Search Neutrality and Competition between First-party and Third-party Sellers on an Online Retail Platform

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Abstract

Many online retail platforms serve both as a bridge connecting buyers and third-party sellers and as another (first-party) seller competing with other sellers on their sites. A platform’s ability to control and personalize consumers’ search rankings has led to increasing antitrust concerns that a platform may self-preferentially boost its own products’ search rankings over the third-party competitors’. Major economies (the US, EU) have passed or been discussing search-neutrality regulations, requiring search rankings to be based purely on product relevance. Our paper provides an analytical framework to study how search neutrality affects consumer search and the competition between the platform and third-party sellers. We find that search neutrality generally weakens the price competition when the platform personalizes consumers’ search rankings. Without search neutrality, the profit-maximizing platform will make the third-party product non-prominent in search rankings to most consumers. As a result, the third-party seller needs to invite more consumer search with a lower price, triggering stronger price competition. By contrast, search neutrality guarantees both products’ prominence in search rankings for respective high-valuation consumers, so neither the first-party nor the third-party sellers is incentivized to invite search from these consumers and hence will set higher prices to extract these consumers’ surplus. Due to the alleviated competition, when many consumers prefer the third-party product to the first-party one, search neutrality can reduce consumer surplus despite increasing the search outcome.

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relevance. Furthermore, search neutrality can benefit the platform despite limiting its ability to profit from freely deciding each consumer’s search rankings.

Key words: online platform, competition, search ranking, search bias, search neutrality, platform regulation, antitrust
1. Introduction

Online retail platforms have been playing a growing role in consumers’ daily life, connecting them with millions of sellers that offer a variety of products and services. In 2020, the worldwide gross merchandise sales in the top 100 online retail platforms reached $2.67 trillion, and sales on the leading retail sites such as Alibaba, Amazon, and eBay, accounted for 62% of global online sales.³

Within five years, Amazon’s sales grew from $246.16 billion in 2017 to $468.78 billion in 2021.⁴ Global consumer spending in mobile apps from the leading mobile platforms also displayed a similar explosive growth. Apple’s App Store generated $41.5 billion revenue globally in the first half of 2021, representing 22.1% growth compared to the same period last year, and Google Play’s revenue also increased by 30% to $23.4 billion.⁵ One common characteristic across all these online platforms is their ability to personalize consumers’ search rankings based on factors including products’ relevance and popularity, their prices, as well as consumers’ characteristics and past behaviors. By contrast, such personalization is often infeasible for offline retailers. For example, even if two consumers type in the same keyword on Amazon, they often see different lists of products, particularly different top-ranked ones, displayed by the platform. The differences in products’ ranking lead to consumers’ different search and purchase behaviors.

In addition to personalized search rankings, another common feature of online platforms is that they often compete directly with independent third-party sellers on their platforms by offering similar first-party products (and services). In 2021, Amazon offered 22,617 private-label products, tripling the number of private-label products offered in 2018.⁶ Amazon’s first-party sales as a

³ [https://www.digitalcommerce360.com/article/infographic-top-online-marketplaces/](https://www.digitalcommerce360.com/article/infographic-top-online-marketplaces/)
⁵ [https://sensortower.com/blog/app-revenue-and-downloads-1h-2021](https://sensortower.com/blog/app-revenue-and-downloads-1h-2021)
percentage of total sales are 43% for consumer electronics, 35% for beauty products, 33% for home and kitchen products, and 41% for consumables.\(^7\) In these situations, an online platform serves both as a bridge connecting buyers and third-party sellers and also as another (first-party) seller competing with other sellers on its own platform. Potential conflicts of interests lead to serious concerns about search neutrality—the principle that the search results on any search engine (a platform acts like a search engine when consumers search for products on its site) should be “comprehensive, impartial, and based solely on relevance.”\(^8\) A prominent issue is that platforms preferentially treat their first-party products, albeit their lower relevance, over third-party sellers’ in search rankings because it is more profitable for the platforms to sell the former. For example, some employees from Amazon anonymously revealed that Amazon artificially boosts its first-party products that are more profitable for Amazon in its search rankings.\(^9\) 73% of third-party sellers in a survey expressed their concerns about Amazon’s first-party products competing with the third-party products.\(^10\) Recently, the European Commission (EC) specifically highlighted its concern about “the dual role that platforms play when they both facilitate market access and compete at the same time with suppliers, which can lead to platforms unfairly promoting their own services to the disadvantage of these suppliers” (European Commission 2016). EC is currently investigating whether Amazon preferentially chooses its own products over the third-party sellers’ in Amazon’s “Buy Box,” which accounts for 80% of transactions on Amazon.\(^11\) Meanwhile, The Federal Trade Commission of the U.S. launched its search-neutrality investigation on Amazon in

\(^7\) https://www.marketplacepulse.com/articles/9-of-amazons-sales-in-clothing-are-from-its-private-label-brands  
\(^8\) http://www.searchneutrality.org/search-neutrality  
2019 over whether it has “an unfair advantage over third-party sellers when it competes with them to sell similar products on its own platform” and “puts its own product in the front of line.”

Amazon is not the only platform under similar a series of search-neutrality investigations and lawsuits. In 2019, The Wall Street Journal and The New York Times separately conducted extensive investigations showed Apple’s App Store clearly and consistently ranked its own apps ahead of competitors. Apple even admitted in court that it ranked its own Files app first when users searched for competitor Dropbox. Along the same line, EC fined Google €2.42 billion in 2017 over the claim that Google has abused its market dominance as a search engine by giving an illegal advantage to Google Shopping, Google’s comparison-shopping service, in search rankings. Recently, EC also complains that “Google favors its own ad-buying tools in the advertising auctions it runs.” Antitrust legislators have put forward search-neutrality regulations that demand the platforms to non-discriminatively treat the first-party and the third-party products in search rankings. For example, EC’s penalty on Google Shopping in 2017 required Google to “apply the same processes and methods to position and display rival comparison shopping services in Google’s search results pages as it gives to its own comparison shopping service.” EC is discussing Digital Market Act, which will prohibit platforms from artificially boosting the search ranking of their first-party products. Meanwhile, the U.S. legislators are discussing the American Choice and Innovation Online Act (H.R.3816, 2021-22), which will criminalize platforms’

conducts that “advantage the covered platform operator’s own products, services, or lines of business over those of another business user.”

The rationale of the search-neutrality regulations is that platforms’ preferential treatment of their own products steers consumers to first-party products that are inferior to third-party products, hence this practice may hurt the consumers. Interestingly, consumers do not seem to be bothered much by this particular practice. In fact, their tendency to use the retail platforms is on the rise. A survey in 2019 covering 2,000 UK consumers found that more consumers increased their shopping at Amazon (21%) than decreased it (13%), that 59% of the consumers said they are loyal to Amazon, and that 70% of consumers indicated Amazon as the first retailer they would go to when shopping online. Furthermore, the average rating of Amazon’s first-party products is 4.3 out of 5, suggesting that consumers in general like Amazon’s first-party products.

Motivated by the series of investigations and lawsuits on major retail platforms, this paper explores the welfare implications of search-neutrality regulations on the online platforms that can personalize consumers search rankings and tend to artificially boost the search ranking of the first-party products. Specifically, the paper seeks to address how search-neutrality regulations will affect the price competition between the platform and the third-party sellers, the profits of the platform and third-party sellers, and consumers’ search and shopping behaviors on the platform and their welfare.

