Platform Encroachment and Own-Content Bias*

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Abstract

This paper presents a model of platform encroachment, in which a platform not only acts as an intermediary between consumers and third-party sellers, but also sells its first-party products. When encroaching, the platform chooses between fair and biased search engines. Under the fair search, all products are equally likely to appear in search results, whereas the first-party product is more likely to appear under biased search. Biased encroachment makes the platform impose a lower commission on sellers, which leads to a lower equilibrium price which consequently attracts more consumers. Increased consumer participation can raise seller participation through indirect network externalities.

Keywords: encroachment, first-party selling, intermediary, search biases, two-sided markets

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I Introduction

E-commerce platforms operate online marketplaces that intermediate vastly numerous direct transactions between buyers and sellers (e.g., Amazon.com and eBay in the U.S., Rakuten in Japan, Tmall and JD.com in China, and Flipkart in India).[1] Those e-commerce titans earn commission revenues from each unit sold at the marketplaces, but they also sell first-party products along with third-party products. This can be regarded as platform encroachment. Third-party sellers must compete not only with other sellers but also with the platform which makes the rules applied in the marketplace.[2] That might sound unfair to third-party sellers. Moreover, some observers argue that platforms steer consumers to their first-party products by manipulating search engines and recommendation systems. Such biases can be regarded as own-content biases.[3]

These practices have been attracting attention particularly from policymakers and public administrators.[4] For example, in March 2019, U.S. Senator Elizabeth Warren posted a proposal suggesting that America's largest tech companies, such as Amazon, Facebook, and Google, be broken up because they have too much power.[5] Especially, she argued that "Amazon crushes small companies by copying the goods they sell on the Amazon Marketplace and then selling its own branded version." Actually, before this statement was given, India enacted a separation of large platforms. In February 2019, the Indian government imposed a new regulation prohibiting the dual use of marketplace and reseller modes, which eventually broke up Amazon and Flipkart.[6]

The purpose of this paper is exploration of the effects of first-party selling and own-content biases on third-party sellers and consumers. First, a benchmark model is examined in which a monopoly platform operates the only marketplace which enables sellers and consumers to transact directly, but which does not sell any first-party product. It can be regarded as pure intermediary. The model accommodates endogenous participation decisions by sellers and consumers. Sellers incur a fixed entry cost to participate in the marketplace, whereas consumers have heterogeneous outside options. Consumers determine how many products to sample (or search). Then they decide which of them to purchase. The platform sets a commission fee that sellers must pay for each unit sold in the marketplace. Charging a low commission fee leads sellers to set low prices, which attracts more consumers. Subsequently, because of indirect network externalities, a greater number of consumers are associated with more sellers participating in the marketplace. In equilibrium, the platform chooses an optimal commission fee that internalizes the indirect network externalities.

Next, the benchmark model is extended such that the platform encroaches into the marketplace with its first-party product by incurring some encroachment cost. Specifically, search engines of two types are considered. The first is a fair search engine in which both first-party and third-party products are equally likely to be displayed among the search results of every consumer. This can be regarded as fair encroachment. By contrast, the second is a biased search engine that favors the platform's first-party product, making it more likely to be included in search results. This can be regarded as biased encroachment. Then, three platform designs of pure intermediary, fair encroachment, and biased encroachment are compared to assess platform encroachment effects, and to assess how those effects vary according to the search engine type.

Results provide important implications for competition policy. First, comparison between pure intermediary and fair encroachment models produces a neutrality result by which these platform designs yield the same commission, price, and number of consumer searches in equilibrium, eventually leading to the same numbers of consumers and of sellers, including the platform's first-party selling. Fair encroachment replaces one third-party product with the platform's first-party product. The platform gains from fair encroachment when its encroachment cost is less than the sellers' entry cost.

Second, compared to the other two models, biased encroachment is shown to lower the equilibrium commission. The biased search engine enables the platform to earn profits effectively from first-party selling, which increases its expected profit per consumer. Consequently, the platform strives to attract more consumers to its marketplace. To this end, it charges a lower commission to make the resulting prices lower. The increased consumer participation can also stimulate seller participation. Therefore, if this seller-side expansion effect dominates the direct effect by which own-content biases inhibit seller participation through reduction in third-party seller profitability, then biased encroachment increases the number of sellers as well as the number of consumers. As for the platform, biased encroachment can yield the greatest profit among the three platform designs, unless its encroachment cost is sufficiently high.

Moreover, this study examines how platform encroachment with own-content biases affects consumers and third-party sellers. For the consumer side, among the three platform designs, biased encroachment engenders the highest consumer participation and surplus because of reductions in the equilibrium commission and price. For the seller side, biased encroachment is demonstrated as more likely to engender the greatest degree of seller participation when the consumer's search cost is high. Consumers with a high search cost would be reluctant to participate in the platform. Anticipating this passive behavior, third-party sellers also hesitate to join. Own-content biases can influence this problem favorably.

Finally, welfare effects of own-content biases are assessed. Whenever the platform deploys biased encroachment, it produces the greatest social welfare among the three platform designs. This result indicates that own-content biases are not necessarily anti-competitive. Rather, they can be regarded as pro-competitive.

As a caveat, it should be described that the pro-competitive result might depend to some extent on specific model features. For example, because the model includes the assumption that all sellers be ex ante identical for consumers, biased intermediation by the platform generates no direct loss in terms of expectations. Additionally, in the present model, the platform uses no data-based ranking algorithms to improve matching. If such algorithm is present, then biased intermediation will generate some mismatch costs. Although the model presented herein lacks these features, the results provide a new perspective on the pro-competitive aspect of own-content biases.

Additionally, as an extension, another platform design is also investigated, in which the platform does not encroach into its marketplace, but it favors a prominent seller among the search results. The pure intermediary platform can monetize by selling the right of prominence in search results through an auction. Results demonstrate another neutrality result such that the equilibrium outcome of this extended model is equivalent to that of biased encroachment. Along with neutrality between pure intermediary and fair encroachment models, one can infer that the consequences of biases in search results can be assessed independently of whether the platform encroaches into the marketplace.

I(i) Literature

This paper is related to two strands of the literature. The first strand includes studies of first-party selling by platform intermediaries, which can be interpreted as a mixed one of two popular business models: marketplace and reseller modes.[7] First-party selling effects have been studied from wide-ranging perspectives, such as the chicken-and-egg problem in participation coordination between buyers and sellers (Hagiu and Spulber [2013]), the negative effect on investment incentives of sellers with high demand potentials (Jiang et al. [2011]), the degree of substitution between sellers' products (Tian et al. [2018]; Zennyo [2020]), and the platform's private label products (Etro [2020]). Nevertheless, these studies do not allow for own-content biases or platform privilege of any other kind.

The second strand comprises studies of consumer search biases. Existing studies investigate the benefits of being a 'prominent' seller in consumer searches (Armstrong et al. [2009]; Armstrong and Zhou [2011]) and explore how an intermediary platform manipulates search biases (Hagiu and Jullien [2011]; Teh [2019]). However, these studies do not address the issue of first-party selling by intermediaries.

The literature includes few reports describing studies of the combination of first-party selling and own-content biases. Studies by Burguet et al. [2015] and de Cornière and Taylor [2014, 2019] address this topic by allowing an intermediary platform to integrate one competing seller and to steer uninformed consumers to that seller. However, in their models, the platform is not allowed to collect commissions from third-party sellers, which constitutes a crucially important difference from the study presented herein.[8]

Kittaka [2020] allows a dual role platform to earn commissions from sellers. That model incorporates ordered searches by consumers. The platform is allowed to distort the order of consumer searches so that they search its first-party product first. The search order distortion is shown to soften price competition. Moreover, prohibiting the dual role can improve social welfare. However, unlike this paper, the platform does not internalize indirect network externalities between buyers and sellers in his model because the model includes assumptions of the number of sellers and a commission fee to be fixed exogenously.

Hagiu et al. [2020] develop a stylized model consisting of a platform, an innovative seller, and fringe sellers. The model allows the platform to determine a commission fee for third-party sellers endogenously. However, similarly to work presented earlier by Kittaka [2020], the model lacks endogenous participation decisions by sellers and consumers, which stands in sharp contrast to the presented herein. Accordingly, some of their results differ from those derived in the present study. For example, Hagiu et al. [2020] demonstrate that the platform's product imitation and self-preferencing are detrimental to consumers and sellers. By contrast, the study presented herein shows that own-content biases can be beneficial to consumers and sellers because own-content biases enable the platform to earn greater profits per consumer, leading the platform to lower its commission fee for attracting more consumers. These results were not obtained from the model of Hagiu et al. [2020] because of their assumption of a fixed number of consumers. Moreover, through indirect network externalities that are not examined in their model, the increased consumer participation can also attract more sellers to the marketplace.

