Dominating Adjacent Markets via Self-Preferencing*

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Abstract

This paper studies a scenario where buyers and sellers interact through a monopoly platform. To accomplish interactions, sellers must also purchase ancillary products either from the platform or from competing firms. Examples include iOS developers employing electronic payment systems, Amazon sellers utilizing shipping and pricing services, and Airbnb hosts purchasing professional photography. By reducing sellers' profits when they use rival ancillary products alongside the platform's monopolized intermediation services, the platform promotes its ancillary product sale in adjacent markets and practices self-preferencing. I develop a theoretical model to investigate the motivations and welfare implications of this self-preferencing phenomenon. I show that when self-preferencing is profitable for the platform, sellers always benefit, while buyers may be worse off under certain conditions. Applying the model to several high-profile cases and empirically analyzing relevant interventions, I highlight the potential factors influencing regulation effectiveness and provide the first empirical evidence on self-preferencing regulations.

Keywords: Multi-Sided Market, Self-Preferencing, Antitrust Regulation.
JEL Codes: L21, L40, L51.

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1 Introduction

The prevalence of digital platforms has provided us with unprecedented access to information and unparalleled convenience. Recently, the global number of internet users has reached a milestone of 5 billion, constituting 67 percent of the world's total population.[1] Unlike other market types, the positive network effects in multi-sided markets enhance the appeal of dominant platforms and help those platforms accumulate even larger market shares. Consequently, we are increasingly reliant on gatekeeper companies. Take Alphabet (the owner of Google and YouTube) and Amazon as examples. Each day, there are around 9 billion searches made on Google, 122 million active users browsing on YouTube, and around 1.6 million packages shipped by Amazon.[2]

In addition to their core services, gatekeeper platforms have continually expanded their reach into new industries.[3] Many of these newly acquired businesses sell ancillary products needed to accomplish transactions or interactions in the primary market. Thus, monopoly platforms can easily leverage their dominant positions and users' trust in the primary market to promote their ancillary product sales in the adjacent market. I define this phenomenon—where a firm gains market share in a competitive adjacent market by reducing users' surplus when they use rival ancillary products alongside the firm's monopolized intermediation services—as self-preferencing across markets. The practice of self-preferencing can be achieved through various strategies, including restricting its competitors' access to key resources (like data), reducing the monopoly platform's service interoperability, or user steering in its marketplace.

In recent decades, self-preferencing in adjacent markets has been prevalent and extensively discussed in policy reports. To provide a few examples, in 2021, the European Commission (EC) initiated an investigation into Google's self-favoring practices in the advertising technology (adtech) industry.[4] To interact, publishers (apps or websites) and advertisers in the display advertising market must rely on multiple layers of adtech. Since 2014, Google has been leveraging its dominance in one adtech layer to expand in other layers. Its practices include blocking rivals' access to ad auction information, optimizing algorithms using competitors' data, and restricting technology interoperability with other companies. In 2024, the U.S. Department of Justice (DoJ) also accused Google of exerting monopolistic

[1] See https://www.statista.com/statistics/617136/digital-population-worldwide/.

[2] See https://earthweb.com/how-many-google-searches-per-day/, and https://www.globalmediainsight.com/blog/youtube-users-statistics/, and https://www.algrim.co/3031-how-many-orders-does-amazon-get-every-day.

[3] If dominant firms can use sales or data from one market to steer users toward their products in other markets, they can easily take over target companies in other industries at a discounted price. The details of this takeover strategy are analyzed in Heidhues et al. (2024).

[4] See https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3143.

control over digital advertising and demanded that the company divest to break up its monopoly.[5]

Similar strategies were also adopted by Amazon and Apple. Specifically, Amazon was found by the EC to exhibit bias in its recommendation algorithm, Buy Box,[6] in favor of sellers who use Amazon's logistics and delivery services.[7] Given that approximately 80% of Amazon sales are completed through Buy Box recommendation,[8] this self-preferencing mechanism leaves sellers with no alternatives but to utilize Amazon's delivery services.[9] In March 2024, Apple was also fined €1.8 billion by the EC because music streaming app developers have been forbidden by Apple from informing users about alternative and cheaper alternative subscription services.[10] In Europe, the self-preferencing practice is now strictly forbidden in the Digital Markets Act (see Peitz (2023) and Decarolis and Li (2023b)). In the US, the Senate Committee on the Judiciary also voted on the "American Innovation and Choice Online Act", which forbids platforms from practicing discriminatory treatments in providing services, i.e. self-preferencing.[11]

Despite the prevalence and heated discussions, there is surprisingly little economic research on how this self-preferencing phenomenon affects market outcomes, and even less guidance on related regulatory interventions. In this paper, I develop a tractable theoretical model that incorporates the following market features. There are two groups of users: buyers and sellers. Each group derives value from interactions with the other group and has heterogeneous outside options. To interact, buyers and sellers must rely on a monopoly platform. Also, sellers must purchase an ancillary product, in addition to the intermediation service, to accomplish interactions. Although the intermediation service in the primary market is monopolized, the ancillary product in the adjacent market is provided by both the platform itself and other competing firms. The choice of ancillary products affects the surplus of both buyers and sellers. Moreover, there can be inconsistencies between their preferences. For instance, iOS users may prefer purchasing cheaper music subscriptions outside of Apple, while developers find it too costly to marketing channels other than Apple.

Based on the model, I analyze how the market evolves when the platform reduces the profits of sellers who use rival ancillary products alongside intermediation services. There are several interesting

[5] See https://www.ft.com/content/57af8cc1-a39b-495a-a68a-ccfe644a23d7.

[6] The Amazon Buy Box is a section on the right side of an Amazon product detail page, where customers can purchase or add a featured offer to their shopping cart directly.

[7] See https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7777.

[8] See https://www.cnbc.com/2020/11/11/eu-investigates-amazon-what-it-means-for-us-antitrust-probes.html.

[9] According to the investigation published by the Italian Competition Authority (ICA) for the same practice, around 70% of order delivery on Amazon switched from third-party couriers to Amazon within three years after Amazon introduced its own shipping business. See https://www.competitionpolicyinternational.com/wp-content/uploads/2022/04/EU-Column-April-2022-Full.pdf

[10] See https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1161.

[11] See https://www.rhsmith.umd.edu/research/will-banning-self-preferencing-digital-markets-help-or-hurt.

findings. First, I show that self-preferencing is profitable for the platform only when there is a high level of substitutability among ancillary products and the quality of the platform's ancillary product is not too low. The practice of self-preferencing, on the one hand, allows the platform to charge higher prices and capture a larger market share in the adjacent market. However, on the other hand, the resulting price increase for ancillary products makes it more costly for sellers to complete transactions and discourages user entry. To maintain market participation, the platform has to reduce its platform fee and obtain lower profit in the primary market.

Second, I find that the welfare implication of self-preferencing is complex and jointly determined by various factors, including network effects, ancillary product similarity, and the preferences of buyers and sellers regarding ancillary products. In adjacent markets, self-preferencing typically discourages the entry of competing firms and diminishes competition. Interestingly, within the baseline model setup, the platform's motivation for self-preferencing is always congruent with sellers' interests. In other words, sellers are always better off given that it is profitable for the platform to practice self-preferencing. This is because self-preferencing increases the likelihood of sellers choosing the platform's own ancillary product, bringing in more profit for the platform and motivating it to attract more sellers. Consequently, sellers benefit and are surprisingly better off due to self-preferencing. The negative welfare impact in the primary market may arise only on the buyer side under specific conditions. Specifically, if buyers derive much lower utility from the platform's ancillary product compared to rivals, self-preferencing can harm buyers even though it remains profitable for the platform. Otherwise, buyers also benefit.