To answer these questions, this paper develops an analytical model where an online platform (the first-party seller) offers a first-party product to compete with a third-party seller, who pays the platform a percentage commission (typically 15% on Amazon and 30% on Apple’s App Store).

Consumers with unit demands have heterogeneous preferences for the two competing products. One group (type) of consumers have a higher likelihood of finding the first-party product a match for them compared to that of the third-party product, while the opposite is true for the other group (type) of consumers. Ex ante, consumers observe the product prices but do not know whether each product will match their preferences, so they need to sequentially search the products to resolve the uncertainty of product match. They start their search from the top-ranked (prominent) product and then decide whether to incur a search cost to inspect the lower-ranked (non-prominent) product. The platform personalizes its search rankings for consumers based on their preference types. We analyze and compare the market outcomes with and without the search-neutrality regulation. Without the search-neutrality regulation, the platform chooses the prominent product for each consumer to maximize its total profit given the products’ prices; in reality the platforms’ personalized ranking algorithms take prices as inputs and can adjust rankings promptly after any price changes. Other things being equal, the platform will tend to rank the first-party product, which typically have a higher profit margin for the platform, in front of the third-party one for a consumer even if the latter tends to be a better match. By contrast, with the search-neutrality regulation, the platform is forbidden from ranking products based on the sellers’ identity (i.e., whether they are first party or third party), and thus it will rank products based on which product tends to be a better match to the consumer regardless of the seller’s identity.

Our modeling framework captures four key features of the competition between the two types of sellers (i.e., the platform and the third-party seller). First, the platform directly competes with the third-party seller while also profits from the latter’s sales through commissions. Second, the platform can personalize consumers’ search rankings and can preferentially treat its first-party product by ranking it higher than its competitor without the search-neutrality regulation. Third,
consumers find it relatively easy to learn the top-ranked (prominent) product but need to incur higher and heterogeneous search costs to explore the non-prominent product in their search results. Finally, the platform and the third-party seller will set prices strategically depending on whether the search-neutrality regulation is in place.

We highlight several major findings. First, the search-neutrality regulation can increase the equilibrium prices of both the first-party seller (the platform) and the third-party seller. In other words, search neutrality can alleviate the two sellers’ price competition. Since consumers will start with searching the prominent product and then decide whether to continue searching the non-prominent product, they will be more likely to search the latter when the non-prominent product is cheaper. In the absence of search neutrality, the platform will optimally make the third-party product non-prominent for most consumers. Anticipating this action from the platform, the third-party seller will dramatically reduce its price because otherwise very few consumers would visit the third-party seller. The platform will in turn need to reduce its own price to prevent too many consumers from searching and potentially buying the third-party product. By contrast, in the presence of search neutrality, each product will be made prominent for a sufficiently large group of consumers who relatively strongly prefer this product, and the product will be non-prominent only for consumers with a lower match likelihood. Therefore, each seller will have a weaker incentive to lower its price because the loss of profit margin on consumers who relatively prefer this product would outweigh the gain of attracting more searches from consumers who prefer this product less. As a result, in equilibrium, both sellers will set relatively high prices. Importantly, this result applies only to online platforms that can personalize product prominence for each consumer but not to offline retailers in which the product prominence (e.g., in-store displays) are uniformly applied to all consumers.
Second, search neutrality will increase the third-party seller’s profit, and it can also increase the platform’s profit when the third-party product on average is more likely to match consumers’ preferences or when consumers’ average search cost is low. Without the search-neutrality regulation, most consumers will find the third-party product in the non-prominent position, and the third-party seller needs to attract consumer searches by lowering its price; the third-party seller has a stronger incentive to reduce its price if reducing its price can attract more consumers searches—when consumers’ average search cost is low—or if a consumer’s search of the third-party product has a higher chance to be converted to a sale—when consumers are more likely to find the third-party product a match. Hence, in these situations, the price competition will strong without search neutrality. By contrast, as suggested above, search neutrality can alleviate the price competition and increase the platform’s profit, even if the regulation makes the platform’s product less prominent for some consumers. Furthermore, this regulation also improves the third-party seller’s profit because of the alleviated competition and its higher prominence for some consumers. Note that in reality it is hard for third-party sellers to verify what ranking rule the platform actually adopts, so without search neutrality the platform is often unable to commit to not ranking products based on the platform’s expected profit after the sellers set the prices, even if ranking products based on their match probabilities would alleviate the price competition and potentially increase the platform’s profit. Thus, search neutrality can effectively serve as the platform’s commitment device to alleviate competition and potentially improve its profit.

Third, search neutrality can reduce consumer surplus even though it increases consumers’ search relevancy. This is more likely to happen when many consumers prefer the third-party product to the first-party one, in which case the third-party product will have a higher average conversion rate conditional on a consumer search. Hence, the third-party seller has a stronger incentive to reduce
its price to invite consumer to search in the absence of search neutrality, which strengthens the price competition. By contrast, search neutrality guarantees the third-party product’s prominence for these consumers, which reduces the third-party seller’s willingness to invite searches by reducing its price. As a result, search neutrality can dramatically alleviate the price competition and potentially harm consumers.

Taken together, our results shed some new light on the current search-neutrality regulations and lawsuits on the dominant platforms such as Amazon. The most striking insight is that the often-criticized preferential treatment of the first-party product by the platform may facilitate price competition between the platform and the third-party sellers, and thus potentially benefit consumers. Furthermore, although the search-neutrality regulation restricts the platform’s ability to manipulate each product’s prominence in consumers’ search results, it can mitigate the price competition and benefit both sellers. In summary, the regulators need to be cautious about the potential tradeoff between search neutrality and price competition when they carry out the search-neutrality regulations on online platforms that can personalize the consumers’ search rankings. Especially, search neutrality can harm consumers if many consumers prefer the third-party product to the first-party one.

Search neutrality is also related to the widely discussed concept of net neutrality, as they both aim to challenge intermediation biases. (See Greenstein et al. (2016) for a literature review on net neutrality.) Despite the similarities, search neutrality and net neutrality differ in two fundamental aspects. First, net neutrality prevents the Internet service providers (ISPs) from throttling the content delivery speed of certain content providers, which will directly affect consumers’ consumption utility of the contents (e.g., video resolution, online gameplay lags). By contrast, search neutrality bars retail platforms from arbitrarily prioritizing its own product in consumers’
search results, which influences a product’s visibility to consumers but not their consumption utility of this product. Second, net neutrality is an “egalitarian” principle because it demands all contents should enjoy the same Internet speed. By contrast, search neutrality is a “meritocratic” principle because it requires the platform to present each consumer with the most relevant products rather than to present different products with equal probabilities.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature, Section 3 introduces the model, and Section 4 presents the analysis and the results. Finally, Section 5 concludes and discusses future research opportunities.