Recent work by Anderson and Bedre-Defolie [2021] resembles that described in this paper in that they examine the framework of two-sided markets with endogenous participation on both consumer and seller sides. They demonstrate that platform encroachment (hybrid mode in their terminology) leads the platform to charge a higher seller commission because consumer demand for each seller and its elasticity change when the platform offers its own product. In the arguments presented herein, by contrast, such is not the case because of the search framework used, where consumers randomly sample s of the available n active sellers. Then they choose the one generating the highest utility. In this framework, the platform's first-party selling increases the total number of sellers by one, but it does not alter consumer behavior. Therefore, platform encroachment itself does not alter the commission imposed on third-party sellers, as long as the search engine is fair. This search framework is adopted because of its usefulness in investigating the effects of biased intermediation by the platform. Alternatively, in Anderson and Bedre-Defolie [2021], biased intermediation is modeled as that the platform can raise the perceived quality of its first-party product at the expense of lowering the perceived quality of third-party products. Although these differences yield different consequences, the two papers provide complementary mechanisms for platform encroachment and own-content biases.

II Benchmark Model: Pure Intermediary

A benchmark model is developed by extending Anderson et al. [1992]'s useful search model based on the multinomial logit.[9]

II(i) Setting

A monopoly platform operates a marketplace that intermediates direct transactions between consumers and third-party sellers. Sellers pay a commission fee, denoted by c, to the platform for each unit sold through the marketplace.[10] For simplicity, sellers are assumed to incur no other costs for selling in the marketplace.

First, one can consider the following timeline. In Stage 1, the monopoly platform charges a per-unit commission c. Then, consumers and sellers decide whether to participate in the marketplace. In so doing, consumers have different outside options; sellers incur a fixed entry cost that is identical for all potential sellers. In Stage 2, sellers choose prices, whereas consumers determine the number of searches. As a result of consumer search, each consumer has a consideration set, from which the consumer chooses a seller able to provide the highest surplus. More details are presented in the following.

At the beginning of Stage 2, the numbers of consumers and third-party sellers are already fixed, denoted respectively as N and n. Seller $i \in \{1, \ldots, n\}$ posts a price p_i. Consumer $l \in [0, N]$ obtains surplus $v - p_i + \mu\epsilon_{il}$ from seller i's product, where v denotes the stand-alone benefit that is assumed to be identical for all products and which is normalized to zero, μ represents the degree of product differentiation, and ϵ_{il} is viewed as a match value expressing the benefit of product i to consumer l.

Consumers do not know the value of their ϵ_{il} a priori, but know that ϵ_{il} is an i.i.d. taste shock. A logit demand model is considered, in which the shocks follow a type-I extreme value distribution. The shocks are revealed if consumers search by incurring a per-unit search cost of σ. Consumers decide the number of (simultaneous) searches, which is denoted as s_l. For simplicity, search results are presumed to be randomly determined independently of product prices. That is, every product is equally likely to be displayed in each consumer's search result.

After the search, each consumer recognizes a consideration set consisting of the products displayed in the search result. Herein, $\mathcal{C}_l$ is used to represent the consideration set of consumer l, i.e., $|\mathcal{C}_l| = s_l$. The probability that seller i's product is included in consumer l's consideration set is calculated as $\text{Prob}(i \in \mathcal{C}_l; s_l) = \min\{s_l/n, 1\}$. Consumers are homogeneous with respect to their search behavior. Therefore, one can drop the subscript 'l' from $\mathcal{C}_l$ and s_l in the following.

Each consumer l purchases a unit of the product from a seller that generates the highest surplus among the consideration set. Therefore, given $i \in \mathcal{C}_l$, the probability that the consumer purchases the product from seller i is given as shown below.

$$\mathbb{P}_i = \frac{\exp(-p_i/\mu)}{\sum_{j \in \mathcal{C}_l} \exp(-p_j/\mu)}$$

In total, the expected demand for seller i is given as $D_i = N \cdot \text{Prob}(i \in \mathcal{C}; s) \cdot \mathbb{P}_i$.

Therefore, the expected profit of seller i can be represented as $\pi_i = (p_i - c)D_i$. The expected surplus of consumer l is calculated as shown below.

$$V = \mathbb{E}\left[\mu \ln \sum_{j \in \mathcal{C}_l} \exp\left(-p_j/\mu\right)\right] - \sigma s_l$$

In Stage 1, after observing commission c, consumers and sellers make their participation decisions. Consumers are assumed to be heterogeneous with respect to their outside options. Specifically, the value of outside option of consumer l is given as l, which follows a cumulative distribution function $F(l)$ with a continuously differentiable positive density $f(l)$. Consequently, consumers with $l \leq V$ will join the platform, i.e., $N = F(V)$. Consumer surplus is computed as $CS = \int_0^N (V - l)dF(l)$.

Next, to join the platform, sellers must incur a fixed entry cost denoted as e. The number of sellers is determined according to the zero-profit condition of free entry, i.e., n solves $\pi_i = e$. Because of the zero-profit condition, although the seller surplus is equal to zero in equilibrium, one can interpret that numerous participating sellers imply high profitability in the marketplace. Therefore, one can use the number of third-party sellers as an indicator of seller surplus.

The platform earns its profit from commission revenues paid by third-party sellers. The platform is not allowed to charge a membership fee to consumers.[11] Therefore, the platform chooses c to maximize profit $\Pi = c \sum_i D_i = c \cdot N$.

Social welfare is defined as the sum of consumer surplus and profits of all firms: $W = CS + \Pi + \sum_i (\pi_i - e)$.

The analysis of this paper specifically examines a situation in which consumers do not sample all products sold in the marketplace. That is, $s < n$ holds in equilibrium, which requires the following assumption.

Assumption 1. *The fixed entry cost of sellers is assumed to be sufficiently low to satisfy*

$$e < \min\left\{\frac{\mu^2\sigma \cdot \psi(\mu,\sigma)}{2(\mu-\sigma)(\mu+\sigma)}\ ,\ \frac{\sigma \cdot \psi(\mu,\sigma)}{2} + \frac{\mu\sigma^2}{2(\mu-\sigma)}\right\},$$

where $\psi(\mu,\sigma) = \mu \ln \frac{\mu}{\sigma} - \mu - \frac{\mu^2}{\mu-\sigma}$.

II(ii) Equilibrium

The benchmark game is solved using backward induction.

First, decisions made in Stage 2 are examined. The following lemma presents the symmetric Nash equilibrium.

Lemma 1. *Given* c, N, *and* n, *there exists a symmetric equilibrium for Stage 2 with* $p^*(c) = c + \frac{\mu^2}{\mu-\sigma}$ *and* $s^* = \frac{\mu}{\sigma}$. *The resulting sellers' and consumers' payoffs are computed respectively as* $\pi^*(c) = \frac{N}{n} \cdot \frac{\mu^2}{\mu-\sigma}$ *and* $V^*(c) = \mu \ln(\mu/\sigma) - \mu - p^*$.

It is noteworthy that the resulting price is independent of the number of sellers. This stems from the assumption that consumers purchase from a seller out of s sellers they sample, as presumed in Anderson et al. [1992]. This search framework greatly simplifies the analysis for price competition, even if the number of sellers changes endogenously. Moreover, this situation would be a natural one because no consumer samples all the products sold in the marketplace.

Next, the decisions made in Stage 1 are considered. Given commission fee c, consumers with $l \leq V^*(c)$ participate in the marketplace, which implies that $N^*(c) = F(V^*(c))$. For simplicity, one assumes that $F(\cdot)$ is a uniform distribution along the unit interval $[0,1]$, i.e., $l \sim U(0,1)$. Consequently, $N^*(c) = V^*(c)$. Sellers participate in the marketplace with free entry, i.e., the resulting number of sellers solves the zero-profit condition $\pi^*(c) = e$.

