)} + D_B \frac{1 - G(a_B + p_j - p_p^*)}{1 - G(a_B)} \right], \tag{14}$$

where p_p^* is the symmetric price equilibrium in both platforms and p_j is the uniform price set by seller j. The profit function is the same as the one derived in section 2, but now sellers must charge the same price on both platforms. The following result characterizes the unique equilibrium of the sellers sub-game at $t = 2$, for given values of a_A, a_B, when price parity clauses are exogenously imposed on both platforms:

Lemma 1. *Suppose price parity clauses are exogenously imposed on both platforms. Then, for given a_A and a_B, if $\underline{s}$ is not too small, the unique symmetric price equilibrium in the sellers' stage is given by sellers charging*

$$p_p^* = \frac{\lambda(a_A)\lambda(a_B)}{D_B\lambda(a_A) + D_A\lambda(a_B)} \tag{15}$$

in both platforms. The equilibrium price is strictly decreasing in a_A and a_B (strictly *increasing in s_A and s_B). Moreover, if $a_A > a_B$:*

$$p_A^* < p_p^* < p_B^*, \tag{16}$$

where p_A^* and p_B^* are the equilibrium prices in platforms A and B when PPCs are not imposed. Finally, if $a_A = a_B$:

$$p_A^* = p_B^* = p_p^*. \tag{17}$$

Proof. See Appendix. □

The equilibrium price now depends on both platforms' reservation values, as it is a composition of the equilibrium prices in both platforms in the absence of PPCs. The reservation values' effect on the uniform equilibrium price is twofold. First, there is a composition effect, under which a platform setting a higher reservation value than its rival attracts more consumers, and therefore, becomes more important for sellers. Second, there is a competition effect, under which a higher reservation value, equivalent to a lower search cost, increases the degree of seller competition. Both effects go in the same direction, meaning that a higher reservation value on a given platform increases sellers' competition and makes that platform more important for sellers relative to the other platform, implying the uniform equilibrium price is lower.[26]

The equilibrium price in Lemma 1 allows us to understand how the pass-through from reservation values to the equilibrium price is affected when PPCs are in place. Around a symmetric equilibrium, the pass-through from the reservation value of either platform to the equilibrium price is given by

$$\frac{\partial p_p^*}{a_k}(a_A = a_B) = \frac{\lambda'}{2}, \tag{18}$$

while in the case with no PPCs, the pass-through from reservation values to the equilibrium price in a platform is λ'. As the pass-through rate from a platform's reservation value to the equilibrium price is now lower, the platform has lower incentives to implement higher prices through high obfuscation (lower reservation value), as the increase in obfuscation needed to raise prices is higher, which lowers consumer's expected match values and therefore their demand for the platform.

The intuition for this reduced pass-through is that, when a platform decreases its reservation value, sellers now internalize that if they increase their price, they must also increase their price on the other platform. Therefore, this price increase is lower, and the corresponding pass-through rate is also lower. The reduced-pass through effect is new in the price parity literature and arises when studying a variable that

[26]The assumption that $\underline{s}$ is not too small is needed to ensure that the sellers' profit functions are quasiconcave. More details in the Appendix.

can affect competition between sellers, such as obfuscation. This effect reduces incentives to obfuscate and goes in the opposite direction of the standard inelastic demand effect.

Next, I characterize the platforms' optimal strategies regarding their search design. At $t = 1$, platform A maximizes

$$\max_{a_A} \Pi_A(a_A, a_B) = p_p^*(a_A, a_B) D_A(a_A, a_B), \tag{19}$$

with respect to a_A. The first-order condition is given by

$$\frac{\partial p_p^*}{\partial a_A} D_A + \frac{p_p^*}{2t} = 0. \tag{20}$$

Around a symmetric equilibrium, I have

$$\lambda(a_p^*) = -\frac{t\lambda'(a_p^*)}{2}, \tag{21}$$

where a_p^* is the symmetric equilibrium reservation value. The following proposition characterizes the unique symmetric bottleneck equilibrium of the game:

Proposition 2. *Suppose assumption 1 holds, and price parity clauses are exogenously imposed by both platforms. Then, for any $t > 0$, there exists a unique symmetric bottleneck equilibrium. There exist values $\underline{t}_p$ and $\overline{t}_p$, with $\underline{t}_p < \overline{t}_p$, such that the equilibrium reservation value (search cost) is as follows*

- *If $t < \underline{t}_p$, then $a_p^* = \overline{a}$. (corner solution)*
- *If $\underline{t}_p \leq t \leq \overline{t}_p$, then $a_p^* \in [\underline{a}, \overline{a}]$, given by the solution of (21). (interior solution)*
- *If $\overline{t}_p < t$, then $a_p^* = \underline{a}$. (corner solution)*

The equilibrium reservation value is weakly decreasing in t and the equilibrium search cost is weakly increasing in t (strictly in an interior solution).

Proof. See Appendix. □

As in the case with no PPCs, increased platform competition, given by a lower value of t, leads to higher reservation values, lower search costs, and lower prices. Therefore, platform competition remains useful to decrease obfuscation practices, even when PPCs are in place. There is also no possibility of showrooming between platforms for the same reason as before. In this equilibrium, there no delisting from firms, because for given and symmetric values of a_A and a_B, the equilibrium price with and without PPCs are equal. Therefore, a seller cannot benefit from delisting from a platform, to avoid the PPC, and change its price in the other platform, as the optimal price in such a deviation is the same price that the seller is already setting under PPCs.