2. Literature Review

This paper contributes to the economics and marketing literature of intermediary neutrality.²¹ A stream of this literature examines how platforms may discriminate against different third-party sellers or service providers in the search or recommendation results (Armstrong and Zhou 2011; Chen and He 2011; Hagiu and Jullien 2011; Inderst and Ottaviani 2012; Teh and Wright 2020; Zhou and Zou 2021). By contrast, closer to our context are some theoretical and empirical studies analyzing how a platform can preferentially treat its own products compared to those of the third-party sellers’. For example, it can boost the search rankings of its own products (de Cornière and Taylor 2019; Song 2021; Zhu and Liu 2018), or bundle them with other services or products on the platform (Bakos and Brynjolfsson 2000; Parker and Van Alstyne 2005). The platform can also create copycats of successful third-party sellers’ products, which reduces these sellers’ innovation and sales efforts (Farrell and Katz 2000; Gans and Stern 2003; Jiang et al. 2011; Wen and Zhu 2019). An event-ticket platform can limit consumers’ capabilities of reselling their tickets on other

²¹ Some law literature has discussed search neutrality from legal perspectives (Bostoen 2018; Crane 2012; Krämer and Schnurr 2018; Lao 2013).
platforms; interestingly, the restriction can lead to lower prices and benefit consumers (Zou and Jiang 2020). Very few papers have considered the platform’s self-preferencing biases when the recommendations and search rankings are personalized, which is common practice of modern retail platforms. In particular, De Cornière and Taylor (2019) show that a platform’s recommendation bias towards its own products can increase the platform’s investments in quality improvement or marginal-cost reduction and thus benefit consumers. Our paper differs from their framework by incorporating consumer search and shows that the platform’s search ranking bias can possibly benefit consumers and harm the platform even if the platform and the sellers compete only on prices. Finally, our paper is related to several papers that analyze the effect of the merger between a platform and a third-party service provider (Bourreau and Gaudin 2018; de Cornière and Taylor 2014). Their context is search advertising or streaming platforms, whose market structures are markedly different from that of a retail platform which we focus on.

This paper also contributes to the literature of ordered consumer search, where consumers’ search sequence is partially or fully predetermined (Arbatskaya 2007; Armstrong 2017; Armstrong et al. 2009; Armstrong and Zhou 2011; Gu and Liu 2013; Jiang and Zou 2020; Zhong 2020; J. Zhou 2011). The majority of this literature assumes that consumers search for both product prices and fit, in which situation the prominent seller will set a lower price (Armstrong et al. 2009). Armstrong and Zhou (2011) consider a situation where consumers observe product prices before searching, but a consumer’s valuation of the two products are perfectly negatively correlated, so a consumer effectively learns her valuations for both products after searching the prominent product. By contrast, our paper considers the case where consumers observe product prices before search and thus they only search for product-fit information, and they need to search the non-prominent
product to learn their exact valuations for it. This framework better depicts the online shopping environment, and shows that the prominent seller will set a higher price.

3. Model

3.1. Firms and Consumers

A unit mass of consumers can choose from two competing products, whose marginal production costs are both normalized to zero, on a retail platform. One product is sold by the platform itself, and the other by a third-party seller on the platform. To facilitate exposition, we sometimes denote the first-party seller (the platform) or the third-party seller as a seller in the paper. We label the platform’s own product as product F (which stands for “first-party”), and that of the third-party seller as product T (which stands for “third-party”).

Consumers demand at most one unit of the product and may find a product to either match their preference or not. If product \( j \) matches consumer \( i \)’s preference, the consumer’s valuation is \( v_{ij} = 1 \). Otherwise, the product is a mismatch and consumer \( i \)’s valuation is \( v_{ij} = 0 \). There are two distinct groups of consumers in the market with heterogenous preferences for the two products. On the one hand, an \( N_f = \alpha \) fraction of consumers, labeled as type-\( f \) consumers, on average prefer product \( F \) to product \( T \). Specifically, their valuation distributions for the two products are respectively

\[
v_{fF} = \begin{cases} 
1, \text{ with probability } \rho_H \\
0, \text{ with probability } 1 - \rho_H 
\end{cases}
\]

and
\[
v_{fT} = \begin{cases} 
1, \text{ with probability } \rho_L \\
0, \text{ with probability } 1 - \rho_L 
\end{cases},
\]

where \(1 \geq \rho_H > \rho_L \geq 0\).

On the other hand, an \(N_t = 1 - \alpha\) fraction of consumers, labeled as type-\(t\) consumers, prefer product \(T\) to product \(F\) on average. Specifically, their valuation distributions for the two products are

\[
v_{tF} = \begin{cases} 
1, \text{ with probability } \rho_L \\
0, \text{ with probability } 1 - \rho_L 
\end{cases}
\]

and

\[
v_{tT} = \begin{cases} 
1, \text{ with probability } \rho_H \\
0, \text{ with probability } 1 - \rho_H 
\end{cases}
\]

Let \(\rho_{ij}\) denote the probability that product \(j\) matches a type-\(i\) consumer, so \(\rho_{fF} = \rho_{tT} = \rho_H\) and \(\rho_{fT} = \rho_{tF} = \rho_L\). Note that even though a type-\(f\) consumer ex ante prefers product \(F\), it is possible for her less preferred option product \(T\) to be a match for her while product \(F\) a mismatch, which occurs with the probability \((1 - \rho_H)\rho_L\). The same is true in terms of type-\(t\) consumers’ preference matching for the two products. Managerially, the size of type-\(f\) consumers, \(\alpha\), captures the popularity of the first-party product relative to that of the third-party product.

Let \(p_j\) denote product \(j\)’s price (\(j \in \{F, T\}\)). The platform charges the third-party seller a percentage commission \(r\) based on the latter’s price \(p_T\). In other words, for each unit sale of product \(T\), the platform earns \(r p_T\) and the third-party seller earns \((1 - r) p_T\). To focus on the more interesting case where the platform has a strong incentive to “bias” the search rankings towards its own product, we assume \(r < \rho_L / \rho_H\) throughout the paper. This condition reflects that the platform typically receives a significantly higher profit from selling a unit of its own product than that of a
third-party product, and it is consistent with the common practice that a platform often prioritizes promoting its own product. On the one hand, \( r \) is not prohibitively high in reality—often less than 15% on major retail platforms such as Amazon and Walmart.com across most product categories. On the other hand, the match probabilities for competing products sold by the platforms and the third-party sellers typically do not differ too much, so the ratio \( \rho_L/\rho_H \) will be reasonably large. Otherwise, the first-party and the third-party products would barely compete with each other.

In practice, after consumers enter their search queries, the platform returns a list of relevant products with their prices and basic information that provides consumers with an initial impression of the product match. We define this as “pre-search” in our context. Consumers then need to click into a specific product’s webpage to gather more information about the exact product match. We define this in-depth investigation as “search” in our framework. To capture this two-stage process of pre-search and search, we assume that a consumer knows the products’ prices and expected valuations \( E[v_{ij}] \) after pre-search (making the search query, in the first stage) and before searching any specific product. Furthermore, she needs to search a particular product in depth (in the second stage) to learn precisely whether it matches her preference or not (i.e., the precise value of \( v_{ij} \)). In Section 4.1, we will elaborate consumers’ search decisions.

The platform can personalize the search rankings for each consumer based on her expected valuations for the products, i.e., this consumer’s type \( i \in \{f, t\} \). Following the common terminologies in the ordered-search literature, we call the product that appears in the first place in the search outcomes the prominent product, and the second-place one the non-prominent product. We also refer to the product that appears in a more prominent position as having a lower or smaller search ranking. Note that a product can be prominent for one type of consumers but non-prominent for the other type if the platform tailors its search rankings for different types of consumers. When
shopping on the platform, consumers search the products sequentially, starting from the prominent product. Following the search literature, we assume that a consumer’s first search is free, so she will always search the prominent product for her, but she needs to incur a positive search cost to search the non-prominent product. This assumption is consistent with the empirical findings that a product’s search ranking affects consumers’ search cost but not their expected valuations for the product, with the top positions requiring lower search costs (Ursu 2018). After the first search, this consumer has three distinct alternatives. She can buy her prominent product right away, quit searching without buying anything, or incur a search cost to inspect the non-prominent product. She will choose an action that maximizes her expected utilities. To capture heterogeneous search costs (for the non-prominent product), we assume that a consumer’s search cost $c_i$ follows a uniform distribution on $[0, C]$. Throughout this paper, we consider the case of $C \geq 1$ such that the consumer with the highest search cost $c_i = C$ will not search the second product in equilibrium. This is consistent with the empirical evidence that in many search sessions consumers search only one product (Chen and Yao 2017; Ursu 2018). All the results would remain qualitatively the same when $C < 1$ provided that $C$ is not too low.