Specifically, the demand functions for the consumer side and seller side are given as shown below.

$$N^*(c) = \left(\mu \ln \frac{\mu}{\sigma} - \mu - \frac{\mu^2}{\mu - \sigma}\right) - c$$
$$n^*(c) = \frac{N^*(c)}{e} \cdot \frac{\mu^2}{\mu - \sigma}$$

For ease of exposition, let $\psi(\mu, \sigma) \equiv \mu \ln \frac{\mu}{\sigma} - \mu - \frac{\mu^2}{\mu - \sigma}$.

The platform chooses c to maximize

$$\Pi^*(c) = c \cdot N^*(c). \tag{1}$$

The first-order condition is given as

$$N^*(c) + c \cdot \frac{dN^*(c)}{dc} = 0. \tag{2}$$

Solving this condition yields the following proposition related to the equilibrium for the benchmark model. Superscript 'I' represents the equilibrium outcome when the platform serves as a pure *intermediary*.

Proposition 1. *Presuming that the platform serves as a pure intermediary, then the platform charges the following commission fee in equilibrium.*

$$c^I = \frac{\psi(\mu, \sigma)}{2} = \frac{1}{2}\left(\mu \ln \frac{\mu}{\sigma} - \mu - \frac{\mu^2}{\mu - \sigma}\right)$$

The other outcomes are presented in Table I.

The equilibrium commission fee c^I increases with μ and decreases with σ. The former implies that, as the sellers become more differentiated, the platform charges a higher commission. The latter means that the higher the consumers' search cost becomes, the lower the commission fee is.

III Platform Encroachment

In this section, the benchmark model is extended such that the platform sells its first-party product through the marketplace (i.e., platform encroachment).

How the benchmark model changes with platform encroachment is described in Section III(i). Specifically, search engines of two types are considered: fair and biased. Section III(ii) presents the analysis of fair encroachment, whereas Section III(iii) exhibits the analysis of biased encroachment. Finally, in Section III(iv), three models are compared to investigate the optimal platform design: pure intermediary, fair encroachment, and biased encroachment.

III(i) Changes in the setting

The platform encroaches into the marketplace by selling its first-party product with a fixed encroachment cost, which is denoted as e_0. Unlike the benchmark model, the platform competes with third-party sellers in Stage 2. Here, p_0 is used to denote the price for the first-party product.

As in the benchmark model, the probability that each third-party product is included in a search result is identical across all third-party sellers. Regarding the probability of the first-party product, search engines of two types are examined. The first one is a fair search engine in which the probability that the first-party product is included in a search result is equal to the probability for third-party products. Consequently, given n and s_l, the probability that seller i's product appears in the search result of consumer l is calculated as $\text{Prob}(i \in \mathcal{C}_l; s_l) = s_l/(n+1)$ for $i = \{0, \ldots, n\}$.

The second one is a biased search engine in which the first-party product is more likely to appear in search results. For simplicity, the completely biased search engine is considered, i.e., the first-party product is certainly displayed in all consumers' search results. That is, for all $l \in [0, N]$, it holds that $\text{Prob}(0 \in \mathcal{C}_l; s_l) = 1$ and $\text{Prob}(i \in \mathcal{C}_l; s_l) = (s_l - 1)/n$ for $i = \{1, \ldots, n\}$. This assumption is relaxed in Section V(ii).

Irrespective of the type of search engine, the platform's profit is written as $\Pi = p_0 D_0 + c(N - D_0) - e_0$, where $D_0 = N \cdot \text{Prob}(0 \in \mathcal{C}; s) \cdot \mathbb{P}_0$ with

$$\mathbb{P}_0 = \frac{\exp(-p_0/\mu)}{\sum_{j \in \mathcal{C}} \exp(-p_j/\mu)}.$$

III(ii) Fair search engine

First, one can examine decisions in Stage 2. As in the benchmark model, the symmetric equilibrium among third-party sellers is examined, i.e., $p_i = p^{**}$ for $i \in \{1, \ldots, n\}$. Additionally, p_0^{**} is used to denote the equilibrium price for the first-party product and s^{**} to represent the number of consumer searches.

The following lemma presents the symmetric Nash equilibrium for Stage 2.

Lemma 2. *Presume that the platform encroaches into its marketplace and that the search engine is fair. Given c, N, and n, there exists a symmetric equilibrium for Stage 2 with $p_0^{**}(c) = p^{**}(c) = c + \frac{\mu^2}{\mu - \sigma}$ and $s^{**} = \frac{\mu}{\sigma}$. The resulting sellers' and consumers' payoffs are given respectively as $\pi^{**}(c) = \frac{N}{n+1} \cdot \frac{\mu^2}{\mu - \sigma}$ and $V^{**}(c) = \mu \ln(\mu/\sigma) - \mu - p^{**}$.*

It is noteworthy that the resulting prices for the first-party and third-party products are the same (i.e., $p_0^{**} = p^{**}$) because both the platform and third-party sellers have the same marginal cost in price competition. The third-party sellers' marginal cost of selling a product is equal to c, which is the per-unit commission paid to the platform. In addition, the platform's effective marginal cost is equal to c. If the platform wins to sell a unit of its first-party product to a consumer, then it fails to earn per-unit commission revenue c, which it can receive from a third-party seller. Therefore, all first-party and third-party products are sold at effectively the same marginal cost, which results in the same price.

Moreover, it is worth emphasizing that the resulting price and the number of searches are the same as those of the benchmark model (i.e., $p^* = p^{**}$ and $s^* = s^{**}$). This result derives from the search framework used in this paper: consumers purchase from a seller out of s sellers they sample. That is, price competition depends on the number of consumer searches, not on the number of sellers. Therefore, even though platform encroachment changes the number of products from n to $n+1$, it does not change the resulting price, which yields the same consumer surplus (i.e., $V^* = V^{**}$).

In contrast, the seller profit has changed because some consumers are taken by the encroaching platform, i.e., $\pi^* > \pi^{**}$, which implies that seller participation in Stage 1 declines with platform encroachment.

Next, the decisions in Stage 1 must be examined. Demand functions for the consumer side and seller side are given respectively as shown below.

$$N^{**}(c) = \left(\mu \ln \frac{\mu}{\sigma} - \mu - \frac{\mu^2}{\mu - \sigma}\right) - c$$
$$n^{**}(c) = \frac{N^{**}(c)}{e} \cdot \frac{\mu^2}{\mu - \sigma} - 1$$

Given a commission, the demand function for the consumer-side is the same as that derived in the benchmark model, i.e., $N^*(c) = N^{**}(c)$. In contrast, platform encroachment reduces the number of third-party sellers by one, i.e., $n^{**}(c) = n^*(c) - 1$, implying that, including the first-party product, the total number of products sold in the marketplace has not changed.

Then the profit of the platform is calculated as shown below.

$$
\begin{aligned}
\Pi^{**}(c) &= \{p_0^{**}(c) - c\} N^{**}(c) \cdot \frac{s^{**}}{n^{**}(c)+1} \cdot \frac{1}{s^{**}} + c \cdot N^{**}(c) - e_0 \\
&= \frac{\mu^2}{\mu - \sigma} \cdot \frac{N^{**}(c)}{n^{**}(c)+1} + c \cdot N^{**}(c) - e_0 \\
&= \frac{\mu^2}{\mu - \sigma} \cdot \frac{N^{*}(c)}{n^{*}(c)} + c \cdot N^{*}(c) - e_0 \\
&= c \cdot N^{*}(c) + e - e_0 \qquad (3)
\end{aligned}
$$

Therefore, the first-order condition is the same as that of the benchmark model presented in Equation (2), which yields the following proposition.

Proposition 2. *Presume that the platform encroaches into its marketplace and that the search engine is fair. The equilibrium commission fee is the same as that derived in the benchmark model (i.e.,* $c_f^E = c^I$*). The other outcomes are presented in Table I.*

Superscript 'E' represents the equilibrium outcome for the case with platform *encroachment*. Subscript 'f' denotes that the search engine is *fair*.

Proposition 2 demonstrates that platform encroachment does not alter the equilibrium commission fee if the search engine is fair between first-party and third-party products. Detailed comparisons for the other outcomes are presented in Section IV.

III(iii) Biased search engine

First, one can examine decisions in Stage 2. The symmetric equilibrium among third-party sellers is examined, i.e., $p_i = p^{***}$ for $i \in \{1, \ldots, n\}$. Moreover, the first-party price and the number of consumer searches are denoted by p_0^{***} and s^{***}, respectively.