The comparison between this result and the case where no PPCs are set depends on the comparison between both first-order conditions and the thresholds that define when corner solutions hold in each case, namely $\underline{t}$, $\overline{t}$, $\underline{t}_p$, and $\overline{t}_p$. When both equilibriums are interior, how PPCs affect market outcomes depends crucially on the value of λ', which in turn, depends on the match value distribution's curvature. In fact, note that $\lambda' = -1 - \frac{G''(1-G)}{g^2}$. Therefore, whether λ' is greater, equal, or lower than -1 depends on the concavity, linearity, or convexity of G, similarly to how cost pass-trough is related to the curvature of demand.[27] With this in mind, the following result compares the unique symmetric bottleneck equilibrium of the game when PPCs are exogenously imposed in both platforms, with the case where PPCs are not enforced:

Proposition 3. *Suppose assumption 1 holds. Then*

- *If G is globally convex, meaning that $\lambda' < -1$, then $\underline{t}_p < \underline{t}$ and $\overline{t}_p < \overline{t}$. The equilibrium reservation value and consumer surplus are weakly lower, while the equilibrium price and platform profits are weakly higher under price parity clauses. The relationships are strict when $t \in (\underline{t}_p, \overline{t})$.*
- *If G is globally concave, meaning that $\lambda' > -1$, then $\underline{t} < \underline{t}_p$ and $\overline{t} < \overline{t}_p$. The equilibrium reservation value and consumer surplus are weakly higher, while the equilibrium price and platform profits are weakly lower under price parity clauses. The relationships are strict when $t \in (\underline{t}, \overline{t}_p)$.*
- *If G is globally linear, meaning that $\lambda' = -1$, then $\underline{t}_p = \underline{t}$ and $\overline{t}_p = \overline{t}$. The equilibrium reservation value, consumer surplus, equilibrium price, and platform profits are the same as when no PPCs are imposed.*

Proof. See Appendix. □

The intuition for the result is as follows. When PPCs are exogenously set in both platforms, the pass-through rate from a platforms' reservation value to the equilibrium price around the symmetric equilibrium is one half of the pass-through without PPCs, that is, it goes from λ' to $\frac{\lambda'}{2}$. This reduced pass-through decreases the incentives to obfuscate. The demand effect, on the other hand, goes from $\frac{1-\lambda'}{2t}$ to $\frac{1}{2t}$. This demand effect increases the incentive to obfuscate. Suppose G is linear, meaning that $\lambda' = -1$. Then, the demand becomes one-half less sensitive than it was before (from $1/t$ to $1/2t$). In that case, both effects exactly offset each other and

[27] See Weyl and Fabinger (2013).

PPCs make no difference in market outcomes. When G is convex, then $\lambda' < -1$, and the sensitivity of demand with respect to reservation values decreases relatively more than the marginal pass-through rate. Therefore, the effect of PPCs on platforms demands is more important than the reduced pass-through effect, implying that PPCs lead to lower equilibrium reservation values and higher obfuscation. The opposite result is obtained when G is concave.

Proposition 3 provides a result of a global nature, in which the distribution of G is always concave, convex, or linear. Some distributions might change the curvature of G for different reservation values. This is the case for any distribution where the density function increases and then decreases. Given that log-concave distributions are unimodal, this means that G can go from convex to concave, but not vice versa. For these distributions, it suffices to look at the value of λ' around a symmetric equilibrium a_p^* to use the result of Proposition 2. In fact, $\lambda'(a_p^*) < -1$ if and only if $\lambda'(a^*) < -1$, and $\lambda'(a_p^*) > -1$ if and only if $\lambda'(a^*) > -1$, so looking at the value of λ' evaluated at either equilibrium reservation value is enough to use the result of the proposition. These details are explained further in the proofs of Proposition 2 and 3 in the Appendix.

The following example illustrates this result using the Generalized Pareto Distribution:

Example 2. *Suppose the distribution of match values follows a GPD with parameter $\xi < 0$. Using (21), I obtain*

$$a_p^* = \frac{-t\xi - 2}{2\xi}. \tag{22}$$

Moreover, $\underline{t} = -2\frac{(1+\xi\overline{a})}{\xi}$ and $\overline{t} = -2\frac{(1+\xi\underline{a})}{\xi}$. Using the result of Example 1, we have that $a^* > a_p^*$ if and only if

$$t\xi(1+\xi) > 0, \tag{23}$$

which is equivalent to $\xi < -1$. As for the GPD $\lambda' = \xi$, the equilibrium reservation value is lower, or equivalently, the equilibrium search cost and price are higher under PPCs when $\xi < -1$, as stated in Proposition 3.

In contrast with most of the literature, in this section I show how (exogenous) price parity clauses might lead to lower search costs, prices, and higher consumer surplus and total welfare.[28] This result is explained by PPCs having two opposite effects on platform competition, namely a demand effect and a pass-through effect. I show how when platforms use search design to influence competition between

[28] Johansen and Vergé (2017) also find that clauses restricting competition between platforms might benefit consumers when interbrand competition is intense.

sellers, which a useful but imperfect tool to affect equilibrium prices in the agency model, either of these two effects may dominate, and PPCs may benefit or hurt consumers.

Endogenous price parity clauses: Now, I endogenize the PPC decision as a choice variable for both platforms in the first stage of the game. When G is linear, price parity clauses do not affect obfuscation equilibrium levels, as stated in Proposition 3. When G is not linear, I show that there is a unique equilibrium, depending on whether G is strictly concave or convex, where both platforms set PPCs and choose a reservation value equal to a_p^*, or where both platforms do not set PPCs and choose a reservation value equal to a^*. The following result characterizes the equilibrium of the endogenous price parity game:

Proposition 4. *Suppose assumption 1 holds. Then, for any $t > 0$:*

- *If G is strictly convex, the unique symmetric bottleneck equilibrium is one with both platforms setting price parity clauses, and reservation values equal to a_p^*.*
- *If G is strictly concave, the unique symmetric bottleneck equilibrium is one with no price parity clauses, and reservation values equal to a^*.*
- *If G is strictly linear, then $a_A = a_B = a^* = a_p^*$ and any combination of platforms setting or not setting PPCs is an equilibrium.*