3.2. Game Sequence

There are three stages in the game. First, the two competing sellers (i.e., the platform and the third-party seller) simultaneously set their prices. Second, the personalized search rankings are generated by the platform for each individual consumer based on the consumers’ preference type. We will describe the platform’s search-ranking decision and how it is affected by the search-neutrality regulation in Section 3.3. Lastly, consumers make their search and purchase decisions. In practice, the platform’s personalized search-ranking algorithms often account for product prices and update product search rankings very frequently, whereas the sellers rarely change their prices.
as often. Hence, it is reasonable to assume that the sellers’ pricing decisions (in the first stage) occur before the generation of search rankings (in the second stage).

3.3. Personalized Search Ranking

The platform personalizes the search ranking (i.e., which product is prominent) for each consumer, based on the consumer’s type and the product prices. Without search neutrality, the platform will choose each consumer’s search ranking to maximize the platform’s total profit given the product prices. Since a consumer’s purchase decision will not influence other consumers’, for each consumer the platform will choose the ranking to maximize its expected profit from this consumer. Because the platform receives all the revenue from the first-party product but only a proportion $r$ of the third-party product’s revenue as the commission, the platform tends to preferentially treat the first-party product by making it prominent even for type-$t$ consumers, who are more likely to find the third-party product a match. By contrast, search neutrality prohibits such preferential treatment, so the platform has to make the first-party product (product $F$) prominent for type-$f$ consumers and the third-party product (product $T'$) prominent for type-$t$ consumers. We label the scenario without the search-neutrality regulation as “NR” (no regulation) and the scenario with the regulation as “R” (with regulation).

To conclude this section, we highlight our model setup captures two important features unique to online (but not offline) retail settings. First, an online platform can personalize product prominence for different consumers via personalized search rankings. By contrast, although an offline retailer can make a product prominent through in-store display and feature advertising, the prominence must be uniformly applied to all consumers. Second, online shoppers typically observe product prices before incurring a search cost to search for a product’s detailed information. By contrast,
offline shoppers often need to incur the search cost before finding out a product’s price and other information. These two unique features of online retailing are essential in driving our main findings.

4. Analysis

We solve for the perfect Bayesian equilibrium through backward induction, starting with consumers’ search and purchase decisions. Note that these decisions are conditional on product prices and the search ranking outcome for each consumer.

4.1. Consumer Decisions

Let us focus on a type-\(i\) consumer. For this consumer, let \(j_1\) and \(j_2\) respectively denote the prominent product and the non-prominent product, where \(j_1, j_2 \in \{F, T\}\) and \(j_1 \neq j_2\). After this consumer has learned her valuation for the prominent product \(v_{ij_1}\), she decides whether to search the non-prominent product \(j_2\). If she does not search the non-prominent product, she can either buy the prominent product or leave the market. In this case, her total payoff is given by 

\[
u_i^{\{j_1\}} = \max\{v_{ij_1} - p_{j_1}, 0\},
\]

where the superscript of \(u_i^{\{j_1\}}\) represents the set of products already searched by the consumer. The first term in this payoff function, \(v_{ij_1} - p_{j_1}\), is the consumer’s utility if she purchases the prominent product. The second term, 0, represents the consumer’s utility of choosing the outside option. By contrast, if the consumer searches the non-prominent product by incurring the search cost \(c_i\), she will be able to choose amongst all three options to maximize her utility. In this case, her total payoff is given by 

\[
u_i^{\{j_1,j_2\}} = \max\{v_{ij_1} - p_{j_1}, v_{ij_2} - p_{j_2}, 0\} - c_i.
\]

She will search the second product if and only if 

\[E_{v_{ij_2}} \left[u_i^{\{j_1,j_2\}} \right] > u_i^{\{j_1\}}.\]

It turns out that whether the prominent product is cheaper than the non-prominent one will play a major role in determining the consumer’s search and purchase decisions. As a result, we discuss the two cases sequentially,
starting with the case where $p_{j_1} > p_{j_2}$. Clearly, charging a price higher than 1 is a dominated strategy by either seller, so in what follows, we consider the case with $0 < \max\{p_{j_1}, p_{j_2}\} \leq 1$.

Case 1: $p_{j_1} > p_{j_2}$. In this case, the prominent product is more expensive. We discuss the two possible situations depending on whether the prominent product is a match.

First, suppose that the consumer finds the prominent product a mismatch ($v_{ij_1} = 0$), which happens with probability $1 - \rho_{ij_1}$. In this scenario, $u_{i}^{\{j_1\}} = 0$, and the consumer will not buy the prominent product. Furthermore, her expected payoff from searching the non-prominent product is then $E_{v_{ij_2}}[u_{i}^{\{j_1, j_2\}}] = E_{v_{ij_2}}[\max\{v_{ij_2} - p_{j_2}, 0\}] - c_i = \rho_{ij_2}(1 - p_{j_2}) - c_i$, and she will search the non-prominent product if and only if $c_i < \rho_{ij_2}(1 - p_{j_2})$. If she chooses to search, with probability $\rho_{ij_2}$ she will find the non-prominent product a match ($v_{ij_2} = 1$) and thus purchase it (recall that the prominent one is a mismatch). With probability $1 - \rho_{ij_2}$, the non-prominent product also turns out to be a mismatch, so she will not buy any product. Put differently, after searching both products and finding neither to be a good match, she will choose the outside option (no-purchase). On the other hand, if $c_i \geq \rho_{ij_2}(1 - p_{j_2})$, she will not search product $j_2$, then she will not purchase either product. This concludes the analysis of the prominent product being a mismatch.

Second, suppose that the consumer finds the prominent product a match ($v_{ij_1} = 1$), which happens with probability $\rho_{ij_1}$. In this scenario, the consumer’s utility of buying the prominent product right away is $u_{i}^{\{j_1\}} = 1 - p_{j_1}$, and her expected payoff from searching the non-prominent product is $E_{v_{ij_2}}[u_{i}^{\{j_1, j_2\}}] = E_{v_{ij_2}}[\max\{1 - p_{j_1}, v_{ij_2} - p_{j_2}\}] - c_i = \rho_{ij_2}(1 - p_{j_2}) + (1 - \rho_{ij_2})(1 - p_{j_1}) - c_i$. Anticipating the potential gains from the costly search, she will search the non-prominent
product if and only if \( E_{\psi_{ij_2}}[u_i^{(j_1,j_2)}] > u_i^{(j_1)} \), which is equivalent to \( c_i < \rho_{ij_2}(p_{j_1} - p_{j_2}) \).

Conditional on this search, with probability \( \rho_{ij_2} \) she will find the non-prominent product a match and thus buy it because it is cheaper than the prominent one, \( p_{j_2} < p_{j_1} \). This event that the consumer has searched both products and found both to match her preference happens with probability \( \rho_{ij_1}\rho_{ij_2} \). With probability \( 1 - \rho_{ij_2} \), she will find the non-prominent product a mismatch and then go back to buy the prominent one. By contrast, if \( c_i \geq \rho_{ij_2}(p_{j_1} - p_{j_2}) \), she will purchase the prominent product without searching the non-prominent one. This concludes the analysis of the prominent product being a match.