Lemma 3. *Presuming that the platform encroaches into its marketplace, then search engine is biased completely toward the first-party product. Given* c*,* N*, and* n*, there* *exists a symmetric equilibrium for Stage 2 with* $p_0^{***}(c) = p^{***}(c) = c + \frac{\mu^2}{\mu-\sigma}$ *and* $s^{***} = \frac{\mu}{\sigma}$. *The resulting sellers' and consumers' payoffs are given as* $\pi^{***}(c) = \frac{N}{n} \cdot \frac{s^{***}-1}{s^{***}} \cdot \frac{\mu^2}{\mu-\sigma}$ *and* $V^{***}(c) = \mu \ln(\mu/\sigma) - \mu - p^{***}$.

From Lemmas 1, 2, and 3, it follows that $p^* = p^{**} = p^{***}$, $s^* = s^{**} = s^{***}$, and $V^* = V^{**} = V^{***}$. Consequently, given a commission c, the consumer-side demand function in Stage 1 is the same across the three models: $N^*(c) = N^{**}(c) = N^{***}(c)$.

By contrast, the sellers' profit has changed. Platform encroachment reduces the sellers' profit, i.e., $\pi^*(c) > \pi^{***}(c)$, which also implies $n^*(c) > n^{***}(c)$. Specifically, the seller-side demand function in Stage 1 is computed as follows.

$$n^{***}(c) = \frac{N^{***}(c)}{e} \cdot \frac{s^{***}-1}{s^{***}} \cdot \frac{\mu^2}{\mu-\sigma}$$

Therefore, the platform's profit is calculated as shown below.

$$\begin{aligned}
\Pi^{***}(c) &= \{p_0^{***}(c) - c\} N^{***}(c) \cdot 1 \cdot \frac{1}{s^{***}} + c \cdot N^{***}(c) - e_0 \\
&= \frac{\mu^2}{\mu-\sigma} \cdot \frac{N^{***}(c)}{s^{***}} + c \cdot N^{***}(c) - e_0 \\
&= \frac{\mu\sigma}{\mu-\sigma} \cdot N^*(c) + c \cdot N^*(c) - e_0 \\
&= \left(c + \frac{\mu\sigma}{\mu-\sigma}\right) \cdot N^*(c) - e_0 \qquad (4)
\end{aligned}$$

Comparing the profit function (4) with those in the other models (1) and (3), one can notice that the presence of own-content biases enables the platform to earn greater profits per consumer. Specifically, the term $\frac{\mu\sigma}{\mu-\sigma}$ in Equation (4) represents gains from own-content biases per consumer. This higher per-consumer profitability encourages the platform to attract more consumers. Indeed, in comparison with the first-order condition (2) derived in the other two models, the following first-order condition implies that the equilibrium commission fee declines with own-content biases as

$$N^*(c) + \left(c + \frac{\mu\sigma}{\mu-\sigma}\right) \cdot \frac{dN^*(c)}{dc} = 0, \tag{5}$$

because $\frac{dN^*(c)}{dc} < 0$.

The following proposition summarizes the preceding argument. Subscript '*b*' denotes that the search engine is *biased*.

Proposition 3. *Presume that the platform encroaches into its marketplace and the search engine is biased completely toward the first-party product. The platform charges a commission fee as*

$$c_b^E = \frac{\psi(\mu,\sigma)}{2} - \frac{\mu\sigma}{2(\mu-\sigma)},$$

which is strictly less than c^I and c_f^E. The other outcomes are presented in Table I.

Interestingly, own-content biases lead the platform to reduce its commission fee. More detailed comparisons across the three models are presented in Section IV.

Place Table I about here.

III(iv) Platform design

Three platform designs are examined: (i) pure intermediary, (ii) fair encroachment, and (iii) biased encroachment. Here, the optimal platform design is sought.

Comparison between Π^I, Π_f^E, and Π_b^E yields the following proposition.

Proposition 4. *Under Assumption 1, fair encroachment is never optimal for the platform. Letting $\bar{e}(\mu,\sigma) \equiv \frac{\mu\sigma\{2(\mu-\sigma)\psi+\mu\sigma\}}{4(\mu-\sigma)^2}$, then the biased encroachment is optimal if and only if $e_0 < \bar{e}(\mu,\sigma)$ holds. Otherwise, if $e_0 > \bar{e}(\mu,\sigma)$ hold, the pure intermediary is optimal.*

As one might expect, the platform refrains from encroaching into its marketplace if the encroachment cost is sufficiently high. Otherwise, the platform has an incentive to encroach. In so doing, it biases search results in favor of its first-party product.

IV Competitive Effects of Own-Content Biases

In an earlier section, Proposition 4 shows that the platform chooses either pure intermediary or biased encroachment depending on the degree of its encroachment cost. This section presents the effect of own-content biases. Specifically, the equilibrium commission, price, consumer participation, seller participation, and social welfare are compared among the three models to provide additional insights into how the platform's design choice affects other players in the marketplace.

First, the following corollary is derived.

Corollary 1. *Among the three models, the equilibrium commission fees are ordered as* $c^I = c_f^E > c_b^E$. *Accordingly, the lower commission fee results in the lower price, which in turn attracts more consumers. Formally,* $p^I = p_f^E > p_b^E$, $N^I = N_f^E < N_b^E$, *and* $CS^I = CS_f^E < CS_b^E$.

Corollary 1 indicates that platform encroachment itself is not detrimental to consumers. Fair encroachment does not change consumer participation or the resulting surplus. In addition, and what is of greater interest, biased encroachment is rather beneficial to consumers. Own-content biases induce the platform to lower its commission fee, which makes the resulting price lower. Therefore, consumers benefit from platform encroachment with own-content biases.

In contrast, the effect of biased encroachment on third-party sellers is ambiguous.

Corollary 2. *Fair encroachment does not maximize the number of third-party sellers (i.e.,* $n^I > n_f^E$*). Biased encroachment maximizes seller participation if and only if* $\mu > \psi(\mu,\sigma)$ *holds. Otherwise, pure intermediary maximizes seller participation.*

Actually, $\psi(\mu, \sigma)$ is a decreasing function in $\sigma > 0$. Therefore, condition $\mu > \psi(\mu, \sigma)$ is more likely to hold as σ becomes larger. In other words, the higher the per-unit search cost becomes, the more likely the biased platform encroachment is to maximize the number of third-party sellers.

The intuition underlying this result is the following. Consumers with a high search cost are expected to be reluctant to join the marketplace. Even in that case, as shown in Corollary 1, biased encroachment makes the platform strive to attract more consumers by lowering its commission fee. Both the low commission and greater consumer participation can benefit third-party sellers eventually. Therefore, when these gains dominate losses from an increase in the number of competitors associated with platform encroachment, biased encroachment encourages third-party sellers to participate in the marketplace.

Finally, the welfare effect is demonstrated as explained below.

Corollary 3. *Whenever the platform chooses biased encroachment, it produces the greatest social welfare. Formally, it follows that* $W_b^E > \max\{W^I, W_f^E\}$ *if* $e_0 < \bar{e}(\mu, \sigma)$.

In summary, biased encroachment not only increases consumer participation (Corollary 1); it can also stimulate seller participation (Corollary 2). Therefore, when the fixed cost is so low that the platform encroaches into its marketplace with the biased search engine (Proposition 4), the platform's private decision is desirable in terms of social welfare (Corollary 3). Therefore, one can conclude that own-content biases are not necessarily anti-competitive. Rather, they can be pro-competitive.

V Extensions

As presented in this section, the model is extended in several ways to confirm the robustness of the results derived earlier.

V(i) Biased search engine without platform encroachment

In the main analyses, to explore the effects of platform encroachment and own-content biases, three platform designs have been examined: pure intermediary, fair encroachment, and biased encroachment. One can consider another design in which the platform does not encroach into its marketplace, but one for which the search engine is biased in favor of a third-party seller (say, a prominent seller). The pure intermediary platform might monetize by selling the right of prominence in search results to third-party sellers.[12] This subsection presents an investigation of how selling the prominence alters the equilibrium.

Specifically, the following game is examined. First, a pure intermediary platform charges a commission c. Second, the platform sells the right of prominence in search results through an auction among $\overline{n}$ potential sellers, where $\overline{n}$ is presumed to be sufficiently large. Moreover, all sellers are assumed to be identical. As a result of the auction, a winning seller is determined, where the winner is selected randomly if all bids are equal. Third, consumers and sellers (including a winning seller and the other standard sellers) decide, in the same manner as that of the main analyses, whether to participate in the marketplace. Fourth, active sellers choose prices. Consumers sample s of the available n active sellers; then they choose the one generating the highest utility.