Proof. See Appendix. □

As with Proposition 2, this result is stated globally for the case where G is always strictly convex, concave, or linear. For distributions where the curvature changes for different reservation values, it is enough to evaluate λ' at either a^* or a_p^* to use the result stated in Proposition 4. The intuition of this result is as follows. Consider the first case where the unique equilibrium is the one with no platform setting PPCs and both platforms choosing a^*. In the first stage, say platform A deviates by setting a PPC. If platform A increases its reservation value, then the equilibrium price in A is lower than in B, and A's price parity clause is not binding. Therefore, its optimal choice of reservation value is still a^*, and this is not a profitable deviation. On the contrary, if platform A decreases its reservation value to increase the price its sellers are charging, its price parity clause becomes binding. The optimal reservation value's choice is then described by the price parity game of Proposition 2. This deviation is profitable only if $a_p^* < a^*$, or equivalently, when $\lambda' < -1$. Therefore, when $\lambda' > -1$, both platforms not setting PPCs is the unique equilibrium of the game.

Now, consider the equilibrium where both platforms set a PPC and choose a_p^*. Suppose that platform A deviates and does not set a PPC. If A increases its reservation value, decreasing the equilibrium price in its marketplace, platform B's PPC becomes binding. Therefore, the optimal choice of reservation value for A is a_p^* and reducing the reservation value cannot be a deviation. On the other hand, if A decreases its reservation value, there is an upwards pressure on its equilibrium price. Then, the game becomes a no price parity game. In this case, decreasing its reservation value is a profitable deviation only if $a_p^* > a^*$, or equivalently, when $\lambda' > -1$. Finally, when G is linear, both first-order conditions are equivalent whether PPCs hold or not, and therefore the equilibrium reservation value is always the same, and any combination of platforms' decisions regarding whether to impose PPCs is an equilibrium.

Proposition 4 extends the results found in the literature arguing that PPCs are likely to hurt consumers. In this setting, in which platforms use an alternative variable to influence the equilibrium price charged by seller, PPCs are observed in equilibrium only if they lead to higher prices and lower consumer surplus and total welfare. This result also shows that there are cases where PPCs are not observed in equilibrium, and it is because not setting PPCs leads to higher prices and profits for the platforms. Therefore, when PPCs are not observed, it is not due to a prisoner's dilemma like dynamic in which platforms would prefer to collude and set PPCs, but because that outcome is better for them. A similar result is obtained in Johansen and Vergé (2017), with the difference that in their model, consumers and sellers might also be better, while here, when PPCs are observed in equilibrium, it is always detrimental to consumers. In contrast, Wang and Wright (2020) and Edelman and Wright (2015) show that when PPCs (or price coherence) are a choice variable for platforms, they always impose them in equilibrium. Boik and Corts (2016), on their part, find that both platforms setting PPCs and both platforms not setting PPCs are equilibriums of the game and that either case can be more profitable for platforms. Here, whether PPCs are observed or not, it is always the beneficial case for platforms.

5. Conclusion

In this paper, I develop a theoretical model to study PPCs when platforms design a search environment for consumers and sellers to interact. I find that, in absence of PPCs, when platform differentiation is not too weak, then platform obfuscate consumers in equilibrium. This extends the obfuscation by intermediaries' literature. This result does not rely on advantageous information by the intermediary or by sellers and does not need any behavioral assumption from consumers. Then, I use this framework to study the effect of price parity clauses on platform competition.

I show that, when price parity clauses are exogenously imposed in both platforms, price parity clauses can increase or decrease obfuscation and prices. When price parity clauses are endogenously chosen by platforms, I find that the unique equilibrium involves price parity clauses being set if and only if this leads to higher obfuscation and prices. This result supports the notion that PPCs are likely to increase prices and harm consumers. In addition, I also show that PPCs are not always imposed when available as a tool for platforms, which happens if PPCs would lead to lower prices and profits for platforms.

While most of the literature focuses on showrooming and sellers' direct channels, in this article I focus on platform competition and assume that sellers do not sell directly to consumers. If sellers have a direct channel in this model, we need to assume that there is a search cost faced by consumers when searching sellers' direct channels, and this search cost would be greater than the search costs chosen by platforms. Else, direct channels would never be sampled. The corresponding reservation value, say a_d, becomes the new lower bound for platforms' choice of reservation values. Lower reservation values would lead to no consumers joining the platforms. Therefore, if this value is binding, due to weak platform competition, obfuscation in equilibrium is lower than in the absence of direct channels, independently of whether PPCs are imposed or not. However, the impact of PPCs studied in Section 4 remains unaffected, unless platform competition is weak enough so that both a^* and a_p^* are lower than a_d, in which case both platforms set reservation values equal to a_d, independently of whether PPCs are imposed or not. Overall, obfuscation is lower, and platforms are more likely to have incentives to impose PPCs in order to increase obfuscation.

Another relevant topic that is not considered explicitly in the model is the role of ordered search in platforms incentives to obfuscate and to impose PPCs. Considering exogenous ordered search in the Wolinsky model, as in Armstrong, Vickers, and Zhou (2009), would no affect the main results of this article, because search costs would still increase equilibrium prices by softening seller competition. However, in practice platforms decide the order in which sellers are shown and sell the most prominent spots to them. For example, Mamadehussene (2020) studies price comparison platforms, and shows that when platforms sell prominence, they allow for more obfuscation than they would if firms were shown randomly. A similar effect may arise in my model. However, prominence also generates a distortion that reduces consumer surplus, affecting consumer participation. Due to this two opposite effects, the overall effect on obfuscation is ambiguous, as is the influence of ordered search on incentives to impose PPCs. This is an interesting but complex alley for future research.