Third, the paper further contributes to the policy aspect by analyzing three recent antitrust cases. I start by discussing a structural regulation proposed by the EC concerning Google's self-preferencing in the adtech industry. I highlight that while divestment can effectively eliminate the platform's motivation for self-preferencing, it also diminishes its efforts to attract users. Therefore, policymakers must carefully weigh and compare these two potentially conflicting impacts on welfare: the benefit of removing self-preferencing incentives and the cost of the platform's diminished motivation to attract user participation. I also point out that divestment is more likely to be effective if there is a strong competitor who can offer a sufficiently high-quality product for buyers.

I next study a regulatory approach by the French Competition Authority (FCA) concerning Google's same practice. Different from the EC, the FCA's investigation focused solely on the adtechs used by publishers and led to several adjustments by Google. As part of its commitments to comply with the FCA's requirements, Google agreed to share ad auction data with competing adtech companies in France. The aim is to assist rivals in technology improvement. I show that the data-sharing adjustment is unlikely to succeed and may even backfire on the market if Google's self-preferencing in adtech extends across advertisers and publishers. To test my theoretical predictions, I examine the weekly ad

revenue and advertiser count on the 50 most popular domains in each European Economic Area (EEA) state. In comparison to other EEA countries, France experienced a sharp decline in both advertiser participation and publisher ad revenue following the data-sharing adjustment. The results are highly consistent with my theoretical predictions and serve as the first empirical evidence for self-preferencing regulation in the adtech market.

Lastly, I discuss the EC's regulation addressing Amazon's self-preferencing in logistics services. To mitigate self-preferencing, the EC required Amazon to ensure fairness and introduce a second Buy Box in the European market. Incorporating the transaction stage between buyers and sellers in the baseline model, I show that this intervention is unlikely to improve buyer surplus when buyers highly rely on Amazon's recommendations. To gather empirical evidence, I analyze Keepa data on Buy Box prices and seller participation in the pet category across nine countries. The virtual examination shows no significant changes in product prices following the intervention, raising doubts about the immediate benefits to consumers in the short run. On the seller side, there is even a slight reduction in participation, suggesting a potential decrease in seller surplus from joining the market.

The remainder of the paper is organized as follows. I next illustrate the paper's contribution to the literature. In Section 2, I introduce the model setup and then proceed to the analysis of market equilibrium. I investigate the impact of self-preferencing in Section 3. Specifically, I first study how markets evolve after self-preferencing in a simple case in Section 3.1, where ancillary products are all identical for buyers. I then allow buyers to have heterogeneous preferences over ancillary products in Section 3.2 and explore how it affects the impact of self-preferencing. In Section 4, I discuss the potential effects of recent regulatory approaches and provide empirical evidence. Lastly, I conclude in Section 5.

1.1 Contribution to Literature

This paper intersects with several strands of literature. Firstly, it draws inspiration from research on multi-sided markets, wherein two or more distinct groups interact through platforms (Belleflamme and Peitz, 2021). Several seminal works (Rochet and Tirole, 2004; Jullien, 2005) highlight the significance of network effects in multi-sided markets. These effects lead users to increasingly prefer platforms with larger sizes, thereby contributing to industry concentration.

Building upon multi-sided market literature, this paper, as far as I am concerned, presents the first formal economic definition for the specific phenomenon of cross-market self-preferencing. The conduct differs from tying, as the platform's monopolized intermediation service is not always tied

to its ancillary products. Sellers can typically access the platform's intermediation services even when utilizing rival ancillary products. For example, hosts can list on Airbnb while hiring external photographers, advertisers using non-Google ad tech can interact with publishers employing Google ad tech, and sellers utilizing FedEx shipping can still sell on Amazon. Additionally, this phenomenon is also distinct from bundling, as there is not necessarily a bundling of ancillary products and intermediation services involved.

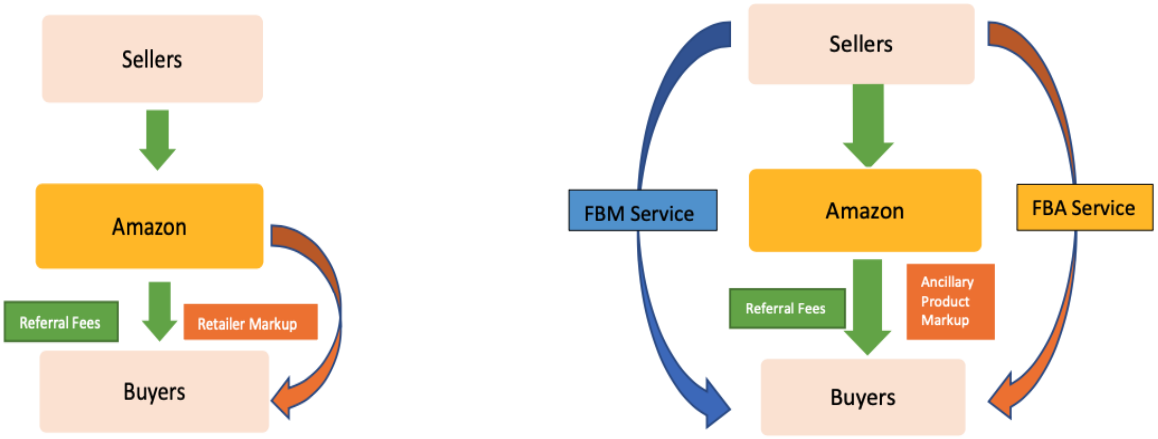
Indeed, the conduct does not fall into the narrow classification of self-preferencing in existing literature. Most research particularly focuses on hybrid mode platforms, which not only serve as intermediaries connecting sellers with buyers but also operate as retailers selling products directly to consumers (De Corniere and Taylor, 2019; Kittaka et al., 2023; Dendorfer, 2023). In the hybrid mode, the platform's tradeoff often involves monetization through sellers' referral fees or direct product sales margins (Etro, 2022). Several studies discuss the platform's choice of operating in hybrid mode and self-preferencing strategy. For instance, Kang and Muir (2022) adopt a mechanism design approach and show that the platform's tradeoff always resolves in favor of consumers if it is the monopoly in the upstream market. Hagiu et al. (2022) model self-preferencing as the platform hides innovative sellers' products from buyers on its platform. De Corniere and Taylor (2014) examine the impact of integration on user steering in the advertising market, and Athey and Morton (2021) focuses on the impact of ancillary tool manipulation on user multihoming. In the recent work of Padilla et al. (2022) and Motta (2023), they provide several well-established economic theories for a rationale for foreclosure/self-preferencing in digital markets.

Other research (see Kittaka et al. (2023) and Kittaka and Sato (2022)) highlights that the welfare implication of self-preferencing largely hinges on its influence on the referral fee. For instance, Anderson and Bedre-Defolie (2022) demonstrate that an improvement in the quality of the platform's product strengthens the platform's incentive for "insidious steering." Consequently, the platform tends to increase referral fees for third-party products, making products more expensive and thereby diminishing consumer welfare. Zennyo (2022) incorporates consumer search into his study and models self-preferencing as always including the platform's own offer in consumers' consideration set. He finds that self-preferencing makes it more profitable to attract consumers. Thus, the platform chooses to reduce referral fees, resulting in lower product prices and improved welfare. Employing a more general approach, Etro (2023) shows that self-preferencing has ambiguous impacts on referral fees and thus consumer surplus, depending on its product's demand elasticity.