In the final stage, given that a winning seller has prominence in search results (say, seller 1), price competition occurs. As in Lemmas 1, 2, and 3, each seller charges the same price, irrespective of whether the seller is a prominent seller. Formally, $p_i = \hat{p}$ for all $i = 1, \ldots, n$, as presented below.

Lemma 4. *Consider that the platform does not encroach into its marketplace and that the search engine is biased in favor of a prominent seller. Given c, N, and n, there exists a* *symmetric equilibrium with* $\hat{p}(c) = c + \frac{\mu^2}{\mu-\sigma}$ *and* $\hat{s} = \frac{\mu}{\sigma}$*. The resulting consumer payoff is given as* $\hat{V}(c) = \mu \ln(\mu/\sigma) - \mu - \hat{p}$*. The prominent seller earns* $\hat{\pi}_1(c) = N \cdot \frac{\mu\sigma}{\mu-\sigma}$*, whereas the others obtain* $\hat{\pi}(c) = \frac{N}{n-1} \cdot \frac{\hat{s}-1}{\hat{s}} \cdot \frac{\mu^2}{\mu-\sigma}$.

The resulting price and number of searches are the same as those of Lemmas 1, 2, and 3 (i.e., $\hat{p} = p^* = p^{**} = p^{***}$ and $\hat{s} = s^* = s^{**} = s^{***}$). As a result, the consumer payoff also remains unchanged, i.e., $\hat{V}(c) = V^*(c) = V^{**}(c) = V^{***}(c)$. Therefore, the number of consumers who participate in the marketplace is derived as $\hat{N}(c) = \psi(\mu,\sigma) - c$, which is equivalent to $N^*(c)$.

Lemma 4 also implies that the prominent seller gains a greater payoff than the other standard sellers, i.e., $\hat{\pi}_1(c) > \hat{\pi}(c)$. Consequently, it participates in the marketplace as long as at least one standard seller does. Thus, the resulting number of sellers solves the zero-profit condition for standard sellers, i.e., $\hat{\pi}(c) = e$, resulting in $\hat{n}(c) = 1 + \frac{N}{e} \cdot \frac{\hat{s}-1}{\hat{s}} \cdot \frac{\mu^2}{\mu-\sigma}$.

In the second stage, $\overline{n}$ potential sellers participate in an auction to win the right of prominence. In equilibrium, all identical sellers post the same bid, denoted as $\hat{b}$. Consequently, a prominent seller is determined randomly. The winning seller derives $\hat{\pi}_1(c) - e - \hat{b}$. The others obtain zero profit, irrespective of whether they will participate in the marketplace as a standard seller afterward. Therefore, given commission c, the equilibrium bid must be equal to the value of prominence, i.e., $\hat{b}(c) = \hat{\pi}_1(c) - e$.

In the first stage, the platform chooses c to maximize the following profit.

$$\begin{aligned}
\hat{\Pi}(c) &= c\hat{N}(c) + \hat{b}(c) \\
&= c\hat{N}(c) + \hat{N}(c) \cdot \frac{\mu\sigma}{\mu-\sigma} - e \\
&= \left(c + \frac{\mu\sigma}{\mu-\sigma}\right) \cdot N^*(c) - e
\end{aligned}$$

One can note that the first-order condition is the same as that of biased encroachment presented in Equation (5).

Proposition 5. *When the platform does not encroach into its marketplace and the search engine is biased in favor of a prominent seller, the equilibrium commission fee is the same as that of biased encroachment.*

This proposition shows that, provided that the search engine is completely biased, the resulting commission fee is independent of whether the platform encroaches or not. It is noteworthy that this neutrality result stems from the fact that, in both platform designs, the platform can fully extract gains generated from the search bias.

The neutrality result also holds even when the search engine is fair, as already demonstrated in Proposition 2. In total, one can infer that the competitive effect of biases in search results can be assessed independently of whether the platform encroaches into the marketplace or not. The ability to bias search results, which generates additional revenues, induces the platform to impose a lower commission fee on third-party sellers in an effort to attract more consumers. The increased consumer participation might enhance the participation of third-party sellers through indirect network externalities.

V(ii) Generalization of search engine biases

Section III presents examination of search engines of two extreme types. Here, the degree of search bias is generalized. One can use $\beta \leq 1$ to demonstrate the probability that the first-party product is included in the search result of each consumer, which measures the degree of own-content biases. That is, if $\beta = 1$, then the search engine is completely biased toward the first-party product, which is equivalent to the case of biased encroachment.

In this generalized model, by definition, it holds that $\text{Prob}(0 \in \mathcal{C}; s) = \beta$. Then, provided that third-party products are equally likely to appear in a search result, the probability that third-party seller i is included in the search result of each consumer is given as

$$\mathrm{Prob}(i \in \mathcal{C}; s) = \beta \cdot \frac{s-1}{n} + (1-\beta) \cdot \frac{s}{n} = \frac{s-\beta}{n} \quad \text{for} \quad i = 1, \ldots, n.$$

If $\beta = s/(n+1)$, then $\mathrm{Prob}(0 \in \mathcal{C}; s) = \mathrm{Prob}(i \in \mathcal{C}; s)$ holds, implying that the search engine is fair. In this subsection, own-content biases are presumed to exist, i.e., $s/(n+1) < \beta \leq 1$.

From Lemmas 1, 2, and 3, price competition in Stage 2 is independent of the characterizations of $\mathrm{Prob}(i \in \mathcal{C}; s)$. That is, irrespective of the value of β, all prices are set at $p^*(c)$ and the number of consumer searches is s^*, implying consumer participation remains as $N^*(c)$.

In Stage 1, the encroaching platform chooses c to maximize

$$\begin{aligned} \Pi &= \{p^*(c) - c\} N^*(c) \cdot \beta \cdot \frac{1}{s^*} + c \cdot N^*(c) - e_0 \, , \\ &= \left(c + \beta \cdot \frac{\mu\sigma}{\mu - \sigma}\right) \cdot N^*(c) - e_0 \, , \end{aligned} \tag{6}$$

which engenders the following proposition.

Proposition 6. *In the generalized model of search biases, the commission fee is computed as* $c(\beta) = \frac{\psi(\mu,\sigma)}{2} - \beta \cdot \frac{\mu\sigma}{2(\mu-\sigma)}$*, which decreases with* β*.*

As the degree of own-content biases gets larger, the platform earns greater per-consumer profits from first-party selling, as presented in Equation (6). To gather more consumers, the platform charges a lower commission. Therefore, the mechanism underlying in the main analyses still works, even with the generalization of search biases.

V(iii) Platform competition

The effects of platform competition on the main results can be derived.

Specifically, two differentiated platforms A and B are considered. To analyze the consumers' choices of platform, a Hotelling model of product differentiation is used. Consumers have heterogeneous tastes for the platform, denoted by $x \in [0,1]$, which are distributed uniformly on the unit interval with unit density. Platforms A and B are differentiated along with the unit interval, with platform A located at 0 and platform B at 1. Each user incurs a constant proportional disutility per unit length, denoted as t.

For this extended analysis, it is assumed that, in Stage 1, after observing commissions c_A and c_B, consumers decide which platform to join (i.e., single-homing), whereas sellers decide whether to participate in each platform (i.e., multi-homing).

Price competition in Stage 2 remains unchanged. Then, given c_k, N_k, and n_k ($k = A, B$), all prices are set at $p^*(c_k)$. The number of consumer searches is eventually equal to s^*. Each consumer enjoys a surplus of $V^*(c_k) = \mu \ln(\mu/\sigma) - \mu - p^*(c_k) = \psi(\mu,\sigma) - c_k$. Therefore, the utility of consumers who choose platform k is given as shown below.

$$\begin{cases} u_A(x) = \psi(\mu,\sigma) - c_A - tx \\ u_B(x) = \psi(\mu,\sigma) - c_B - t(1-x) \end{cases}$$

Solving $u_A(x) = u_B(x)$ gives the types of consumers who are indifferent between the two platforms as $\hat{x} = \frac{t - c_A + c_B}{2t}$. Consequently, the consumer demands for two platforms are given as $N_A(\mathbf{c}) = \hat{x}$ and $N_B(\mathbf{c}) = 1 - \hat{x}$, where $\mathbf{c} = (c_A, c_B)$. It is apparent that $\frac{dN_k(\mathbf{c})}{dc_k} = -\frac{1}{2t}$.