Figure A1 in the appendix summarizes the consumer’s decision tree when \( p_{j_1} > p_{j_2} \). Accounting for all the possible scenarios, when \( p_{j_1} > p_{j_2} \), the prominent product’s demand from type-\( i \) consumers is

\[
D_{ij_1} = N_i \cdot \left\{ (1 - \rho_{ij_1}) \cdot 0 + \rho_{ij_1} \left[ 1 - \frac{\rho_{ij_2}(p_{j_1} - p_{j_2})}{c} \cdot \rho_{ij_2} \right] \right\} \\
= \frac{N_i \rho_{ij_2}}{c} \left( C - \rho_{ij_2}^2 p_{j_1} + \rho_{ij_2}^2 p_{j_2} \right). \tag{1}
\]

In Equation (1), \( N_i \) is the population of type-\( i \) consumers, \( (1 - \rho_{ij_1}) \cdot 0 \) is the probability of the prominent product being a mismatch multiplied by the corresponding conditional purchase probability—consumers will never buy a mismatched product. Similarly, \( \rho_{ij_1} \) is the probability of the prominent product being a match, and the following term, \( [1 - \frac{\rho_{ij_2}(p_{j_1} - p_{j_2})}{c} \cdot \rho_{ij_2}] \), is the corresponding conditional purchase probability. When the prominent product is more expensive, i.e., \( p_{j_1} > p_{j_2} \), consumers who find it a match will purchase it unless they have a sufficiently low search cost to search the non-prominent product, which happens with probability \( \frac{\rho_{ij_2}(p_{j_1} - p_{j_2})}{c} \), and
also find the non-prominent product a match, which happens with probability \( \rho_{ij_2} \). In total, the prominent product’s demand from type-\( i \) consumers increases in its own matching probability \( \rho_{ij_1} \), and decreases in its rival’s matching probability \( \rho_{ij_2} \). Due to the advantage of its positional prominence, its demand also increases when consumers on average have a higher search cost.

Similar to the analysis of the prominent product, when \( p_{j_1} > p_{j_2} \), the non-prominent product’s demand from type-\( i \) consumers is given by

\[
D_{ij_2} = N_i \cdot \left\{ \left( 1 - \rho_{ij_1} \right) \cdot \frac{\rho_{ij_2}(1-p_{j_2})}{c} \cdot \rho_{ij_2} + \rho_{ij_1} \left[ \frac{\rho_{ij_2}(p_{j_1}-p_{j_2})}{c} \cdot \rho_{ij_2} \right] \right\} 
\]

\[
= N_i \cdot \frac{\rho_{ij_2}^2}{c} \cdot \left( 1 - \rho_{ij_1} + \rho_{ij_1} \cdot p_{j_1} - p_{j_2} \right). 
\]

In stark contrast with that of the prominent product, the non-prominent product’s demand from type-\( i \) consumers decreases when consumers have higher search costs (a higher \( C \)). Intuitively, a higher search cost prevents more consumers from exploring the second (non-prominent) product and thus lowers its total demand.

**Case 2: \( p_{j_1} \leq p_{j_2} \).** In this case, because the prominent product is less expensive, the consumer will buy \( j_1 \) as long as it is a match (\( v_{ij_1} = 1 \)), which happens with probability \( \rho_{ij_1} \). Next, suppose that the consumer finds the prominent product to be a mismatch for her (\( v_{ij_1} = 0 \)), which happens with probability \( 1 - \rho_{ij_1} \). In this situation, the consumer’s search and purchase behaviors are the same as that when \( p_{j_1} > p_{j_2} \) and \( v_{ij_1} = 0 \), which we have discussed in Case 1. Figure A2 in the appendix summarizes the consumer’s decision tree when \( p_{j_1} \leq p_{j_2} \). Overall, the prominent product’s and the non-prominent product’s demands from type-\( i \) consumers are respectively,
\[
\begin{cases}
D_{ij_1} = N_i \cdot \rho_{ij_1} \\
D_{ij_2} = N_i \cdot \left( \frac{(1-\rho_{ij_1})\rho_{ij_2}^2}{c} \cdot (1-p_{j_2}) \right)
\end{cases}
\]

(3)

A key observation is that a product’s demand is more elastic to its own price when the product is non-prominent than when it is prominent, other things being equal. Specifically, let \( l \) be the index of the focal product and \(-l\) that of the other product. If \( p_l > p_{-l} \), then product \( l \)'s demand elasticity of its own price (for consumer \( i \)) is 
\[-p_l \left( \frac{c}{\rho_{l,-l}^2} + p_{-l} - p_l \right)^{-1}\] when it is prominent, which is less negative than the counterpart when product \( l \) is non-prominent, 
\[-p_l(1 - p_l)^{-1}.\] Similarly, if instead \( p_l < p_{-l} \), then product \( l \)'s demand elasticity of its own price is zero when it is prominent, which is less negative than when the product is non-prominent. Intuitively, very few consumers will search the non-prominent product unless its price is sufficiently low, while many consumers who find the prominent product a match will buy it without further searching for the non-prominent product to save the search cost even if the prominent product is relatively expensive. Hence, a seller will have an extra incentive to reduce its price if its product is non-prominent to more consumers. Interestingly, the result is opposite to that of Proposition 1 in Armstrong, Vickers, and Zhou (2009), which finds that the prominent seller will set a lower price than its non-prominent rival. The difference arises because consumers know product prices in our setting but need to search for them in Armstrong, Vickers, and Zhou (2009). When consumers observe prices before search, the non-prominent seller can attract more consumers by lowering its price. However, when consumers do not directly observe the prices, they will not believe that the non-prominent seller would charge such a low price because of the well-known holdup problem as of Diamond (1971). Our model setting is more applicable to the context of online shopping platforms, where consumers clearly see all the prices before searching any products in depth. Result 1 summarizes this result.
Result 1. Other things being equal, a seller’s demand is more elastic to its own price if it is at the non-prominent position than at the prominent position.

After analyzing the consumers’ search and purchase behaviors and how prominence affects a seller’s demand, we proceed to analyze the sellers’ pricing decisions and how they are affected by the search-neutrality regulations. In order to highlight the two product’s difference that one is sold by the platform and the other the third-party seller and to simplify the exposition, we consider the case of $\alpha = \frac{1}{2}$ in the main analysis, so that the two products are equally popular among the consumers. We will examine the effect of product popularity $\alpha$ in Section 4.4.

4.2. The Case Without the Search-Neutrality Regulation (NR)

We start with the analysis for the scenario without the search-neutrality regulation, in which case the platform chooses its search rankings for each type of consumers to maximize its total expected profit. Proposition 1 shows that there exists a pure-strategy equilibrium under our assumption of $r < \frac{\rho_L}{\rho_H}$.

Proposition 1. Suppose $r < \frac{\rho_L}{\rho_H}$. When the search-neutrality regulation is absent,

(1) the platform ranks its own product in the prominent position for all consumers.