The above mechanism of self-preferencing in hybrid mode provides critical insights. However, it does not fully apply to the "cross-market" self-preferencing in the paper. To illustrate the difference, it would be useful to consider Amazon as an example, as both types of self-preferencing are present

in its marketplace. In the EC's investigation against Amazon, the Executive Vice-President pointed out: "We must ensure that dual role platforms with market power, such as Amazon, do not distort competition... Its rules should not *artificially favor Amazon's own retail offers* or *advantage the offers of retailers using Amazon's logistics and delivery services*. With e-commerce booming, and Amazon being the leading e-commerce platform, fair and undistorted access to consumers online is important for all sellers."

Figure 1: Two Types of Self-Preferencing



(a) Hybrid Mode Self-Preferencing

(b) Cross-Market Self-Preferencing

In the speech, two types of self-preferencing are highlighted. First, Amazon was found to favor its own retail offers, i.e., self-preferencing in hybrid mode as discussed in the existing literature. Second, Amazon was also found to favor sellers whose orders are shipped and fulfilled by Amazon, i.e., "cross-market" self-preferencing studied in this paper. Several key market features distinguish these two forms of self-preferencing. For instance, in the first scenario, Amazon competes with sellers for buyers. As illustrated in recent studies (see Choi and Jeon (2021), and Bisceglia and Tirole (2023)), many digital platforms are willing to subsidize buyers and typically charge zero fees for intermediation services. These non-negative price restrictions significantly influence market outcomes and regulations in digital markets. However, such constraints rarely apply to the seller side, who are the purchasers of ancillary products in the second scenario. Additionally, unlike the first scenario, where buyers are both the purchasers and users of products, in the second scenario, sellers are the purchasers of ancillary products, while buyers are the end users. In other words, the choice of ancillary products (e.g., shipping), though solely determined by sellers, affects the surplus of both sellers and buyers. Since buyers and sellers may prioritize different aspects of ancillary products, this potential inconsistency in preferences introduces additional complications to the phenomenon.

More importantly, the underlying mechanisms are different. In the context of self-preferencing in hybrid mode, the platform competes with sellers while also extracting profit from these competitors through referral fees. However, in the context of cross-market self-preferencing, the competition focus shifts to the adjacent market (shipping industry) as shown in Figure 1. In this scenario, the platform can no longer employ referral fees to extract surplus from its competitors, such as FedEx or DHL, for shipping products sold in the Amazon marketplace. The double marginalization issue widely studied in hybrid mode self-preferencing disappears. The tradeoffs for the platform now arise from the intricate relationship between Amazon and other shipping companies. On the one hand, they are competitors, as users perceive their products as close substitutes. Hence, restricting competitors' products increases the attractiveness and profit of Amazon's own products in the ancillary product market. On the other hand, sellers consume the intermediation service and ancillary products together, creating a complementary relationship between them. Thus, reducing the value of competitors' products in the adjacent market also diminishes the value and profit of Amazon's primary market.

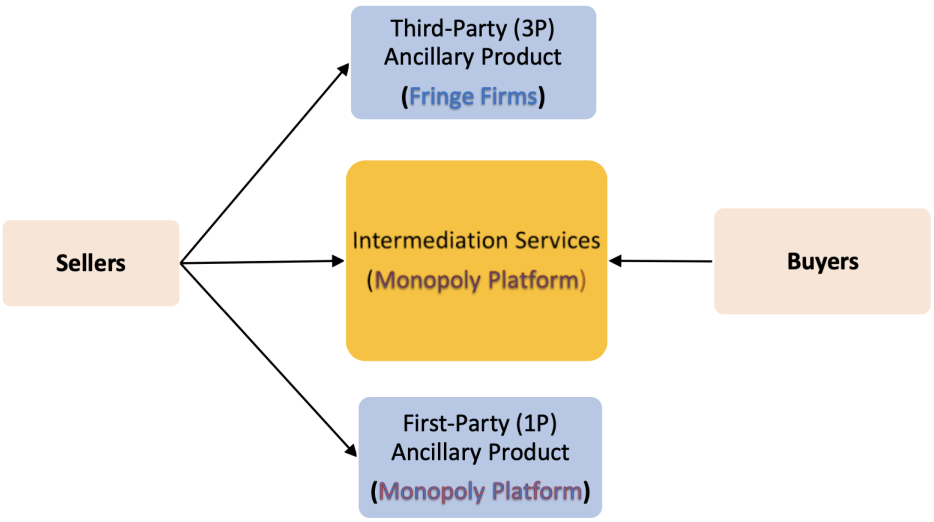
The work is also naturally related to research on user steering or search design (Hagiu and Jullien, 2011; Inderst and Ottaviani, 2012; Tadelis, 2016; Hunold and Muthers, 2017; Shen and Wright, 2019; Li et al., 2020; Long and Liu, 2023) and vertically integration (Bourreau and Gaudin, 2022; Drugov and Jeon, 2019; Hagiu et al., 2022; Zha et al., 2023). Besides the theoretical research, my paper is also related to empirical works on platform steering. Similarly to the theoretical works, the majority of attention has been placed on Amazon favoring its own brand or offers in product recommendations. For instance, Farronato et al. (2023) and Waldfogel (2024) both demonstrate that Amazon-branded products are ranked better than observably similar products in consumer search results; and Chen and Tsai (2019) point out that products sold by Amazon receive substantially more "Frequently Bought Together" recommendations in its marketplace. In the work of Lee and Musolff (2021), they show that Amazon's algorithmic recommendation is highly price elastic and consumers prefer Amazon. As a consequence, such a self-preferencing mechanism does not act as an entry barrier for sellers and, on the contrary, increases consumer surplus in the short run. Similarly, Lam (2021) also points out that alleviating self-preferencing reduces welfare unless firms do not re-optimize prices. In the work of Gutiérrez (2022), he underscores that self-preferencing regulation is highly product- and platform-specific, meaning that interventions that increase welfare in some categories may decrease welfare in others.

2 The Model

2.1 Model Setup

This paper explores a scenario depicted in Figure 2, wherein a monopoly platform—such as Amazon, Google, Airbnb, or Apple's App Store—facilitates interactions among users from two distinct groups. To simplify notation, I refer to one group of users as sellers (he/his) and the other group as buyers (she/her). However, the model setup is general and encompasses other market types. For example, in the context of App Store, the user groups transform into App developers and mobile users. In addition to the platform's intermediation services, users must also acquire an ancillary product to accomplish interactions or transactions with others. Although the choice of ancillary products affects the surplus of both buyers and sellers, I assume, without loss of generality, that sellers are the ones who choose and pay for the ancillary products in the market.

Figure 2: Monopoly Platform with Ancillary Products



While the platform monopolizes intermediation services, it faces competition in the adjacent market. In addition to the platform owner, firm A, there are also N competitive fringe firms offering ancillary products. These fringe firms all incur the same entry cost L and their products have no vertical differentiation.[12] Specifically, I refer to firm A's ancillary product as first-party (1P) product and all other firms' ancillary products as third-party (3P) product. Accordingly, I categorize sellers who use 1P ancillary products as 1P sellers and sellers who use 3P ancillary products as 3P sellers. To

[12]This entry cost is different from platform fee as it is not collected by firm A.

simplify without loss of generality, I normalize the marginal costs of producing ancillary products and intermediation services to zero throughout the analysis.[13]

There are positive cross-group network effects in the market, so each seller anticipates a higher profit/surplus as more buyers join the platform. This market characteristic is captured by the term $U_s^1 = e_s n_B - m_S$, where $e_s > 0$ measures the magnitude of network effects, n_B is the number of buyers on the platform, and m_S is sellers' platform fee for intermediation services. Another component, denoted by U_s^2, accounts for the diverse surplus experienced by sellers based on their tastes and choice of ancillary products in the adjacent market. Each seller has two ancillary products in his consideration set: one is always the 1P product from firm A, and the other is his most preferred 3P product. Each fringe firm has an equal chance of being the seller's favorite, making the probability that a fringe firm $k \in \{1,2,...,N\}$ is included in the seller's consideration set equal to $1/N$. Sellers perceive the two products in the consideration set as both vertically and horizontally differentiated.