Considering the generalized model presented in Section V(ii), the first-order condition is presented as

$$N_k(\mathbf{c}) + \left(c_k + \beta \cdot \frac{\mu\sigma}{\mu - \sigma}\right) \cdot \frac{dN_k(\mathbf{c})}{dc_k} = 0 \quad \text{for} \quad k = A, B,$$

which implies that $c_A = c_B = t - \beta \cdot \frac{\mu\sigma}{\mu-\sigma}$ in the symmetric equilibrium.

It is readily apparent that this equilibrium commission fee decreases with the degree of search biases (i.e., β). Therefore, even with platform competition, the main finding remains qualitatively unchanged.

V(iv) Membership fee

In the main analyses, free entry of third-party sellers is considered. That is, they must incur a fixed entry cost e to participate in the platform's marketplace. One can regard the entry cost as a membership fee charged by the platform. This subsection presents an analysis of how the equilibrium outcomes change if the platform can charge both a membership fee and a commission fee endogenously. Specifically, the game is altered so that the platform chooses c and e in Stage 1. The other setting remains unchanged. Therefore, in what follows, the platform's decisions in Stage 1 are analyzed for three models of platform design.

First, the profit of the pure intermediary platform is given as presented below.

$$\begin{aligned} \Pi &= cN^*(c) + en^*(c) \\ &= cN^*(c) + e \cdot \left(\frac{N^*(c)}{e} \cdot \frac{\mu^2}{\mu - \sigma}\right) \\ &= \left(c + \frac{\mu^2}{\mu - \sigma}\right) \cdot N^*(c) \end{aligned} \tag{7}$$

Next, under fair encroachment, the platform profit is calculated as shown below.

$$\begin{aligned}
\Pi &= (p_0^{**} - c)\cdot N^{**}(c)\cdot \frac{s^{**}}{n^{**}(c)+1}\cdot\frac{1}{s^{**}} + cN^{**}(c) + en^{**}(c) - e_0 \\
&= \frac{\mu^2}{\mu-\sigma}\cdot\frac{N^*(c)}{n^*(c)} + cN^*(c) + e\cdot\left(\frac{N^*(c)}{e}\cdot\frac{\mu^2}{\mu-\sigma} - 1\right) - e_0 \\
&= \left(c + \frac{\mu^2}{\mu-\sigma}\right)\cdot N^*(c) - e_0 \qquad (8)
\end{aligned}$$

Lastly, the profit under biased encroachment is written as the following.

$$\begin{aligned}
\Pi &= (p_0^{***} - c)\cdot N^{***}(c)\cdot 1\cdot\frac{1}{s^{***}} + cN^{***}(c) + en^{***}(c) - e_0 \\
&= \frac{\mu^2}{\mu-\sigma}\cdot\frac{N^*(c)}{s^*} + cN^*(c) + e\cdot\left(\frac{N^*(c)}{e}\cdot\frac{s^*-1}{s^*}\cdot\frac{\mu^2}{\mu-\sigma}\right) - e_0 \\
&= \left(c + \frac{\mu^2}{\mu-\sigma}\right)\cdot N^*(c) - e_0 \qquad (9)
\end{aligned}$$

From Equations (7), (8), and (9), one can note that the platform's profit functions are independent of e, as long as it is sufficiently low to satisfy Assumption 1. When the platform charges a membership fee in addition to a commission fee to third-party sellers, it can extract all surplus from third-party sellers. This capability implies that the platform behaves as a monopolistic multi-product firm that sells n products. Therefore, irrespective of its platform design, the monopolist earns the same profit from consumers, excluding the fixed encroachment cost e_0. As a result, all three models yield the same first-order condition with respect to commission fee c. Therefore, the effects of own-content biases are nullified when the platform can charge both membership and commission fees.

VI Discussions

This section presents some discussion of how the main results would change when relaxing some of the assumptions imposed for this study. First, in the main analyses, all products sold in the marketplace are assumed to be ex ante identical to consumers in terms of the stand-alone benefit and marginal cost. Such can be the case, for example, when the platform and third-party sellers procure the same product from a manufacturer and then resell the product to consumers. In many cases, however, products are heterogeneous in many respects such as quality, design, and shipping cost. The platform might present some (dis)advantages over third-party sellers, depending on circumstances. Some disadvantages might be related to production costs. The platform might have some advantages in distribution costs.

The main results presented in this paper are expected to remain robust even if some heterogeneity among products is incorporated because the key mechanism depends on the fact that own-content biases enable the platform to earn greater profits per consumer visiting the marketplace. Although the existence of product heterogeneity might affect the extent to which own-content biases increase the platform's per-consumer profit, it would remain fundamentally intact that the increased per-consumer profit associated with own-content biases incentivizes the platform to lower its commission fee in an effort to attract many consumers.

Second, the platform is regarded as imposing a per-unit commission. In practice, however, many platforms use ad valorem commissions.[13] With an ad valorem commission rate, denoted as $r \in [0,1]$, seller i's profit can be written as $\pi_i = (1-r)p_i D_i$, which implies that each third-party seller chooses a price as if the marginal cost of selling a product were equal to zero. In contrast, when encroaching, the platform's profit is given as $\Pi = p_0 D_0 + \sum_{i=1}^{n} r p_i D_i$. In symmetric equilibrium with $p_1 = \cdots = p_n = p > 0$, it follows that $\Pi = p_0 D_0 + rp(N - D_0)$. Consequently, the platform's effective marginal cost of selling a product is calculated as rp, which is strictly greater than that of third-party sellers for any $r > 0$.

Therefore, consideration of ad valorem commissions is qualitatively similar to consideration of a situation in which the platform has some cost disadvantage compared to third-party sellers. As discussed above, what is important in this paper is that the presence of own-content biases enables the platform to earn greater profits from each consumer visiting the marketplace. Consequently, an ad valorem commission rate would not yield additional qualitative insights while engendering greater analytical complexity.

VII Conclusion

This paper presents an examination of how first-party selling and own-content biases interplay in e-commerce platforms. Results indicate the possibility that biased encroachment is not necessarily anti-competitive, but rather pro-competitive, which contrasts sharply to the conclusions obtained from existing studies.

The key drivers generating this counter-intuitive finding are twofold: The profitability of first-party selling and the presence of indirect network externalities. Own-content biases help the platform gain effectively from first-party selling; then it increases its per-consumer profits. High per-consumer profitability incentivizes the platform to gather more consumers in the marketplace. Toward this end, the platform decreases its commission fee to lower product prices. Therefore, consumers benefit from biased encroachment. Consequently, more consumers participate in the marketplace. Additionally, although own-content biases make it difficult for third-party sellers to sell their products, they might stimulate seller participation through low commissions and greater consumer participation.

Own-content biases induce the platform to build huge transaction networks, which can be beneficial to the platform, consumers, and sellers. This is the case in which the platform's encroachment cost is low and the consumers' search cost is high.

In other words, a ban on one's own content biases discourages the platform from expanding its marketplace, thereby leading it to charge high commissions. Eventually, product prices in the marketplace rise, which might be detrimental not only to consumers but also to third-party sellers. The same applies to arguments about separation of the marketplace and reseller divisions.

An important caveat is that the pro-competitive effects of own-content biases are shown using the specific model, which might lack some realistic features. Under the search framework used in the model, when the number of sellers is greater than a certain threshold, additional seller participation does not improve the match value: it reduces social welfare because of the entry cost.

Moreover, for search engine biases modeled as described herein, this paper involves no direct harm to consumers in terms of expectations. In equilibrium, all first-party and third-party products are set at the same price. That is, they are ex-ante identical for every consumer. Therefore, including the first-party product among the search results has no deleterious effect on consumers' expected payoff. However, in practice, this would not be the case. Actually, widely various products are sold in a marketplace. Consumers have heterogeneous tastes for them. One might wonder that a biased search engine (or a biased recommendation algorithm) is less beneficial to consumers than the unbiased one if the latter is designed to maximize the net match value of each consumer.