Finally, an interesting direction for further research is that platforms typically sell many different products, which are likely to have different shapes of demand. If a platform must use a uniform PPC policy for all its products, a PPC ban is likely to have heterogeneous effects on different markets with unclear welfare implications. As an example, consider that OTAs offer many different accommodations corresponding to different markets that are difficult to define.

Appendix

Proof of proposition 1

I show that platforms' profit functions are quasiconcave and that the equilibrium is unique. Define $\omega_A(a_A, a_B, t) \equiv \frac{\partial \Pi_A(a_A, a_B)}{\partial a_A}$ and $\omega_B(a_B, a_A, t) \equiv \frac{\partial \Pi_B(a_B, a_A)}{\partial a_B}$ as functions of a_A, a_B and t, and $\omega(a^*, t) \equiv \omega_A(a^*, a^*, t) = \omega_B(a^*, a^*, t)$ as a function of a^* and t.

Now, define $\underline{t}$ as the value of t such that $\omega(\overline{a}, \underline{t}) = 0$ and $\overline{t}$ as the value of t such that $\omega(\underline{a}, \overline{t}) = 0$. Applying the implicit function theorem to $\omega(a^*, t)$, we have that $\frac{\partial a^*}{\partial t} < 0$. Therefore, $\underline{t} < \overline{t}$. Also, note that $\omega(a^*, t)$ is decreasing in t.

i) Quasiconcavity: suppose $t \in [\underline{t}, \overline{t}]$ and fix $a_B \in [\underline{a}, \overline{a}]$. Dividing $\omega_A(a_A, a_B, t)$ by $\lambda'(a_A)$ we obtain

$$\psi(a_A, a_B) = D_A(a_A, a_B) + \lambda(a_A) \frac{(1 - \lambda'(a_A))}{2t\lambda'(a_A)}. \tag{24}$$

Because g is log-concave, then $\lambda'(a_A) < 0$. If this function intersects 0 at a unique value of a_A, $\omega_A(a_A, a_B, t)$ also intersects 0 at a unique a_A. We have

$$\frac{\partial \psi(a_A, a_B)}{\partial a_A} = \frac{1 - \lambda'(a_A)}{2t} + \frac{1}{2t\lambda'^2(a_A)}[\lambda'^2(a_A) - \lambda'^3(a_A) - \lambda(a_A)\lambda''(a_A)] > 0 \tag{25}$$

due to Assumption 1. Therefore, $\psi(a_A, a_B)$ is strictly increasing in a_A and must be equal to 0 at a unique value of a_A, implying $\omega_A(a_A, a_B, t)$ is also equal to 0 for a unique value of a_A. This also implies that for lower values of a_A, $\omega_A(a_A, a_B, t) > 0$, and for higher values of a_A, $\omega_A(a_A, a_B, t) < 0$. Therefore, the profit function is quasiconcave (the analysis is the same for platform B).

When $t < \underline{t}$, then the same logic applies except that $\omega_A(a_A, a_B, t) = 0$ *at most* at a unique value of a_A. In case it does not intersect 0, which happens when t is very small, the profit function is strictly increasing in a_A for any $a_A \in [\underline{a}, \overline{a}]$, in which case the profit function is still quasiconcave. Analogously, when $\overline{t} < t$, platform A's profits may be strictly decreasing in a_A. I conclude that in both cases the profit function is quasiconcave.

ii) Uniqueness: suppose $t \in [\underline{t}, \overline{t}]$. Dividing $\omega(a^*, t)$ by $\lambda'(a^*)$, we obtain

$$\phi(a^*) = \frac{1}{2} + \frac{(1 - \lambda'(a^*))}{2t\lambda'(a^*)}\lambda(a^*). \tag{26}$$

We have

$$\frac{\partial \phi(a^*)}{\partial a^*} = \frac{1}{2t\lambda'^2(a^*)}[\lambda'^2(a^*) - \lambda'^3(a^*) - \lambda(a^*)\lambda''(a^*)] > 0 \tag{27}$$

due to Assumption 1. Therefore, $\omega(a^*, t)$ is equal to 0 for a unique value of a^*. This also implies that for lower values of a^*, $\omega(a^*, t) > 0$ and for higher values of a^*, $\omega(a^*, t) < 0$. Therefore, the equilibrium is unique.

When $t < \underline{t}$, we have $\omega(\overline{a}, \underline{t}) > 0$, meaning that $\omega_A(\overline{a}, \overline{a}, t) > 0$. But platform A cannot increase a_A above $\overline{a}$, as consumers would not participate (the same happens with platform B). Therefore, $a_A = a_B = \overline{a}$ is the unique equilibrium. The argument is analogous when $\overline{t} < t$ and $a_A = a_B = \underline{a}$ is the unique equilibrium.

Proof of lemma 1

Seller j maximizes

$$\Pi_j = (1 - \tau)p_j[\kappa_A(1 - G(a_A + p_j - p_p^*)) + \kappa_B(1 - G(a_B + p_j - p_p^*))], \tag{28}$$

where $\kappa_k = \frac{D_k}{1-G(a_k)}$. Define $D_j = [\kappa_A(1 - G(a_A + p_j - p_p^*)) + \kappa_B(1 - G(a_B + p_j - p_p^*))]$ as seller j's total demand when joining both platforms. Following Caplin and Nalebuff (1991), I show that $1/D_j$ is convex, implying that the each seller's profit function is quasiconcave in its own price. This condition is equivalent to $2D_j'^2 - D_j D_j'' > 0$. Define $A_A = a_A + p_j - p_p^*$ and $A_B = a_B + p_j - p_p^*$. The condition can be written as

$$\begin{aligned}
&2[\kappa_A^2 g^2(A_A) + \kappa_B^2 g^2(A_B) + 2\kappa_A\kappa_B g(A_A)g(A_B)] \\
&+\kappa_A^2 g'(A_A)(1 - G(A_A)) + \kappa_B^2 g'(A_B)(1 - G(A_B)) \\
&+\kappa_A\kappa_B[g'(A_A)(1 - G(A_B)) + g'(A_B)(1 - G(A_A))] > 0.
\end{aligned}$$