The vertical differentiation is modeled by sellers' varied profit when they use different ancillary products alongside the intermediation services: they expect to obtain a profit of v_A^s if they opt for 1P ancillary products, and $v_k^s = v_A^s - \beta_s$ for 3P ancillary products. Specifically, β_s measures the vertical difference between the two ancillary products, which can be either positive, zero, or negative. If 1P sellers expect to achieve a higher profit on the platform than 3P sellers, then $\beta_s > 0$. Otherwise, it is the opposite.

Horizontal differentiation is modeled in the Hotelling fashion: as shown in Figure 3, the two ancillary products in a consideration set are located at the two ends of a unit-length Hotelling line, with the 1P ancillary product located at 0 and the 3P ancillary product located at 1. Sellers are uniformly distributed on this unit interval and incur the cost of not having one's ideal ancillary product that increases linearly in distance at rates t. Within this setup, this second component U_s^2 for seller j, who has fringe firm k in his consideration set and purchases the ancillary product from firm $i \in \{A,k\}$, is given by $U_s^2(\theta_j, i) = v_i^s - p_i - t|\theta_j - l_i|$, where p_i denotes the corresponding ancillary product price, $l_i \in \{0,1\}$ represents the location of product i, and $\theta_j \in [0,1]$ is the position of seller j.

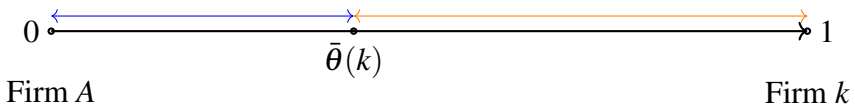


Figure 3: Hotelling Line

[13]The relaxation of this assumption should not affect the main conclusions in the paper.

Combining component U_s^1 and U_s^2, we derive the total surplus of seller j as

$$U_s(\theta_j, i) = U_s^1 + U_s^2 = e_s n_B - m_S + v_i^s - p_i - t|\theta_j - l_i|.$$

Drawing inspiration from the motivating examples, I assume the intermediation service is free for buyers. Similar to sellers, a buyer's surplus also consists of two components. The first component, U_b^1, captures the network effect and is given by $U_b^1 = e_b n_S$, where e_b measures the network effects on the buyer side, and n_S is the number of sellers joining the platform. The second component, U_b^2, reflects buyers' varied utility when sellers choose different ancillary products to fulfill interactions. Specifically, buyers anticipate to derive a utility of $U_b^2 = v_A^b$ if sellers use 1P ancillary product and $U_b^2 = v_k^b = v_A^b - \beta_b$ if sellers use 3P ancillary products. Their relative value for ancillary products is measured by parameter β_b: if $\beta_b = 0$, buyers are completely indifferent among all sellers. If $\beta_b > 0$ ($\beta_b < 0$), buyers expect a higher (lower) utility from 1P sellers than from 3P sellers. Combining components U_b^1 and U_b^2, a buyer's total expected utility from joining the market is given by $U_b = U_b^1 + U_b^2 = e_b n_S + v_i^b$ if her order is fulfilled by firm $i \in \{A, 1, 2, ..., N\}$.

The timeline of the game is as follows: First, the monopoly platform sets its platform fee m_S for sellers. Second, fringe firms determine whether to join the ancillary market, and if so, they and the platform simultaneously choose the prices of ancillary products. Given the platform fees and ancillary product prices, buyers and sellers make entry decisions. Last, sellers who join the market purchase the ancillary product that gives them the highest value. To prevent trivial market equilibria in the analysis, I make the following assumptions:

Assumption 1. *Throughout the study,*

- *the network effects satisfy $e_s > 0$, $e_b \neq 0$, and $e_b e_s < 1$ to guarantee profit concavity;*
- *the product value satisfy $|\beta_s| < 3t$ so that both 1P product and 3P product derive a positive demand at equilibrium; and*
- *the surplus is sufficient large $v_A^s + e_s v_A^b > \frac{18e_s\beta_b t + 6\beta_s t + 45t^2 - 6e_s\beta_b\beta_s - \beta_s^2 - 2e_b e_s\beta_s^2 - 18e_b e_s t^2}{36t}$, such that there exists competition between the 1P ancillary product and 3P ancillary product.*

2.2 Market Equilibrium

As we are interested in the subgame perfect equilibrium, I initiate the analysis by examining sellers' demands for ancillary products, as well as the demand for platform participation on both sides of the

market. I then investigate firms' pricing decisions in the ancillary product market, followed by an exploration of the platform's profit-maximizing pricing strategy for intermediation services.

Seller Demands If firm A and firm $k \in \{1,2,...,N\}$ are in a seller's consideration set, the seller is indifferent between the two firms when his location $\bar{\theta}(k)$ satisfies $U_S(\bar{\theta}(k),A) = U_S(\bar{\theta}(k),k)$. Solving this equation, I derive the indifferent seller's location as follows:

$$\bar{\theta}(k) = \frac{\beta_s + p_k - p_A + t}{2t}. \tag{1}$$

As illustrated in Figure 3, sellers located at $\theta_j < \bar{\theta}(k)$ will purchase from firm A, while the rest will choose firm k. Since fringe firms all have an equal probability of appearing in a seller's consideration set, the demands for the two ancillary products can be expressed as:

$$Q_A = \int_0^N \bar{\theta}(k)\frac{n_S}{N}dk = \int_0^N \frac{(\beta_s + p_k - p_A + t)}{2t}\frac{n_S}{N}dk, \tag{2}$$

$$Q_k = \left(1 - \bar{\theta}(k)\right)\frac{n_S}{N} = (1 - \frac{\beta_s + p_k - p_A + t}{2t})\frac{n_S}{N}, \tag{3}$$

where Q_A represents the demand for 1P products, and Q_k denotes the demand for 3P products from firm k.

Motivated by the intricate rules governing digital markets, I assume that sellers become aware of their consideration set and their specific location on the Hotelling line *after* having accessed the platform. This corresponds to the idea that sellers on Amazon may not consider their storage choice until they receive several orders, or YouTubers may not be motivated to enhance their knowledge in advertising monetization technology until they become popular channels. It is only after a seller joins the platform and understands how the ancillary product works jointly with intermediation services that he becomes aware of his preferences over ancillary products. In such a context, a seller's expected surplus from joining the market, denoted as $E[U_s]$, equals:

$$E[U_s] = e_s n_B - m_S + \int_0^N \left(\int_0^{\bar{\theta}(k)} (v_A^s - p_A - tx)dx + \int_{\bar{\theta}(k)}^1 (v_A^s - \beta_s - p_k - t(1-x))dx \right) \frac{1}{N}dk.$$

As for buyers, their expected utility depends on the distribution of sellers among ancillary products

and can be written:

$$E[U_b] = e_b n_S + \int_0^N \left(\int_0^{\bar{\theta}(k)} v_A^b dx + \int_{\bar{\theta}(k)}^1 (v_A^b - \beta_b) \right) \frac{1}{N} dk.$$

Users in both groups will join the platform when they expect to derive a higher surplus than their outside options. Without loss of generality, I assume that both buyers' and sellers' outside options follow a uniform distribution in the interval $[0,1]$, and their user sizes are normalized to one. Within this model setup, the demands for platform participation in both groups are given by: $n_S = E[U_s]$ and $n_B = E[U_b]$.