(2) the equilibrium prices are $p_{F^*}^{NR} = \frac{2C(\rho_H^2 + \rho_L^2) + (1+r)\rho_L\rho_H(\rho_H^2(1-\rho_L) + \rho_L^2(1-\rho_H))}{\rho_H\rho_L(4\rho_H^2 + 4\rho_L^2 - (1+r)\rho_H\rho_L)} < 1$ and $p_{T^*}^{NR} = \frac{C(\rho_H^2 + \rho_L^2) + 2[\rho_H^2(1-\rho_L) + \rho_L^2(1-\rho_H)]}{4\rho_H^2 + 4\rho_L^2 - (1+r)\rho_H\rho_L} < \frac{1}{2}$ if $\rho_H\rho_L(3 - r) > 2C$, and are $p_{F^*}^{NR} = 1$ and $p_{T^*}^{NR} = \frac{1}{2}$ if $\rho_H\rho_L(3 - r) \leq 2C$.

(3) $p_{F^*}^{NR}$ and $p_{T^*}^{NR}$ both increase with $C$ and $r$, and decrease with $\rho_H$ and $\rho_L$.

(4) in equilibrium, the platform’s price is higher than the third-party seller’s price: $p_{F^*}^{NR} > p_{T^*}^{NR}$. Their difference $p_{F^*}^{NR} - p_{T^*}^{NR}$ increases with $C$ and $r$, and decreases with $\rho_H$ and $\rho_L$. 

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Proposition 1 summarizes the sellers’ equilibrium prices without the search-neutrality regulation. Under the condition $r < \rho_L / \rho_H$, the platform has a strong incentive to make its product prominent for all consumers and will do so in equilibrium. The third-party seller, whose product is non-prominent for all consumers, will have an incentive to attract consumer searches by making its product much cheaper than the platform’s (i.e., setting its price $p_T \leq p_F$). When $\rho_H$ or $\rho_L$ is high, consumers are more likely to find the third-party product a match and hence buy it if they search it, strengthening the third-party seller’s incentive to lower $p_T$ to attract search. In addition, to respond to the third-party seller’s lower price, the platform will also be pressured to lower its price $p_F$ to prevent the consumers who have found the first-party product a match not further searching the cheaper third-party product. This pressure of price reduction by the platform is stronger when the third-party seller is more likely to drop its price—when $\rho_H$ and $\rho_L$ are higher; when more consumers have low search costs—when $C$ is lower; or when the platform loses more profit upon losing a consumer to the third-party seller—when $r$ is lower. Specifically, when $\rho_H$ and $\rho_L$ are relatively low or $C$ and $r$ are relatively high such that $\rho_H \rho_L (3 - r) \leq 2C$, the platform will charge $p_{F, NR}^* = 1$ to extract all surplus from those consumers who will eventually buy its product, and the third-party seller will optimally set $p_{T, NR}^* = \frac{1}{2}$ in response. By contrast, when $\rho_H \rho_L (3 - r) > 2C$, the platform will be pressured to set its price $p_{F, NR}^* < 1$, which in turn drives the third-party seller to drop its price below $\frac{1}{2}$. Furthermore, when $\rho_H \rho_L (3 - r) > 2C$, both the platform’s and the third-party’s equilibrium prices decrease with the two products’ matching probabilities $\rho_H$ and $\rho_L$ and increase with $C$ and $r$. Finally, part (4) of Proposition 1 also states that the two sellers’ price difference $(p_{F, NR}^* - p_{T, NR}^*)$ increases in $C$. This result highlights that the advantage of prominence is further elevated by greater consumer search costs, which discourage additional search.
After analyzing the equilibrium pricing, we next examine how different factors affect the sellers’ equilibrium profits without search neutrality.

**Proposition 2.** When search neutrality is absent, in equilibrium:

1. The platform’s and the third-party seller’s profits may decrease with \( \rho_H \) or with \( \rho_L \) when \( \rho_H \rho_L (3 - r) > 2C \), but both will increase in \( \rho_H \) and \( \rho_L \) when \( \rho_H \rho_L (3 - r) \leq 2C \).

2. The platform’s profit increases with \( C \). The third-party seller’s profit increases with \( C \) if and only if \( 1 \leq C < \frac{\rho_H \rho_L (3 - r)}{2} \).

One may expect that the profits of the platform and the third-party seller should both become higher when their products are more likely to match consumer needs, i.e., when \( \rho_H \) and \( \rho_L \) are higher. In addition, it is natural to intuit that the third-party seller, given its disadvantaged (non-prominent) position, will receive less profit when consumers have higher search costs on average (\( C \) is higher). However, without the search-neutrality regulation, both the platform and the third-party seller can become worse off at the same time when \( \rho_H \) or \( \rho_L \) increases, and the third-party seller’s profit can increase with \( C \) as long as it is not too high. The intuition is that when \( \rho_H \rho_L (3 - r) > 2C \), a higher \( \rho_H \) or \( \rho_L \) can lead to a more intense price competition, as is shown in Proposition 1, which then decreases both sellers’ profits. By contrast, when \( \rho_H \) or \( \rho_L \) increases in the region of \( \rho_H \rho_L (3 - r) \leq 2C \), the equilibrium prices do not change in this region, so both sellers’ profits will increase with \( \rho_H \) or \( \rho_L \) because of the higher matching likelihoods. As for the impact of \( C \), on the one hand, a higher average search cost reduces the platform’s incentive to cut its price to deter consumers from searching the third-party product, which then alleviates the price competition and makes both the platform and the third-party seller better off. This effect exists only when \( \rho_H \rho_L (3 - r) > 2C \). On the other hand, a higher \( C \) reduces the consumers’ willingness to search the non-prominent third-party seller, which benefits the platform and hurts the third-party
seller. Overall, a higher average consumer search cost will benefit the platform; it benefits the third-party seller when \( \rho_H \rho_L (3 - r) > 2C \).

4.3. The effect of search-neutrality regulation

This section analyzes how the search-neutrality regulation affects the market outcome. When such a regulation is in place, the platform is required to make product \( F \) prominent for type-\( f \) consumers and product \( T \) prominent for type-\( t \) consumers. Lemma 1 below summarizes the resulting market outcome.

**Lemma 1.** When the search-neutrality regulation is present, \( p_F^{R*} = p_T^{R*} = 1 \). The platform’s profit is \( \pi_F^{R*} = \frac{\rho_H (1 + r)}{2} \) and the third-party seller’s profit is \( \pi_T^{R*} = \frac{\rho_H (1 - r)}{2} \).

Lemma 1 shows that the search-neutrality regulation can alleviate the price competition between the sellers and both sellers will set high prices. In our framework, all consumers who find their prominent product a good match will buy it, and those finding it a mismatch will not search the non-prominent product. Hence, the search-neutrality regulation essentially makes the sellers local monopolies—a seller serves only the consumers who ex ante relatively prefer its product. This happens because, given the platform’s price, the third-party seller’s profit will be affected in two ways if it reduces its price. First, a decrease in \( p_T \) will reduce the third-party seller’s profit margin from all type-\( t \) consumers who find product \( T \) a good match. Second, reducing \( p_T \) will increase the third-party seller’s profit from the type-\( f \) consumers who have sufficiently low search costs to search product \( T \), which is non-prominent for them, and will find it a match after searching. Because product \( T \) is more likely to match type-\( t \) consumers than to type-\( f \) consumers, the first effect is stronger than the second, giving the third-party seller little incentive to reduce its price.
Following the same logic, given product $T$’s price, the platform is hardly willing to reduce its price $p_F$. In addition to the two effects above, reducing $p_F$ will also cannibalize the third-party seller’s sales and thus decrease the platform’s commission income, so the platform is even less interested in doing so. In equilibrium, consumers will consider only their prominent product, which matches them with probability $\rho_H$, and do not search the non-prominent product, so both sellers’ profits and the industry profit will increase with $\rho_H$ and are independent to $\rho_L$ and $C$.