Additionally, for the arguments presented in this paper, results of consumer searches are presumed to be independent of product prices. In practice, Amazon allows consumers to sort search results by price either from low to high or from high to low, although these are not set as the default. The Amazon default search order sorting is set to ‘featured’, where search results are apparently ordered according to various factors such as prices, reviews, sponsored, and rankings. Indeed, the details are black boxes. Therefore, considering a random search model is expected to be a better first step to examine the competitive effects of own-content biases. It would nevertheless be important to examine how the results presented herein differ for different search algorithms.

These aspects are not incorporated in the stylized model presented here, although this model provides an important message about the pro-competitive effects of own-content biases. It is expected to be necessary to extend the present model in those ways to revisit the results.

Notes

[1]Details are presented in “Top 10 Ecommerce Retailers Will Grow Their Market Share to 60.1% in 2020”, *eMarketer*, July 14, 2020. Source: `https://www.emarketer.com/content/top-10-ecommerce-retailers-will-grow-their-share-60-2020`

[2]In an interview, Sally Hubbard, an antitrust expert, pointed out that “Amazon is controlling the game and playing it too.” She calls this conduct ‘platform privilege’. Source: `https://www.marketplacepulse.com/articles/amazon-is-a-monopoly-an-interview-with-sally-hubbard`

[3]One description is presented in “Amazon Changed Search Algorithm in Ways That Boost Its Own Products”, *the Wall Street Journal*, September 16, 2019. Source: `https://www.wsj.com/articles/amazon-changed-search-algorithm-in-ways-that-boost-its-own-products-11568645345`

[4] The issue of platform privilege has been viewed with suspicion also in online platforms other than e-commerce platforms. Google’s “Project Bernanke” can be regarded as a recent example of platform privilege. Reportedly, Google has used data collected from past bids in its digital advertising exchange to favor its own ad-buying system over that of third-party competitors. Details are presented in “Google’s Secret ‘Project Bernanke’ Revealed in Texas Antitrust Case”, *the Wall Street Journal*, April 11, 2021. Source: `https://www.wsj.com/articles/googles-secret-project-bernanke-`

revealed-in-texas-antitrust-case-11618097760

[5]Source: https://medium.com/@teamwarren/heres-how-we-can-break-up-big-tech-9ad9e0da324c

[6]More details are given in "India's tightens e-commerce rules, likely to hit Amazon, Flipkart", *CNBC*, December 26, 2018. Source: https://www.cnbc.com/2018/12/26/indias-tightens-e-commerce-rules-likelyto-hit-amazon-flipkart.html

[7]Several studies compare the two modes (e.g., Hagiu [2007]; Hagiu and Wright [2015a]; Hagiu and Wright [2015b]; Hagiu and Wright [2019]). Some papers refer to the marketplace and reseller modes respectively as agency and wholesale pricing models (e.g., Abhishek et al. [2016]; Foros et al. [2017]; Johnson [2017]; Johnson [2020]). However, they do not examine the dual model of marketplace and reseller modes.

[8]Inderst and Ottaviani [2012] consider that two product providers compete through commissions paid to an intermediary that advises customers. Recent studies also conform to this line of research (e.g., Teh and Wright [2020]). The present paper differs from theirs in that an intermediary, not a product provider, determines commissions.

[9]More details are presented in Section 7.6 "A Logit Model with Search" (Anderson et al. [1992], pp.246–248).

[10] One might consider that most e-commerce platforms apply ad valorem commissions. However, an ad valorem commission rate is considered to engender more analytical complexity, but it does not seem to yield additional qualitative insights. Therefore, for simplicity and tractability, a per-unit commission fee is addressed in this paper, as in recent relevant studies (e.g., Etro [2020]; Hagiu et al. [2020]). Moreover, the main findings of this study can be expected to remain unchanged qualitatively, as discussed in Section VI.

[11] Section V(iv) presents an examination to allow the platform to charge a fixed membership fee in addition to a commission fee.

[12] According to the 2019 annual report of Alibaba Group, in Taobao Marketplace, merchants can purchase *pay-for-performance* (P4P) to drive consumer traffic to a vendor's storefront. Source: https://www.sec.gov/Archives/edgar/data/1577552/000104746919003492/a2238953z20-f.htm

[13] For example, Amazon sets a fixed commission rate for each category (e.g., 6% for personal computers; 8% for camera & photo, consumer electronics, cell phone devices, unlocked cell phones, and video game consoles; 15% for books, video & DVD, music, software & hardware, and video games). Source: https://services.amazon.com/selling/pricing.htm/ Last visited July 16, 2020.

Appendix: Proofs

Proof of Lemma 1 First, provided that all sellers charge the same price p^*, consumers face the following maximization problem with respect to the number of searches: $\max_s \ \mu \ln\left(s \cdot \exp\frac{-p^*}{\mu}\right) - \sigma s$. Solving this problem yields $s^* = \mu/\sigma$, which is independent of the equilibrium price p^*.

Next, price competition among sellers is examined. Consider that seller i deviates from the symmetric equilibrium, whereas the others charge $p_j = p^*$ for $j \neq i$. The profit of the deviating seller is expressed as

$$\pi_i(p_i; p^*) = (p_i - c)N \cdot \mathrm{Prob}(i \in \mathcal{C}; s^*) \cdot \mathbb{P}_i(p_i; p^*),$$

where $\mathrm{Prob}(i \in \mathcal{C}; s^*) = s^*/n$ and

$$\mathbb{P}_i(p_i; p^*) = \frac{\exp(-p_i/\mu)}{\exp(-p_i/\mu) + (s^* - 1)\exp(-p^*/\mu)}.$$

Solving the profit-maximization problem implies that the optimal price $p_i(p^*)$ solves the following equation.

$$p_i(p^*) = c + \frac{\mu}{1 - \mathbb{P}_i(p_i(p^*); p^*)}$$

In symmetric equilibrium, no seller has any incentive to deviate from charging p^* (i.e., $p_i(p^*) = p^*$), wherein they equally attract consumers in expectation (i.e., $\mathbb{P}_i(p^*; p^*) = 1/s^*$). Therefore, it follows that $p^* = c + \frac{\mu^2}{\mu - \sigma}$. Using s^* and p^*, one can obtain π^* and V^*. ■

Proof of Lemma 2 First, provided that all prices are the same (i.e., $p_0^{**} = p^{**}$), consumers choose s to maximize $\mu \ln\left(s \cdot \exp\frac{-p^{**}}{\mu}\right) - \sigma s$, which yields $s^{**} = \mu/\sigma (= s^*)$.

Next, given s^{**}, one can examine the pricing decisions. If the platform deviates from charging p_0^{**}, then it chooses p_0 to maximize the following deviation profit:

$$\Pi(p_0; p^{**}) = p_0 N \cdot \text{Prob}(0 \in \mathcal{C}; s^{**}) \cdot \mathbb{P}_0(p_0; p^{**}) + cN\{1 - \text{Prob}(0 \in \mathcal{C}; s^{**}) \cdot \mathbb{P}_0(p_0; p^{**})\} - e_0\,,$$

where $\text{Prob}(0 \in \mathcal{C}; s^{**}) = s^{**}/(n+1)$ and

$$\mathbb{P}_0(p_0; p^{**}) = \frac{\exp(-p_0/\mu)}{\exp(-p_0/\mu) + (s^{**}-1)\exp(-p^{**}/\mu)}.$$

Solving this maximization problem implies

$$p_0(p^{**}) = c + \frac{\mu}{1 - \mathbb{P}_0(p_0; p^{**})}. \tag{A.1}$$

In contrast, if seller i deviates from the symmetric equilibrium, then it chooses p_i to maximize the following deviation profit:

$$\pi_i(p_i; p_0^{**}, p^{**}) = (p_i - c)N \cdot \text{Prob}(i \in \mathcal{C}; s^{**}) \cdot \mathbb{P}_i(p_i; p_0^{**}, p^{**}),$$

where $\text{Prob}(i \in \mathcal{C}; s^{**}) = s^{**}/(n+1)$ and

$$\mathbb{P}_i(p_i; p_0^{**}, p^{**}) = \frac{\exp(-p_i/\mu)}{\exp(-p_i/\mu) + \exp(-p_0^{**}/\mu) + (s^{**}-2)\exp(-p^{**}/\mu)}.$$

Solving this maximization problem implies

$$p_i(p_0^{**}, p^{**}) = c + \frac{\mu}{1 - \mathbb{P}_i(p_i; p_0^{**}, p^{**})}. \tag{A.2}$$