Firm Pricing Given the demand functions, I now investigate firms' pricing strategies in the ancillary product market. For fringe firm k, its profit comes solely from selling ancillary products and can be calculated as:

$$\pi_k = p_k Q_k - L = p_k \frac{(-\beta_s + p_A - p_k + t) n_S}{2Nt} - L.$$

As for the monopoly platform, it earns additional profit from providing intermediation services. Accordingly, its profit is expressed as:

$$\pi_A = m_S n_S + \int_0^N p_A \bar{\theta}(k) \frac{n_S}{N} dk = m_S n_S + \int_0^N p_A \frac{(\beta_s - p_A + p_k + t) n_S}{2Nt} dk. \tag{4}$$

As illustrated in the previous analysis, sellers' demand for market participation is jointly determined by all firms in the ancillary product market. To make the model tractable, I assume each firm in the ancillary product market takes the aggregate demand n_S as given when optimizing profits. Solving the system of first-order conditions, I derive the symmetric equilibrium prices as:

$$p_A = t + \frac{\beta_s}{3}, \tag{5}$$

$$p_C = t - \frac{\beta_s}{3}, \tag{6}$$

where p_C represents the price set by all fringe firms at the symmetric equilibrium.

Plugging in the equilibrium prices, the ancillary product demands are equal to:

$$Q_A = (\frac{1}{2} + \frac{\beta_s}{6t})n_S, \tag{7}$$

$$Q_C = (\frac{1}{2} - \frac{\beta_s}{6t})\frac{n_S}{N}, \tag{8}$$

where Q_C denotes the demand for each fringe firm at the symmetric equilibrium. Accordingly, the equilibrium ratio of sellers choosing 1P ancillary product is denoted as $q_A = Q_A/n_S = \frac{1}{2} + \frac{\beta_s}{6t}$.

Platform Pricing Lastly, I proceed to analyze the platform's pricing strategy over intermediation fees. Given the ancillary product prices (expression 5-6) and demands (expression 7-8) at equilibrium, the explicit demands for platform participation can be expressed as:

$$n_B = \frac{6\beta_b(\beta_s - 3t) + 36tv_A^b - e_b(-\beta_s^2 + 18\beta_s t + 45t^2 + 36tm_S - 36tv_A^s)}{36t(1 - e_b e_s)}, \tag{9}$$

$$n_S = \frac{\beta_s^2 - 18\beta_s t + 6e_s(\beta_b\beta_s - 3t\beta_b + 6tv_A^b) - 36tm_S - 45t^2 + 36tv_A^s}{36t(1 - e_b e_s)}. \tag{10}$$

Maximizing the platform's profit by solving the first-order condition, I derive the equilibrium platform fee:

$$m_S^* = \frac{6e_s\beta_b\beta_s - \beta_s^2 - 18e_s\beta_b t - 30\beta_s t - 63t^2 + 36e_s tv_A^b + 36tv_A^s}{72t}. \tag{11}$$

Correspondingly, the equilibrium demands for platform participation are given by:

$$n_B^* = \frac{(2\beta_b\beta_s + 12tv_A^b - 6\beta_b t)(2 - e_b e_s) + e_b\beta_s(\beta_s - 2t) - 9e_b t^2 + 12e_b tv_A^s}{24t(1 - e_b e_s)}, \tag{12}$$

$$n_S^* = \frac{2e_s\beta_b\beta_s + \beta_s^2 - 6e_s\beta_b t - 2\beta_s t - 9t^2 + 12e_s tv_A^b + 12tv_A^s}{24t(1 - e_b e_s)}, \tag{13}$$

and the resulting demands for ancillary products are $Q_A^* = (\frac{1}{2} + \frac{\beta_s}{6t})n_S^*$ and $Q_C^* = (\frac{1}{2} - \frac{\beta_s}{6t})n_S^*$.

I lastly calculate the equilibrium profits of firms and derive:

$$\pi_A^* = \frac{(-2e_s\beta_b\beta_s - \beta_s^2 + 6e_s\beta_b t + 2\beta_s t + 9t^2 - 12e_s t v_A^b - 12t v_A^s)^2}{576t^2(1-e_b e_s)}, \tag{14}$$

$$\pi_C^* = \frac{(3t-\beta_s)^2(-2e_s\beta_b\beta_s - \beta_s^2 + 6e_s\beta_b t + 2\beta_s t + 9t^2 - 12e_s t v_A^b - 12t v_A^s)}{432Nt^2(1-e_b e_s)} - L, \tag{15}$$

where π_C^* denotes the profit of each individual fringe firm at the symmetric equilibrium. Fringe firms continue entering the market until $\pi_C^* = 0$. Employing this free entry condition, it can be easily shown that the number of fringe firms at equilibrium $N^*$is increasing in the total profit of all fringe firms

$$\Pi_C^* = N^* L = \frac{(3t-\beta_s)^2(-2e_s\beta_b\beta_s - \beta_s^2 + 6e_s\beta_b t + 2\beta_s t + 9t^2 - 12e_s t v_A^b - 12t v_A^s)}{432t^2(1-e_b e_s)}.$$

In summary, the market equilibrium in the benchmark can be summarized as shown in the following Proposition.

Proposition 1. *Under Assumption 1, there is a unique equilibrium such that a total of n_B^* buyers and n_S^* sellers, as shown in equations (12) to (13), join the market. Among them, a portion of $(3t+\beta_s)/6t$ opts for 1P ancillary products, while a proportion of $(3t-\beta_s)/6t$ chooses 3P products at the subgame-perfect equilibrium. The fringe firms and the platform choose the pricing strategies listed in expression (5)-(6) and (11), leading to the profits as shown in equations (14)-(15).*

3 Self-Preferencing Impacts

Based on the market equilibrium, I now proceed to investigate the impact of self-preferencing. To begin with, I first examine a simple case where $\beta_b = 0$. This corresponds to the scenario where buyers perceive all sellers and ancillary products as identical, while the platform, through self-preferencing, can diminish the profit of 3P sellers in the market and result in an increase in β_s. Through the analysis of this sample case, I aim to disentangle the underlying mechanisms for self-preferencing motivation and its impacts. I then relax this assumption in the later analysis to examine how buyer preferences influence the impact of self-preferencing.

3.1 A Simple Case

In this section, I focus on the simple case when $\beta_b = 0$. I first explore how firms' pricing strategies and demand evolve as β_s increases, then extend the analysis to examine the effects on firms' profits and social welfare. All proofs and supplementary results are provided in the Appendix.

As illustrated by the equilibrium prices listed in Equations (5)-(6), the prices of 1P and 3P ancillary products are equal in the absence of vertical differentiation for sellers. The introduction of vertical differentiation β_s adjusts the price of 3P ancillary products by $-\beta_s/3$ and the price of 1P ancillary products by $\beta_s/3$. If the monopoly platform diminishes the surplus of sellers who opt for 3P ancillary products, β_s increases and 1P ancillary product becomes relatively more attractive. Consequently, the practice of self-preferencing results in an increase in the platform's ancillary product price and a decrease in its rivals' prices.