Because $g(x)$ is logconcave, then $1 - G(x)$ is logconcave, meaning that $g^2(x) + g'(x)(1 - G(x)) \geq 0$. Therefore, taking all the terms proportional to κ_A^2 and to κ_B^2, we have

$$\begin{aligned}
&\kappa_A^2[2g^2(A_A) + g'(A_A)(1 - G(A_A))] > 0 \\
&\kappa_B^2[2g^2(A_B) + g'(A_B)(1 - G(A_B))] > 0.
\end{aligned}$$

Then, it is sufficient to show that the rest of the terms (all proportional to $\kappa_A\kappa_B$)

are greater than 0, or

$$4g(A_A)g(A_B) + g'(A_A)(1 - G(A_B)) + g'(A_B)(1 - G(A_A)) \geq 0. \qquad (29)$$

This condition is always satisfied when $g'(x)$ is positive, but it may not hold if $g'(x)$ is negative. I derive a condition on $\underline{s}$ such that this condition holds even for the minimum possible value of $g'(x)$. The logconcavity of $1 - G(x)$ implies that $g'(x) \geq -\frac{g(x)}{(1-G(x))}$. Replacing this lower bound for $g'(x)$ in (31) and rearranging terms leads to

$$4 - \frac{\lambda(A_B)}{\lambda(A_A)} - \frac{\lambda(A_A)}{\lambda(A_B)} \geq 0.$$

This condition is always satisfied in a symmetric equilibrium in the platforms' obfuscation game. As the difference between reservation values increases, the condition might not hold. Given that the maximum difference between $\lambda(A_A)$ and $\lambda(A_B)$, for a fixed p_j, depends on the maximum difference between a_A and a_B, if $\underline{s}$ is not too small, then $\overline{a}$ is not too large. Then, the condition is satisfied even when a platform chooses $\underline{a}$ and the other chooses $\overline{a}$, implying each sellers' profit function is strictly quasiconcave. Given that all sellers' profit functions are quasiconcave, the unique equilibrium price equilibrium at the sellers' stage is characterized by each seller first-order condition, which in a symmetric equilibrium leads to (15).

To check that the equilibrium price is decreasing in each platform's reservation value, we have

$$\frac{\partial p_p^*}{\partial a_A} = \frac{\lambda'(a_A)\lambda^2(a_B)D_A + \frac{1}{2t}\lambda(a_A)\lambda(a_B)(\lambda(a_A) - \lambda(a_B))}{(D_B\lambda(a_A) + D_A\lambda(a_B))^2},$$

which is always negative around a symmetric equilibrium. However, if a_A is much larger than a_B it may be the case that this is positive. Using the same argument as above, if $\underline{s}$ is not too small, then $\overline{a}$ is not too large, and the condition is satisfied even when a platform chooses $\underline{a}$ and the other chooses $\overline{a}$.

The final part of the result comes from the equilibrium price being decreasing in a_A and a_B and the fact that at $a_A = a_B$, we have $p_A^* = p_B^* = p_p^*$.

Proof of proposition 2

The proof follows the same steps as Proposition 1. Define $\omega_A^p(a_A, a_B, t) \equiv \frac{\partial \Pi_A(a_A, a_B)}{\partial a_A}$ and $\omega_B^p(a_B, a_A, t) \equiv \frac{\partial \Pi_B(a_B, a_A)}{\partial a_B}$ as functions of a_A, a_B and t, and $\omega^p(a_p^*, t) \equiv \omega_A^p(a_p^*, a_p^*, t) = \omega_B^p(a_p^*, a_p^*, t)$ as a function of a_p^* and t. All profit functions correspond to the case where both platforms impose PPCs.

Now, define $\underline{t}_p$ as the value of t such that $\omega^p(\overline{a}, \underline{t}_p) = 0$ and $\overline{t}_p$ as the value of t such that $\omega^p(\underline{a}, \overline{t}_p) = 0$. Applying the implicit function theorem to $\omega^p(a_p^*, t)$, we have that $\frac{\partial a_p^*}{\partial t} < 0$. Therefore, $\underline{t} < \bar{t}$. Also, note that $\omega^p(a_p^*, t)$ is decreasing in t.

i) Quasiconcavity: suppose $t \in [\underline{t}_p, \bar{t}_p]$ and fix $a_B \in [\underline{a}, \overline{a}]$. Dividing A's first-order condition when PPCs are imposed by $\lambda'(a_A)\lambda(a_B)D_A^2$, we obtain the following function

$$\psi^p(a_A, a_B) = 1 + \frac{1}{2t}\frac{\lambda^2(a_A)(D_A + D_B)}{\lambda'(a_A)\lambda(a_B)D_A^2}. \tag{30}$$

If $\psi^p(a_A, a_B)$ intersects 0 at a unique value of a_A, then $\omega_A^p(a_A, a_B, t)$ also intersects 0 at a unique a_A. Differentiating $\psi^p(a_A, a_B)$ with respect to a_A leads to

$$\frac{\partial \psi^p(a_A, a_B)}{\partial a_A} = \lambda(a_A)\lambda(a_B)D_A^2(2\lambda'^2(a_A) - \lambda(a_A)\lambda''(a_A)) - \frac{D_A\lambda'(a_A)\lambda^2(a_A)\lambda(a_B)}{t} > 0 \tag{31}$$

due to assumption 1. Therefore, $\psi^p(a_A, a_B)$ is strictly increasing in a_A and must be equal to 0 at a unique value of a_A, implying $\omega_A^p(a_A, a_B, t)$ is also equal to 0 at a unique value of a_A. This also implies that for lower values of a_A, $\omega_A^p(a_A, a_B, t) > 0$ and for higher values of a_A, $\omega_A^p(a_A, a_B, t) < 0$. Therefore, the profit function is quasiconcave (the analysis is the same for platform B).