In symmetric equilibrium, no seller has any incentive to deviate (i.e., $p_0(p^{**}) = p_0^{**}$ and $p_i(p_0^{**}, p^{**}) = p^{**}$), wherein they equally attract consumers (i.e., $\mathbb{P}_0(p_0^{**}; p^{**}) =$

$\mathbb{P}_i(p^{**}; p_0^{**}, p^{**}) = 1/s^{**})$. Applying these conditions to Equations (A.1) and (A.2) yields $p_0^{**} = p^{**} = c + \frac{\mu^2}{\mu-\sigma} (= p^*)$. Using s^{**}, p_0^{**}, and p^{**}, one can obtain π^{**} and V^{**}. ■

Proof of Lemma 3 The only difference from Lemma 2 is the content of $\text{Prob}(i \in \mathcal{C}; s)$. In Lemma 2, $\text{Prob}(i \in \mathcal{C}; s) = s/(n+1)$ for all $i \in \{0, \ldots, n\}$. Here, it has changed as shown below.

$$\text{Prob}(i \in \mathcal{C}; s) = \begin{cases} 1 & \text{if } i = 0 \\ \frac{s-1}{n} & \text{if } i = 1, \ldots, n \end{cases}$$

This change does not affect the proof of Lemma 2, which implies that one can obtain the same equilibrium actions, i.e., $p_0^{***} = p_0^{**}$, $p^{***} = p^{**}$, and $s^{***} = s^{**}$.

Additionally, the change in the content of $\text{Prob}(i \in \mathcal{C}; s)$ does not affect the resulting consumer surplus (i.e., $V^{***} = V^{**}$). However, the seller profit has changed as $\pi^{***} = (p^{***} - c)N \cdot \frac{s^{***}-1}{n} \cdot \frac{1}{s^{***}} = \frac{N}{n} \cdot \frac{s^{***}-1}{s^{***}} \cdot \frac{\mu^2}{\mu-\sigma}$ ■

Proof of Proposition 4 First, comparison between Π_f^E and Π_b^E yields that $\Pi_f^E < \Pi_b^E$ holds if and only if $e < \bar{e}(\mu, \sigma)$, where $\bar{e}(\mu, \sigma) \equiv \frac{\mu\sigma\{2(\mu-\sigma)\psi + \mu\sigma\}}{4(\mu-\sigma)^2}$. This inequality certainly holds under Assumption 1. That is, the platform does not adopt fair encroachment in equilibrium. Next, comparison between Π^I and Π_b^E yields that $\Pi^I < \Pi_b^E$ holds if and only if $e_0 < \bar{e}(\mu, \sigma)$. Therefore, one can derive the partition of equilibrium platform design, as presented in the proposition. ■

Proof of Corollary 2 First, from Table I, it is apparent that $n_f^E = n^I - 1$, which indicates that $n^I > n_f^E$ holds certainly. In other words, fair encroachment does not maximize the number of participating sellers. Next, comparison between n^I and n_b^E shows that $n^I > n_b^E$ holds if and only if $\mu < \psi(\mu, \sigma)$. ■

Proof of Corollary 3 First, from Corollary 1, biased encroachment generates the highest consumer surplus. Next, in equilibrium, the seller surplus is equal to zero. Therefore, if biased encroachment enables the platform to gain the highest profit among the three platform designs, it engenders the highest welfare as well. ■

Proof of Lemma 4 First, given that all prices are the same (i.e., $p_i = \hat{p}$ for $i = 1, \ldots, n$), consumers choose s to maximize $\mu \ln\left(s \cdot \exp \frac{-\hat{p}}{\mu}\right) - \sigma s$, which yields $\hat{s} = \mu/\sigma (= s^*)$.

Next, given $\hat{s}$, one can examine pricing decisions. If a prominent seller 1 deviates from charging $\hat{p}$, then it chooses p_1 to maximize the following deviation profit as

$$\pi_1(p_1; \hat{p}) = (p_1 - c)N \cdot \mathrm{Prob}(1 \in \mathcal{C}; \hat{s}) \cdot \mathbb{P}_1(p_1; \hat{p}),$$

where $\mathrm{Prob}(1 \in \mathcal{C}; \hat{s}) = 1$ and

$$\mathbb{P}_1(p_1; \hat{p}) = \frac{\exp(-p_1/\mu)}{\exp(-p_1/\mu) + (\hat{s} - 1)\exp(-\hat{p}/\mu)}.$$

Solving this maximization problem implies that

$$p_1(\hat{p}) = c + \frac{\mu}{1 - \mathbb{P}_1(p_1; \hat{p})}. \tag{A.3}$$

In contrast, if a standard seller i ($i \neq 1$) deviates from the symmetric equilibrium, then it chooses p_i to maximize the following deviation profit as

$$\pi_i(p_i; \hat{p}_1, \hat{p}) = (p_i - c)N \cdot \mathrm{Prob}(i \in \mathcal{C}; \hat{s}) \cdot \mathbb{P}_i(p_i; \hat{p}_1, \hat{p}),$$

where $\mathrm{Prob}(i \in \mathcal{C}; \hat{s}) = (\hat{s} - 1)/(n - 1)$ and

$$\mathbb{P}_i(p_i; \hat{p}_1, \hat{p}) = \frac{\exp(-p_i/\mu)}{\exp(-p_i/\mu) + \exp(-\hat{p}_1/\mu) + (\hat{s} - 2)\exp(-\hat{p}/\mu)}.$$

Solving this maximization problem implies that

$$p_i(\hat{p}_1, \hat{p}) = c + \frac{\mu}{1 - \mathbb{P}_i(p_i; \hat{p}_1, \hat{p})}. \tag{A.4}$$

In the symmetric equilibrium, no price-setter has any incentive to deviate (i.e., $p_1(\hat{p}) = \hat{p}_1$ and $p_i(\hat{p}_1, \hat{p}) = \hat{p}$). They attract consumers equally (i.e., $\mathbb{P}_1(\hat{p}_1; \hat{p}) = \mathbb{P}_i(\hat{p}; \hat{p}_1, \hat{p}) = 1/\hat{s}$). Applying these conditions to Equations (A.3) and (A.4) yields $\hat{p}_1 = \hat{p} = c + \frac{\mu^2}{\mu - \sigma} (= p^*)$. Using $\hat{s}$ and $\hat{p}$, one can obtain $\hat{\pi}_1$, $\hat{\pi}$, and $\hat{V}$ as well. ■

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Table I: Outcomes obtained from the three models

	Pure intermediary	Platform encroachment	
		Fair search	Biased search
c	$\frac{\psi}{2}$	$\frac{\psi}{2}$	$\frac{\psi}{2} - \frac{\mu\sigma}{2(\mu-\sigma)}$
p	$\frac{\psi}{2} + \frac{\mu^2}{\mu-\sigma}$	$\frac{\psi}{2} + \frac{\mu^2}{\mu-\sigma}$	$\frac{\psi}{2} - \frac{\mu\sigma}{2(\mu-\sigma)} + \frac{\mu^2}{\mu-\sigma}$
s	$\frac{\mu}{\sigma}$	$\frac{\mu}{\sigma}$	$\frac{\mu}{\sigma}$
N	$\frac{\psi}{2}$	$\frac{\psi}{2}$	$\frac{\psi}{2} + \frac{\mu\sigma}{2(\mu-\sigma)}$
n	$\frac{\mu^2\psi}{2e(\mu-\sigma)}$	$\frac{\mu^2\psi}{2e(\mu-\sigma)} - 1$	$\frac{\mu\psi}{2e} + \frac{\mu^2\sigma}{2e(\mu-\sigma)}$
Π	$\frac{\psi^2}{4}$	$\frac{\psi^2}{4} + e - e_0$	$\left(\frac{\psi}{2} + \frac{\mu\sigma}{2(\mu-\sigma)}\right)^2 - e_0$
CS	$\frac{\psi^2}{8}$	$\frac{\psi^2}{8}$	$\frac{1}{2}\left(\frac{\psi}{2} + \frac{\mu\sigma}{2(\mu-\sigma)}\right)^2$
W	$\frac{3\psi^2}{8}$	$\frac{3\psi^2}{8} + e - e_0$	$\frac{3}{2}\left(\frac{\psi}{2} + \frac{\mu\sigma}{2(\mu-\sigma)}\right)^2 - e_0$