As for the platform fee, it can be simplified as $m_s^* = (36e_s t v_A^b + 36 t v_A^s - \beta_s^2 - 30\beta_s t - 63t^2)/72t$ when $\beta_b = 0$. Upon analyzing the comparative statics, I find that self-preferencing diminishes the platform fee for sellers. This is because self-preferencing increases the price of 1P ancillary products, making it more expensive for sellers to fulfill transactions on the platform and discouraging their entry. To maintain high user participation, the platform must reduce its platform fees to compensate for this negative effect. Hence, the practice of self-preferencing leads to a reduction in the platform fee m_S.

In summary, the impacts of self-preferencing on firms' pricing strategies in the ancillary product market and intermediation services can be outlined as follows:

Corollary 1. *When $\beta_b = 0$, self-preferencing*

- *increases 1P ancillary product price p_A;*
- *decreases 3P ancillary product price p_C; and*
- *decreases the platform fee m_S.*

Turning to the demand for platform participation, I find that self-preferencing can lead to either higher or lower participation, depending on network effects, ancillary products' vertical differentiation, and their horizontal differentiation. Precisely, the results can be summarized in the following corollary:

Corollary 2. *When $\beta_b = 0$, self-preferencing can either increase or decrease the demands for platform participation. Specifically,*

- *if 1P sellers derive a higher surplus than 3P sellers, i.e., $\beta_s > 0$, then self-preferencing increases sellers' demand for platform participation when $t < \beta_s$ and decreases otherwise;*
- *if 1P sellers derive a lower surplus than 3P sellers, i.e., $\beta_s < 0$, then self-preferencing always decreases sellers' demand for platform participation;*
- *self-preferencing will move buyers' demand for platform participation in the same direction as sellers when $e_b > 0$, while in the opposite direction to sellers when $e_b < 0$.*

The underlying mechanisms are as follows. On the seller side, self-preferencing generates two conflicting effects on their participation. On the one hand, the practice of self-preferencing directly diminishes the surplus of sellers when they choose 3P ancillary products, creating negative impacts. On the other hand, self-preferencing motivates the platform to reduce the platform fee as shown in Corollary 1, simultaneously increasing the surplus of sellers.

If 3P sellers expect to derive higher profits than 1P sellers, i.e., $\beta_s < 0$, the negative impact of self-preferencing on sellers' participation is always dominant. This can be illustrated by revisiting sellers' expected surplus from joining the market:

$$\begin{aligned} E[U_s] &= e_s n_B - m_S + \int_0^N \left(\int_0^{\bar{\theta}} (v_A^s - p_A - tx)dx + \int_{\bar{\theta}}^1 (v_A^s - \beta_s - p_k - tx)dx \right) \frac{1}{N} dk, \\ &= e_s n_B - m_S + \int_0^{q_A} \underbrace{(v_A^s - t - \frac{\beta_s}{3} - tx)}_{\text{sellers using 1P product}} dx + \int_0^{1-q_A} \underbrace{(v_A^s - t - \frac{2\beta_s}{3} - tx)}_{\text{sellers using 3P product}} dx. \end{aligned} \tag{16}$$

As shown in Equation (16), the practice of self-preferencing, measured by an increase in β_s, generates a direct and stronger negative impact on 3P sellers than on 1P sellers. When $\beta_s < 0$, the majority of sellers opt for 3P products. This large ratio of 3P sellers increases the overall strength of self-preferencing's negative impact on sellers and results in a corresponding decrease in their participation.

If 1P sellers expect to derive higher profits than 3P sellers, i.e., $\beta_s > 0$, the overall impact of self-preferencing on sellers' participation can be either positive or negative, depending on sellers' transportation cost. When the transportation cost is low so the two ancillary products are highly similar for sellers, the practice of self-preferencing will cause a significant portion of sellers to switch from 3P products to 1P products. This substantial increase in the platform's market share of ancillary products makes it more profitable for the platform to attract additional sellers. Hence, the platform has

stronger incentives to reduce its platform fee, resulting in an increase in the aggregate demand n_S after self-preferencing.

However, when the transportation cost t is high so the two ancillary products are highly differentiated for sellers, the practice of self-preferencing can only shift a few sellers from 3P ancillary products to 1P ancillary products. As each additional seller attracted to the platform remains likely to choose rivals' ancillary products, the platform's motivation to increase seller participation diminishes. Consequently, the reduction in platform fees induced by self-preferencing is minimal, and this positive impact is outweighed by the negative consequences of diminishing 3P sellers' surplus.

On the buyer side, the distribution of sellers among 1P and 3P ancillary products does not affect buyers' surplus when $\beta_b = 0$, as they are fully identical to buyers in such a market. Consequently, the impact of self-preferencing on buyers' surplus comes solely from the change in seller participation and the cross-group network effect. If buyers prefer having more sellers in the market, i.e., $e_b > 0$, then self-preferencing moves their participation in the same direction as sellers. However, if buyers prefer having fewer sellers in the market, i.e., $e_b < 0$, then self-preferencing moves their participation in the opposite direction as sellers.

Note that within the model setup, the total surplus of sellers and buyers can be expressed as:

$$\begin{aligned} Surplus_S^* &= \int_0^{n_S} E[U_s]dO + \int_{n_S}^1 OdO = \int_0^{n_S} n_S dO + \int_{n_S}^1 OdO = \frac{1+n_S^2}{2}, \\ Surplus_B^* &= \frac{1+n_B^2}{2}, \end{aligned}$$

where O is the outside option. As a consequence, platform participation can be viewed as a measure of user surplus in each group. This further adds intrigue to my findings, as it suggests that self-preferencing doesn't always diminish user surplus at equilibrium. Instead, it has the potential to benefit both buyers and sellers if specific conditions are satisfied. The finding is in surprising contrast to a common belief that self-preferencing is detrimental to consumers. In the simple case where all ancillary products and sellers are identical for buyers, I show it is possible for consumers to achieve a higher surplus following self-preferencing.

Lastly, I examine the platform's profit to shed light on self-preferencing incentives.[14] I find that it is not always profitable for the platform to practice self-preferencing, as summarized in Corollary 3.

Corollary 3. *When $\beta_b = 0$, the practice of self-preferencing can either increase or decrease the platform's and competing firms' profits. Specifically,*

[14] I also analyze the effect of self-preferencing on the demands for ancillary products in Appendix A.

- *if 1P sellers derive a high surplus than 3P sellers, i.e., $\beta_s > 0$, then self-preferencing increases the monopoly platform's profit when $t < \beta_s$ and decreases otherwise;*
- *if 1P sellers derive a lower surplus than 3P sellers, i.e., $\beta_s < 0$, then self-preferencing, always decreases the monopoly platform's profit; and*
- *there exist two cutoffs: $t < \bar{\beta}_s^c < \bar{\bar{\beta}}_s^c < 3t$ such that self-preferencing increases the total profit of all competing firms Π_C^* when $e_s v_A^b + v_A^s < \frac{7t}{8}$ and $\bar{\beta}_s^c < \beta_s < \bar{\bar{\beta}}_s^c$ and decreases otherwise.*

Given the previous findings that self-preferencing may increase the platform's profit from the adjacent market while decreasing its profit from the primary market, it is not surprising to find that self-preferencing can be unprofitable for the platform. The interesting results emerge when combining the results in Corollary 3 with Corollary 2: I find that the platform's incentive for self-preferencing is always congruent with sellers' interests, meaning that sellers always benefit from self-preferencing when it is profitable for the platform to do so. Hence, the practice of self-preferencing does not generate any harmful welfare impact on sellers. This is because self-preferencing increases the likelihood that sellers will choose the platform's own ancillary product. As a result, each additional seller generates more profit for the platform and strengthens its incentive to attract sellers. Hence, sellers benefit from this mechanism and are better off. If buyers are indifferent between 1P sellers and 3P sellers and experience positive network effects, they also benefit from self-preferencing because it promotes seller participation and amplifies the network effects.