ii) To show that the equilibrium is unique, we have the first-order condition at a symmetric equilibrium

$$\frac{\lambda'(a_A)}{4} + \frac{\lambda(a_A)}{2t} = 0. \tag{32}$$

Dividing by $\lambda'(a_p^*)$ and differentiating with respect to a_A, we obtain

$$\frac{\partial \phi(a_p^*)}{\partial a_p^*} = \frac{1}{2t\lambda'^2}[\lambda'^2 - \lambda\lambda''] > 0 \tag{33}$$

due to assumption 1. Therefore, the symmetric equilibrium first-order condition is equal to 0 at a unique value of a_p^*. This also implies that for lower values of a_p^*, $\omega^p(a_p^*, t) > 0$ and for higher values of a_p^*, $\omega^p(a_p^*, t) < 0$. Therefore, the equilibrium is unique.

Following the same steps as in Proposition 1, there exist thresholds $\underline{t}_p < \bar{t}_p$ such that when $t < \underline{t}_p$ the unique symmetric equilibrium is a corner solution with $a_p^* = \overline{a}$ and when $t > \bar{t}_p$ then the unique symmetric equilibrium is a corner solution with $a_p^* = \underline{a}$.

Proof of Proposition 3

I start by showing the comparison between interior solutions and that it is equivalent to use the value of λ' evaluated at a^* or at a_p^* to analyze the impact of PPCs on obfuscation and prices.

Replace the value a_p^* that solves the first-order conditions for a symmetric equilibrium when PPCs are set ($\frac{\lambda'(a_p^*)}{4} + \frac{\lambda(a_p^*)}{2t} = 0$) in the first-order condition for a symmetric equilibrium without PPCs. This leads to

$$\frac{\lambda'(a_p^*)}{4} + \underbrace{\frac{\lambda'(a_p^*)}{4} + \frac{\lambda(a_p^*)}{2t}}_{=0} - \underbrace{\frac{\lambda(a_p^*)\lambda'(a_p^*)}{2t}}_{\frac{\lambda'^2(a_p^*)}{4}} \tag{34}$$

$$= \frac{\lambda'(a_p^*)}{4} + \frac{\lambda'^2(a_p^*)}{4}, \tag{35}$$

where both underbraces come from the first order condition for a_p^*. This expression is positive if $\lambda'(a_p^*) < -1$, meaning that when replacing a_p^* in the first-order condition when PPCs are not imposed leads to a positive first-order condition. Therefore, to satisfy the condition, the value of a^* when PPCs are not set must be higher than a_p^*, in order to reduce the first-order condition back to 0. This implies that $a^* > a_p^*$, $s^* < s_p^*$, and equilibrium prices are higher when PPCs are imposed. When $\lambda'(a_p^*) > -1$ the opposite happens. When $\lambda'(a_p^*) = -1$, both first-order conditions are satisfied and PPCs make no difference in equilibrium.

Now, the value a^* that solves the first-order conditions for a symmetric equilibrium when PPCs are not imposed in the first-order condition for a symmetric equilibrium with PPCs. This leads to

$$\frac{\lambda'(a^*)}{4} + \frac{\lambda(a^*)}{2t} \tag{36}$$

$$= \frac{\lambda'(a^*)}{4} - \frac{\lambda'(a^*)}{2(1-\lambda'(a^*))} \tag{37}$$

where the last term comes from replacing t from the first-order condition for a^*. If $\lambda'(a^*) < -1$, the expression in (14) is negative, meaning that the equilibrium reservation value of $a_A = a_B = a_p^*$ must be lower to satisfy the first-order condition for both firms, implying $a^* > a_p^*$. The opposite happens when $\lambda'(a_p^*) > -1$ and when $\lambda'(a_p^*) = -1$ I have $a^* = a_p^*$.

Thus, we have that $\lambda'(a^*) < -1$ implies $a^* > a_p^*$, and $\lambda'(a_p^*) < -1$ implies the same. Therefore, in equilibrium it cannot happen that $\lambda'(a^*) < -1$ and $\lambda_p'(a^*) > -1$, because this implies that $a^* > a_p^*$ and $a^* < a_p^*$ at the same time, which is a contradiction.

Now I extend to take into account the thresholds $\underline{t}$, $\overline{t}$, $\underline{t}_p$, $\overline{t}_p$. These are defined by:

$$\underline{t} = -\frac{\lambda(\overline{a})(1-\lambda'(\overline{a}))}{\lambda'(\overline{a})} \qquad \overline{t} = -\frac{\lambda(\underline{a})(1-\lambda'(\underline{a}))}{\lambda'(\underline{a})} \tag{38}$$

$$\underline{t}_p = -2\frac{\lambda(\overline{a})}{\lambda'(\overline{a})} \qquad \overline{t}_p = -2\frac{\lambda(\underline{a})}{\lambda'(\underline{a})} \tag{39}$$

When G is globally convex, then $\lambda' < -1$ for all possible reservation values. Therefore, we have that $\underline{t}_p < \underline{t}$ and $\bar{t}_p < \bar{t}$. Now, suppose that $\underline{t} < \bar{t}_p$. When $t \in \{\underline{t}, \bar{t}_p\}$, both equilibria are characterized by the interior solutions. Therefore, as shown above, $a^* > a_p^*$. When $t \in \{\underline{t}_p, \underline{t}\}$, then $a^* = \bar{a}$, which is strictly greater than a_p^* given by the first-order condition in the PPC case. When $t \in \{\bar{t}_p, \bar{t}\}$, then a^* is given by the first-order condition in the no PPC case which is strictly greater than $a_p^* = \underline{a}$. In every case, $a^* > a_p^*$, meaning that equilibrium search cost, price, and profits are higher and consumer surplus is lower under PPCs. When $\underline{t} > \bar{t}_p$, the proof is similar but there are no region where both equilibria are interior.