It is important to note that Lemma 1 should be interpreted as that the search-neutrality regulation can weaken the price competition between sellers, rather than that the sellers must charge the highest possible price of one. In fact, this corner solution happens in our framework only when the two products are close in their likelihoods of matching consumers’ preferences (when $\alpha$ is medium). In section 4.4, we will show that when $\alpha$ is small or large, both products’ equilibrium prices can be strictly lower than one in the scenario with the search-neutrality regulation, and all the results will still qualitatively hold.

Having analyzed the scenarios with and without the search-neutrality regulation, we will next examine the regulation’s impact by comparing the market outcomes of the two scenarios. One might expect that the search-neutrality regulation would hurt the platform because the regulation limits the platform’s ability of optimizing each consumer’s search ranking to maximize its expected profit; meanwhile, the regulation would raise the relevance of search outcomes and benefit the consumers. Counterintuitively, Proposition 3 shows that if the sellers’ strategic pricing decisions are accounted for, the search-neutrality regulation can benefit the platform but hurt the consumers.
Proposition 3. The search-neutrality regulation will strictly improve the platform’s profit when \( \rho_H \) and \( \rho_L \) are sufficiently large and \( C < \max\left\{ \frac{2-r}{2-2r}, \frac{(1+r)(3-r)^2}{2(4-r)} \right\}. \) The regulation will improve the third-party seller’s profit but reduce consumer surplus.

The search-neutrality regulation has two distinct effects on the platform’s profit, the third-party seller’s profit, and consumer surplus. First, it prevents the platform from prioritizing its own product in search outcomes given the product prices. This will hurt the platform but benefit the third-party seller and consumers. Second, the regulation alleviates the pricing competition between the platform and the third-party seller, which will benefit both the platform and the third-party seller but hurt consumers. When \( \rho_H \) and \( \rho_L \) are sufficiently large or \( C \) is sufficiently low, the second effect of the search-neutrality regulation is stronger because the intensity price competition increases with \( \rho_H \) and \( \rho_L \) and decreases with \( C \) without the regulation, as is shown by Proposition 1. Hence, the search-neutrality regulation can increase the platform’s profit but potentially harm consumers because of the softened pricing competition. Theoretically, the regulation serves the platform as a commitment device that guarantees the third-party product’s prominence to type-\( t \) consumers, who are likely to find the third-party product a match. The third-party will then find it optimal to set a higher price to reap these consumers’ surplus rather than lowering its price to attract more searches from type-\( f \) consumers, who have a low match and purchase likelihood for the third-party product even if they search it. As a result, the platform can benefit from the softened price competition. By contrast, without the regulation, after the third-party seller sets its price, the platform will prioritize its first-party product in most consumers’ search rankings. Anticipating that it will be placed at the non-prominent position for most consumers, the third-party seller will optimally set a low price to encourage consumer search, leading to stronger price competition.
Proposition 3 offers significant and surprising insights on the current search-neutrality regulations that restrict platforms’ ability to prioritize their own products in consumers’ search rankings. Our result reveals that when platforms can personalize consumers’ search rankings, there will be a tradeoff between search neutrality and price competition between sellers. Thus, once competing sellers’ strategic pricing decisions are accounted for, the well-intended regulations can actually harm the consumers, although the third-party sellers become better off. Therefore, anti-trust agencies need to evaluate all participants of the online platform in a holistic manner before prescribing any specific policy recommendations.

4.4. Effect of Product Popularity

The main analysis above focuses on the scenario of \( \alpha = \frac{1}{2} \)—the type-\( f \) consumers and the type-\( t \) consumers are of equal populations—to highlight that the two products’ difference in whether they are sold by the platform or by the third-party seller. This section relaxes the assumption of \( \alpha = \frac{1}{2} \) to understand how the products’ relative popularities—a higher \( \alpha \) indicates a higher popularity for the platform’s product compared with the third-party’s—will influence the impact of search-neutrality regulations. To obtain analytical solutions, we present the special case of \( \rho_H = 1 \), which implies that a consumer will always find the more relevant product to match her preference. Similar to the main analysis, the analysis focuses on the case where \( r \) is sufficiently low, which guarantees the platform has a strong incentive to make its product prominent without the search-neutrality regulation in equilibrium. The detailed derivations for equilibrium outcomes are included in the Online Appendix. Lemma 2 characterizes how the equilibrium prices change with \( \alpha \) when the search-neutrality regulation is present and when it is absent.

**Lemma 2.** (1) Without the search-neutrality regulation, there exists a unique \( \alpha_1 \in (0,1] \) such that both sellers’ equilibrium prices, \( p^N_{FR} \) and \( p^N_{TR} \), increase with \( \alpha \) when \( \alpha < \alpha_1 \) and stay constant
at \( p^{NR*}_F = 1 \) and \( p^{NR*}_T = \frac{1}{2} \) when \( \alpha \geq \alpha_1 \). The platform’s equilibrium price is higher than the third-party’s \( (p^{NR*}_F > p^{NR*}_T) \).

(2) With the search-neutrality regulation, as \( \alpha \) increases, both sellers’ equilibrium prices first weakly increase and then weakly decrease. The platform’s equilibrium price is higher than the third-party’s \( (p^{R*}_F > p^{R*}_T) \) when \( \alpha \) is sufficiently high, and the former is lower than the latter \( (p^{R*}_F < p^{R*}_T) \) if \( \alpha \) is sufficiently low.\(^{22}\)

Figure 1 provides two illustrative examples of how product popularity influences the equilibrium prices when the search-neutrality regulation is present and when it is absent. Let us first focus on the scenario without the search-neutrality regulation. In this case, the platform will place its product at the prominent position for all consumers, so in equilibrium it will charge a higher price than the third-party seller does. Furthermore, when there are more type-\( t \) consumers in the market (i.e., when \( \alpha \) is lower), more consumers tend to find the third-party seller’s product a match and buy it if they search the product. In other words, the third-party product will have a higher conversion rate conditional on a consumer searches the product. Hence, the third-party seller will have a stronger incentive to lower its price to attract more searches, which in turn makes the platform decrease its price to prevent consumers from searching the third-party product. As a result, the price competition exacerbates and both sellers will charge a lower price in equilibrium. Next, we consider the scenario with the search-neutrality regulation. When \( \alpha \) is very high, most people find the platform’s product at the prominent position, so the platform tends to charge a higher price

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\(^{22}\) Technically, there exist \( 0 \leq \alpha_{T,2} \leq \alpha_{F,2} < \frac{1}{2} \) and \( \frac{1}{2} < \alpha_{T,3} < \alpha_{F,3} \leq 1 \) such that \( p^{R*}_F \) increases with \( \alpha \) when \( \alpha \in [0, \alpha_{F,2}) \), stays constant at \( p^{R*}_F = 1 \) when \( \alpha \in [\alpha_{F,2}, \alpha_{F,3}) \), and decreases with \( \alpha \) when \( \alpha \in [\alpha_{F,3}, 1] \); and that \( p^{R*}_T \) increases with \( \alpha \) when \( \alpha \in [0, \alpha_{T,2}) \), stays constant at \( p^{R*}_T = 1 \) when \( \alpha \in [\alpha_{T,2}, \alpha_{T,3}) \), and decreases with \( \alpha \) when \( \alpha \in [\alpha_{T,3}, 1] \). Furthermore, \( p^{R*}_F < p^{R*}_T \) if and only if \( \alpha \in [0, \alpha_{F,2}) \), and \( p^{R*}_F > p^{R*}_T \) if and only if \( \alpha \in [\alpha_{T,3}, 1] \).
than the third-party seller’s in equilibrium. Similarly, when \( \alpha \) is very low, the third-party product’s price is higher than the platform’s. Additionally, as Lemma 1 shows, if each seller’s product is prominent for a considerable number of consumers (when \( \alpha \) is medium), then each seller will charge a high price to better extract the surplus of consumers who ex ante prefer the seller’s product. By contrast, if one seller’s product is non-prominent for most consumers (i.e., when \( \alpha \) is high or low), this seller will have strong incentives to lower its price to invite more consumer search, which can reduce the equilibrium prices of both sellers.