3.2 Heterogeneous Buyer Preference

In real markets, buyers may derive varied values from 1P sellers and 3P sellers. Moreover, buyers' preferences for ancillary products can be different from those of sellers. I now consider this possibility and extend the analysis to a more complicated scenario where $\beta_b \neq 0$. Specifically, when $\beta_b > 0$, buyers expect to derive a higher utility from 1P sellers than from 3P sellers. When $\beta_b < 0$, it is the opposite. By investigating the market outcomes in such a market, I focus on how buyers' preferences over the two types of ancillary products affect the welfare implication of self-preferencing.[15]

I find that if buyers exhibit a growing preference for 1P sellers over 3P sellers, the positive impact of self-preferencing on user participation is amplified because a larger proportion of sellers switch to the type that buyers prefer. Hence, the impact of self-preferencing on buyers' participation becomes

[15] All supplementary results and proofs are provided in Appendix A.

positive when this preference is sufficiently strong. Conversely, when buyers strongly prefer 3P sellers over 1P sellers, self-preferencing steers more sellers towards the ancillary products buyers dislike. As a consequence, buyers are discouraged from entering the market following self-preferencing. Due to the existence of positive network effects, the impact of self-preferencing on buyers' participation spreads to the seller side. Hence, self-preferencing increases sellers' demand for platform participation when buyers strongly prefer 1P sellers and decreases otherwise. The results can be summarized as shown in Corollary 4.

Corollary 4. *The impacts of self-preferencing on platform participations, measured by* $\frac{dn_B}{d\beta_s}$ *and* $\frac{dn_S}{d\beta_s}$*, are increasing in buyers' preference over 1P ancillary products. Specifically,*

- *self-preferencing increases sellers' demand for platform participation when* $\beta_b > \frac{t-\beta_s}{e_s}$ *and decreases otherwise;*
- *self-preferencing increases buyers' demand for platform participation when* $\beta_b > \frac{e_b(t-\beta_s)}{2-e_b e_s}$ *and decreases otherwise.*

I also explore how buyers' preferences influence the impact of self-preferencing on firms' profits. The results can be summarized as:

Corollary 5. *The impacts of self-preferencing on firms' profits, measured by* $\frac{d\pi_A}{d\beta_s}$ *and* $\frac{d\Pi_C}{d\beta_s}$*, is always increasing in buyers' preference over 1P ancillary products. Specifically,*

- *self-preferencing increases the monopoly platform's profit when* $\beta_b > \frac{t-\beta_s}{e_s}$ *and decreases otherwise; and*
- *there exists a threshold* $\bar{\beta}_b^C$ *such that self-preferencing increases the total profit of all competing firms* Π_C^* *when* $\beta_b > \bar{\beta}_b^C$ *and decreases otherwise.*

Combining the results in Corollary 4 and Corollary 5, I find that the platform's motivation for self-preferencing remains congruent with sellers' interests. However, unlike the simple case of $\beta_b = 0$, the platform's motivation for self-preferencing can conflict with buyers' interests even when they enjoy positive network effects.

Proposition 2. *Under conditions in which the platform finds self-preferencing profitable, sellers' surplus increases following self-preferencing. However, its impact on buyers' surplus can be either positive or negative. Specifically,*

- *if $\beta_s < t$, self-preferencing always increases buyers' participation and their surplus;*
- *if $\beta_s > t$, self-preferencing increases buyers' participation and their surplus when $\beta_b > \frac{e_b(t-\beta_s)}{2-e_b e_s}$ and decreases otherwise.*

The findings in Proposition 2 highlight the potential negative impact on welfare that may arise following self-preferencing and clarify the conditions under which it might occur. Specifically, it suggests that when self-preferencing is profitable for the platform, sellers always benefit. However, there can be harmful impacts on buyers if $\beta_b < e_b(t-\beta_s)/(2-e_b e_s) < 0$ and $\beta_s > t > 0$. In other words, detrimental effects on welfare emerge for buyers if they derive a much higher value from 3P ancillary products than from 1P ancillary products, while sellers highly prefer 1P ancillary products due to self-preferencing.

When the platform practices self-preferencing, a larger portion of sellers are motivated to choose the platform's 1P ancillary products. This increases the platform's expected profit derived from each additional seller and enhances its incentives to attract seller participation. As a consequence, sellers benefit from lower platform fees and are better off. On the buyer side, there are multiple impacts. On the one hand, buyers benefit from larger seller participation through network effects. However, if buyers highly dislike the 1P ancillary product, the increase in the portion of 1P sellers diminishes their surplus from joining the market and produces a potentially conflicting impact. As a result, the overall impact of self-preferencing on buyer surplus can be either positive or negative, depending on their preference for ancillary products. If there is a significant inconsistency between buyer and seller preferences, self-preferencing could lead to social welfare losses and shall be monitored by policymakers.

4 Policy Applications

In many countries, this form of abusive practice is under investigation or has been regulated through various approaches. To shed light on relevant policies, this section discusses a few high-profile cases and examines the potential impact of their proposed regulations.[16]

I begin by studying the structural remedy proposed by the EC regarding Google's self-preferencing in the adtech industry. I argue that while divestment can effectively eliminate the platform's motivation for self-preferencing, it also reduces its incentives to attract publishers and advertisers. Therefore, it

[16]Although the regulations in the French Competition Authority's case against Google and the European Commission's case against Amazon were the result of agreements between the competition authorities and companies, without any formal remedies or interventions being imposed, I may refer to them as interventions throughout the paper.

is crucial for policymakers to carefully weigh and compare these impacts. I then explore a different regulatory approach taken by the FCA in response to Google's same abusive practice. To comply with the FCA, Google began sharing ad auction data with competitors at a fair price, aiming to help rivals enhance their technology and address Google's comparative advantages. I demonstrate that this data-sharing approach improves welfare if there is a viable competitor capable of providing high-quality services to advertisers. However, when this condition is not met, the regulation could backfire, negatively impacting advertisers and publishers in the advertising market. To test these theoretical predictions, I combine various data sources and provide empirical evidence. Lastly, I discuss the EC's antitrust case to address Amazon's self-preferencing in logistics services. My analysis suggests that the EC's regulatory approach has little impact on product prices and is unlikely to improve consumer surplus if buyers heavily rely on Amazon's recommendations. These patterns are later confirmed by a virtual examination of the Buy Box price and seller participation on Amazon. These findings suggest that nuances in remedy design and market characteristics can critically influence policy outcomes, highlighting the need for policymakers to exercise caution in policy formulation.

4.1 European Google Case: Service Divestment

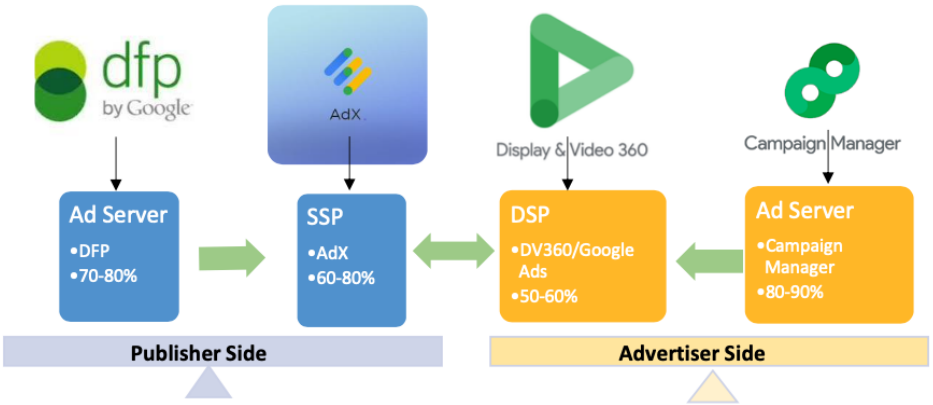
I start by examining an intervention recently proposed by the EC, which aims to address Google's practice of self-preferencing in the adtech industry. In the following analysis, I first introduce its institutional background in Section 4.1.1. Then, I elucidate how the intervention can be integrated into my model and examine its potential implications in Section 4.1.2.