When G is globally concave, then $\lambda' > -1$ for all possible reservation values. Therefore, we have that $\underline{t}_p > \underline{t}$ and $\bar{t}_p > \bar{t}$. Now, suppose that $\underline{t}_p < \bar{t}$. When $t \in \{\underline{t}_p, \bar{t}\}$, both cases are characterized the interior solution given by the first-order conditions. Therefore, as shown above, $a^* < a_p^*$. When $t \in \{\underline{t}, \underline{t}_p\}$, then $a_p^* = \bar{a}$, which is strictly greater than a^* given by the first-order condition in the no PPC case. When $t \in \{\bar{t}, \bar{t}_p\}$, then a_p^* is given by the first-order condition in the PPC case which is strictly greater than $a^* = \underline{a}$. In every case, $a^* < a_p^*$, meaning that equilibrium search cost, price, and profits are lower and consumer surplus is higher under PPCs. When $\underline{t}_p > \bar{t}$, the proof is similar but there are no region where both equilibria are interior.

Proof of proposition 4

I prove each case separately:

Price parity equilibrium: suppose both platform set price parity clauses and set search costs according to (21). This is the unique bottleneck equilibrium if both platforms set price parity clauses, according to proposition 2. The only possible deviation would be a platform not setting a PPC.

Suppose platform A deviates and does not set a price parity clause:

i) If A increases a_A, there is a downward pressure on p_A^*, but because of the price parity of platform B, the prices must remain the same in both platforms, as long as sellers keep multi-homing. Therefore, the initial value of $a_A = a_p^*$ was already a best response for A, so this cannot be a deviation.

ii) If A decreases a_A, there is an upward pressure on p_A^*, leading to $p_A^* > p_B^*$, therefore the price parity clause set by platform B is not binding and equilibrium prices in the sellers sub-game are given by the base case with no price parity. However, if $a_p^* < a^*$, meaning price parity leads to higher obfuscation and prices, the first-order condition of the no price parity case for platform A, starting from $a_A = a_B = a_p^*$ is positive, meaning that lowering a_A cannot be a deviation. If $a_p^* > a^*$, the first-order condition is negative and this is a profitable deviation.

Therefore, if $a_p^* < a^*$, both platforms setting price parity clauses is the unique bottleneck equilibrium of the game.

No price parity equilibrium: suppose both platform do not set price parity clauses and set search costs according to (11). This is the unique bottleneck equilibrium if both platforms do not set price parity clauses, according to proposition 1. The only possible deviation would be a platform setting a PPC.

Suppose platform A deviates and sets a price parity clause:

i) If A increases a_A, there is a a downward pressure on p_A^*, but then the price parity clause set by A is not binding. Therefore, the initial value of $a_A = a^*$ was already a best response for A, so this cannot be a deviation.

ii) If A decreases a_A, there is an upward pressure on p_A^*, leading to $p_A^* > p_B^*$, and then the price parity clause set by A becomes binding, as long as sellers continue to multi-home. However, if $a_p^* > a^*$, meaning price parity leads to lower obfuscation and prices, the first-order condition of the price parity case for platform A, starting from $a_A = a_B = a^*$ is positive, meaning that lowering a_A cannot be a deviation. When $a_p^* < a^*$, the first-order condition is negative and this is a profitable deviation.

Therefore, if $a_p^* > a^*$, both platforms not setting price parity clauses is the unique bottleneck equilibrium of the game.

Now, for completeness of the analysis, I show that an equilibrium with one platform setting a PPC and the other not setting a PPC and symmetric reservation values does not exist. Suppose that platform A sets a PPC. There are two possibilities: either the PPC is binding, which happens when $a_A < a_B$ or the PPC is not binding, which happens when $a_A > a_B$. Thus, the only possible equilibra are $a_A = a_B = a^*$ or $a_A = a_B = a_p^*$:

i) Platform A sets a PPC and B does not, and both set reservation values equal to a_p^*. If $a^* > a_p^*$, platform A increases a_A, the game becomes one without PPCs, and this is a profitable deviation as the first-order condition for A in the no PPC game is positive at $a_A = a_B = a_p^*$. If $a^* < a_p^*$, platform B decreases a_B, the game becomes one without PPCs, and this is a profitable deviation as the first-order condition for B in the no PPC game is negative at $a_A = a_B = a_p^*$. Therefore, this cannot be an equilibrium.

ii) Platform A sets a PPC and B does not, and both set reservation values equal to a^*. If $a^* > a_p^*$, platform A decreases a_A, the game becomes one with PPCs, and this is a profitable deviation as the first-order condition for A in the PPC game is negative at $a_A = a_B = a^*$. If $a^* < a_p^*$, platform B increases a_B, the game becomes one with PPCs, and this is a profitable deviation as the first-order condition for B in the PPC game is positive at $a_A = a_B = a^*$. Therefore, this cannot be an equilibrium.