**Figure 1 Effect of \( \alpha \) on Equilibrium Prices\(^2^3 \)**

![Figure 1](image)

Lemma 2 indicates that without the search-neutrality regulation, the price competition is stronger when \( \alpha \) is low; by contrast, with the regulation the competition is stronger when \( \alpha \) is high or when it is low. A surprising implication is that when more consumers ex ante prefer a seller’s product, this seller’s profit can decrease due to the stronger pricing competition. Corollary 2 formally summarizes this result.

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\(^2^3\) In the left plot, \( C = 1, r = 0.05, \rho_L = 0.85 \). In the right plot, \( C = 1, r = 0.05, \rho_L = 0.75 \).
**Corollary 2.** Without the search-neutrality regulation, the third-party seller’s profit can increase with $\alpha$ if $\alpha$ is sufficiently low. With the search-neutrality regulation, the third-party seller’s profit can increase with $\alpha$ if $\alpha$ is sufficiently low, and the platform’s profit can decrease with $\alpha$ if $\alpha$ is sufficiently high.

After separately examining how the products’ popularity affects the market outcomes when the search-neutrality regulation is in place and when it is not, next we analyze how the impact of the regulation changes with $\alpha$.

**Proposition 4.** The search-neutrality regulation will reduce the consumer surplus when $\alpha \leq \alpha_4$ and increase the platform’s profit when $\alpha > \alpha_5$, where the thresholds $0 < \alpha_4 \leq 1$ and $0 < \alpha_5 \leq 1$. The regulation will increase the third-party seller’s profit.

One may intuit that when there are more type-$t$ consumers (those who are more likely to find the third-party product a match) in the market (i.e., when $\alpha$ is lower), the search-neutrality regulation guarantees that these consumers can find the third-party product at the prominent position and thus should benefit consumers more. Interestingly, Proposition 4 shows that when $\alpha$ is low, the search-neutrality regulation tends to reduce the consumer surplus. Let us consider the situation with a low $\alpha$. Without the regulation, the third-party product is non-prominent for all consumers. As is discussed in Lemma 2, since many consumers are likely to buy the third-party product if they search it, the third-party seller tends to set a lower price to attract consumer search, which in turn forces the platform to reduce its price to prevent too many consumers from searching the third-party product. By contrast, with the regulation, it is the third-party product that will become prominent for most consumers. These consumers will find the platform’s product at the non-prominent position and have a relatively low likelihood of buying it even if they search it, so the
platform has less incentive to reduce its price to attract search. Additionally, given that the third-party product has a higher match probability than the platform does for most consumers, the third-party seller also has a relatively weaker incentive to lower its price to prevent consumers from searching the platform’s product. In other words, when \( \alpha \) is low, the regulation can significantly mitigate the price competition between the platform and the third-party seller, potentially reducing the consumer surplus. By contrast, when \( \alpha \) is high, the competition is relatively mild even without the regulation, as is shown in Lemma 2. Therefore, the regulation is more likely to benefit consumers by guaranteeing the third-party product’s prominence for type-\( t \) consumers.

Additionally, Proposition 4 finds that the search-neutrality regulation can increase the platform’s profit when \( \alpha \) is large. The regulation will alleviate the price competition, which increases the platform’s profit margin. Meanwhile, although the regulation makes type-\( t \) consumers less likely to search the platform’s product, this negative impact on the platform is limited because of the low population of type-\( t \) consumers. As a result, the regulation will increase the platform’s total profit. Figure 2 provides an illustrative example of how the products’ popularity influences the sellers’ profits and the consumer surplus when the search-neutrality regulation is present versus when it is absent. In this example, the regulation makes the platform, the third-party seller, and the consumers better off when \( \alpha \) is sufficiently high, but the platform and consumers are worse off when \( \alpha \) is low.

As a final note, Proposition 4 confirms that the main findings—the search-neutrality regulation can soften price competition between firms and thus may hurt the consumers but benefit the platform—do not rely on that the products have equal popularities (\( \alpha = \frac{1}{2} \)). More importantly, these main findings are not due to that sellers’ equilibrium prices of are both one under the search-neutrality regulation.
5. Conclusion

Many dominant retail platforms (e.g., Amazon on e-commerce and Apple on iOS mobile apps) serve both as a bridge connecting buyers and third-party sellers and also as another (first-party) seller competing with other sellers on the platforms. The conflict of interest has led to increasing antitrust concerns about platforms’ preferential treatment to their own first-party offerings in consumers’ search results, which creates an unfair business environment. Many countries and regions, including the U.S. and the E.U., have passed or been discussing search-neutrality regulations to prohibit such self-preferential treatment, which aims to protect the third-party sellers and the consumers but will limit the platform’s profitability. However, such regulations will unavoidably reshape the strategic interactions between the platform and third-party sellers. Our paper builds an analytical framework to understand how search-neutrality regulations will affect the price competition between the first-party and the third-party sellers and the consumer welfare.

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Figure 2 Effect of $\alpha$ on Equilibrium Profits and Consumer Welfare

In this plot, $C = 1, r = 0.05, \rho_L = 0.7$. 
This paper’s main message is that there often exists a tradeoff between search neutrality and the strength of price competition. Without the regulation, the platform tends to place the third-party seller’s product at a non-prominent position in consumers’ search results, so the third-party seller needs to set a lower price to attract more consumer search. By contrast, the regulation ensures each product’s prominence for those consumers who relatively prefer this product, so a seller will have less a need to attract these consumers to search with a lower price and will instead focus on reaping these consumers’ surplus with a high price. We show that the regulation’s unintended consequence of competition alleviation can eventually hurt consumers when many consumers ex ante prefer the third-party product. We also find that the platform can benefit from the regulation due to the soften competition when many consumers ex ante prefer the platform’s product. The regulation will unambiguously improve the third-party seller’s profit. Importantly, our result implies that the current antitrust search-neutrality regulations in E.U. and the U.S. need to carefully evaluate all participants’ strategic responses before prescribing specific recommendations that will have a lasting impact on the entire ecosystem.

There are multiple directions for future research. First, our framework has analyzed the case in which the platform competes with one third-party seller. Future studies can relax this assumption by considering the competition between the first-party seller with multiple third-party sellers. We expect our main insight will continue to hold. Second, one can study how the search-neutrality regulation will influence the sellers’ other strategic decisions, for example their inventory decisions. Finally, more empirical research is needed to test our theoretical predictions and quantify the overall impact of search-neutrality regulations.
Reference


Appendix

Figure A1 Decision Tree When the Prominent Product is More Expensive

Figure A2 Decision Tree When the Prominent Product is Cheaper