Lemma 2

The following Lemma shows that a right-hand truncation of log-concave distributions functions satisfy Assumption 1, if the truncation point is small enough (but strictly greater than 0):

Lemma 2. *Assume $g(x)$ is a strictly positive everywhere and log-concave density function in $[0, \overline{v}]$. Let $g_t(x, \overline{h})$ be the right hand truncation of $g(x)$ at $\overline{h} < \overline{v}$ and define $\lambda_t(x, \overline{h})$ as the Mills ratio of the truncated distribution. Then:*

- *$\lambda_t(x, \overline{h})$ is strictly increasing in $\overline{h}$.*
- *There exists a $\hat{h} > 0$ such that $\forall\, \overline{h} < \hat{h}$, $\lambda_t(x, \overline{h})$ is strictly log-concave $\forall x \in (0, \overline{h}]$.*

Proof. When a distribution is truncated on the right at $\overline{h}$, the new Mills ratio is given by

$$\lambda_t(x, \overline{h}) = \frac{G(\overline{h}) - G(x)}{g(x)} \tag{40}$$

where $G(\overline{h}) < 1$ if $\overline{h} < \overline{v}$. This expression is clearly strictly increasing in $\overline{h}$ as $G(x)$ is a cumulative distribution function and the density function is strictly positive everywhere. Differentiating with respect to x I have

$$\lambda_t'(x, \overline{h}) = -1 - \frac{g'(x)}{g(x)} \lambda_t(x, \overline{h}), \tag{41}$$

and

$$\lambda_t''(x, \overline{h}) = -\left[\left(\frac{g'(x)}{g(x)} \right)' \lambda_t(x, \overline{h}) + \lambda_t'(x, \overline{h}) \frac{g'(x)}{g(x)} \right]. \tag{42}$$

□

Model with per-transaction fees

In this section, I briefly discuss how the results of the model change when platforms use linear fees instead of the fixed ad-valorem fee. Most of the PPC literature uses linear fees even though many of the most relevant platforms using PPCs during the last decade use ad-valorem fees. Here I show that linear fees make the demand effect always to dominate, making PPC to always lead to higher obfuscation and prices.

Suppose now that platforms charge per-transaction fees f_A and f_B and that PPCs are not imposed in any platform. Then, for given a_A, a_B, f_A and f_B, sellers equilibrium prices in each platform are

$$p_A^* = f_A + \lambda(a_A)$$
$$p_B^* = f_B + \lambda(a_B),$$

while platforms' demands now depend on the linear fees:

$$D_A(a_A, a_B, f_A, f_B) = \frac{1}{2} + \frac{a_A - a_B}{2t} + \frac{f_B + \lambda(a_B) - f_A - \lambda(a_A)}{2t} \tag{43}$$
$$D_B(a_A, a_B, f_A, f_B) = \frac{1}{2} + \frac{a_B - a_A}{2t} + \frac{f_A + \lambda(a_A) - f_B - \lambda(a_B)}{2t}. \tag{44}$$

The timing of the new game is as follows: at stage 1, platforms choose per-transaction fees and reservation values simultaneously. Then, just as before, sellers make participation decisions at stage 2 and consumers join a platform, search, and purchase at stage 3.

Platforms' profit functions are given by $\Pi_A = f_A D_A(a_A, a_B, f_A, f_B)$ and $\Pi_B = f_B D_B(a_A, a_B, f_A, f_B)$. Note that the profit functions are strictly increasing in the platforms own reservation values. This is the critical difference with the case with ad-valorem fees, as platforms no longer have incentives to influence equilibrium prices through the search design variable. Therefore, in equilibrium both platforms set $a_A = a_B = \overline{a}$, and obfuscation is minimized. Thus, in a model with per-transaction fees, obfuscation is not used by platforms, at least from a search perspective. There could still be behavioral reasons for using obfuscation practices outside of the scope of this paper.

Replacing $a_A = a_B = \overline{a}$ in the profit functions and maximizing with respect to the per-transaction fees, leads to a symmetric equilibrium per-transaction fee equal to $f^* = t$, as long as consumers participate in the market. Remembering that consumers participation constraint is given by $\overline{a} - f^* - \lambda(\overline{a}) \geq 0$, if t is too high, consumers participation constraint must bind, meaning that $f^* = \overline{a} - \lambda(\overline{a})$.

When price parity clauses are exogenously set in both platforms, sellers maximize

$$\Pi_j = (p_j - f_A)\left[D_A \frac{1 - G(a_A + p_j - p_p^*)}{1 - G(a_A)}\right] + (p_j - f_B)\left[D_B \frac{1 - G(a_B + p_j - p_p^*)}{1 - G(a_B)}\right]. \tag{45}$$

The equilibrium price in both platforms is

$$p_p^* = \frac{\lambda(a_A)\lambda(a_B) + D_A f_A \lambda(a_B) + D_B f_B \lambda(a_A)}{D_A \lambda(a_B) + D_B \lambda(a_A)}, \tag{46}$$

while platforms' profit functions remain the same. Again, platforms' profits are strictly increasing in reservation values, and therefore they set $a_A = a_B = \overline{a}$. Given these reservation values, platforms' profit functions are strictly increasing in per-transaction fees, subject to consumers participating. The equilibrium price for $a_A =$

$a_B = \overline{a}$ is $p_p^* = \lambda(\overline{a}) + \frac{f_A}{2} + \frac{f_B}{2}$. Note that the pass-through rate is also cut to one half when PPCs are imposed. In equilibrium, consumers' participation constraint must be binding, which happens if and only if $\overline{a} - \lambda(\overline{a}) - \frac{f^*}{2} - \frac{f^*}{2} = 0$. Therefore, the only symmetric equilibrium has per-transaction fees given by $f^* = \overline{a} - \lambda(\overline{a})$.

Comparing both cases, we observe that PPCs lead to weakly higher fees and prices. When t is high, all surplus is extracted from consumers even in the case with no PPCs, and then these clauses have no effect on market outcomes. However, when t is not so high, the equilibrium fees and prices are lower without PPCs. The reason why PPCs cannot benefit consumers as in the main model is because the pass-through effect, which decreases the incentives to obfuscate, is always dominated by the demand effect.

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