4.1.1 Institutional Background

In the display advertising market, publishers, including apps or websites, constitute the supply side that offers available ad spaces, while advertisers represent the demand side that purchases these spaces to catch eyeballs. Both groups rely on an intricate chain of advertising technologies to facilitate their interactions with each other.

In a simplified adtech stack as shown in Figure 4, ad servers work as the first technological layer for publishers. They assist publishers in managing their ad inventory by assessing availability based on historical data and automatically displaying relevant ads. The second technology layer for publishers encompasses supply-side platforms (SSPs), which actively solicit bids from advertisers and facilitate auctions for specific impressions. Advertisers, likewise, also require ad servers to deliver ads and monitor campaign performance. Furthermore, advertisers or their agencies purchasing ad space must

Figure 4: Advertising Technology Chain



also engage with demand-side platforms (DSPs), which allow them to participate in auctions organized by SSPs or other sources.

Each layer of the adtech stack plays an indispensable role and operates in the following sequence: when a user visits a website or app, the publisher's ad server first receives information about available impressions, i.e., ad slots for that particular user, and requests bids for these impressions from connected SSPs. The SSPs then transmit these requests to all connected DSPs, which select winning ads through auctions and send winning bids back to the SSPs. Next, SSPs conduct an auction among bids received from all connected DSPs, choose the winner, and return the winning bid to the publisher's ad server. Lastly, the publisher's ad server conducts a final auction among bids received from all SSPs and notifies the selected ad to be displayed to the user.

In the current advertising market, Google is active and dominant in almost all layers of the adtech stack. As pointed out by the US Department of Justice: "Google now controls the digital tool that nearly every major website publisher uses to sell ads on their websites (publisher ad server); it controls the dominant advertiser tool that helps millions of large and small advertisers buy ad inventory (advertiser ad network); and it controls the largest advertising exchange (ad exchange), a technology that runs real-time auctions to match buyers and sellers of online advertising."[17] The company provides an ad server service, "DoubleClick for Publishers (DFP)", and an SSP, "Google Ad Exchange (AdX)" for publishers. Both the DFP and AdX fall under Google's re-branded "Google Ad Manager" services, but they fulfill distinct functions. According to the FCA, Google's DFP controls 70-80% of ads served in the European Economic Area (EEA), dominating the publisher ad server market. Regarding SSPs, Google manages up to 80% of sales in the EEA, depending on the state. On the advertiser side, Google's

[17] See justice.gov/opa/pr/justice-department-sues-google-monopolizing-digital-advertising-technologies.

Campaign Manager serves 80-90% of all impressions, while its DSPs, Google Ads and Display & Video 360, capture 50-60% of demand.[18]

In 2023, the EC published its statement of objections. The investigation revealed that, since 2014, Google had been favoring its own ad exchange, AdX, in the ad selection auction run by its dominant publisher ad server, DFP. For instance, Google informed AdX in advance of the highest bid from competitors that it needed to surpass to win the auction. Additionally, Google was found to favor AdX through its ad-buying tools, Google Ads and DV360, by practices such as reducing the bids these tools sent to rival SSPs in ad auctions.[19]

Based on these findings, the EC cast doubts on the efficacy of behavioral remedies in deterring Google from persisting or adopting new self-preferencing practices. It strongly emphasized the need for a more effective solution to address Google's abusive practices in the adtech industry. Precisely, the EC suggested that the most impactful approach to address competitive concerns might involve a mandatory divestment of specific services by Google. Compared to behavioral remedies, the divestment approach is deemed potentially more effective in eliminating Google's self-preferencing motivation and restoring competition in the adtech industry. However, considering the intricate market structure of adtech markets, uncertainties persist regarding how this structural remedy might impact pricing strategies and social welfare.

To investigate, I write the overall changes following the divestment as follows:

$$\begin{aligned} \Delta EQ &= EQ'(\beta_s') - EQ(\beta_s), \\ &= \underbrace{EQ'(\beta_s') - EQ(\beta_s')}_{\text{changes due to market structure}} + \underbrace{EQ(\beta_s') - EQ(\beta_s)}_{\text{changes due to self-preferencing removal}} . \end{aligned} \tag{17}$$

where ΔEQ represents the overall changes in market equilibrium, EQ is the equilibrium strategy before divestment, EQ' is the equilibrium strategy after divestment, β_s measures the magnitude of self-preferencing before the intervention, and β_s' measures the magnitude of self-preferencing after the intervention.

As shown in Equation (17), the overall market change resulting from divestment can be categorized into two effects. First, given the ancillary product values, the equilibrium strategy changes due to the modifications in market structure induced by divestment. Second, given the market structure and equilibrium strategy, the value of 3P ancillary products improves due to the elimination of self-preferencing.

[18] See https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3929310.

[19] See https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3207.

The second effect has been well-illustrated in the benchmark. Therefore, the focus now naturally falls on the first effect—how the change in market structure alone influences market outcomes.

To study, I analyze the market outcomes post-divestment, where the 1P product is operated by a separate company from the monopoly platform. By comparing this scenario with the market before divestment, where the 1P product is operated by the monopoly platform, I shed light on the first effect. Combining these findings with our insights from the benchmark, my goal is to provide a comprehensive analysis of the benefits and costs associated with divestment regulation.

4.1.2 Policy Implication

Translating the divestment into my model, I study the scenario where the ownership of 1P ancillary product is now switched from the monopoly platform to a different company, denoted as firm B. Since we want to focus on the first effect - the changes in market outcomes solely induced by market structure modification - I assume the ancillary product values remain the same. Within this new market setup, the transaction stage in the ancillary product market remains unaffected. Thus the 1P ancillary product and 3P ancillary product adopt the same pricing strategy and derive the same equilibrium market share as in Section 2.2. Accordingly, sellers' demand for platform participation remains to be Equation (10).

After divestment, the platform only collects the profit from selling intermediation services. Hence, its profit now equals to:

$$\pi_A = m_S n_S = \frac{ms\left(\beta_s^2 - 18\beta_s t + 6e_s(\beta_b\beta_s - 3t\beta_b + 6tv_A^b) - 36tm_S - 45t^2 + 36tv_A^s\right)}{36t(1-e_be_s)}.$$

By solving the first-order condition, I can derive the profit-maximizing platform fee as:

$$m_S^{d*} = \frac{\beta_s^2 - 18\beta_s t + 6e_s(\beta_b\beta_s - 3\beta_b t + 6tv_A^b) - 45t^2 + 36tv_A^s)}{72t}.$$

To investigate the impact of divestment on welfare, I compare the platform participation before and after the ownership change. On the seller side, the change in platform participation is given by:

$$n_S^{d*} - n_S^* = -\frac{(\beta_s + 3t)^2}{36t(1-e_be_s)} < 0,$$

where n_S^{d*} is sellers' participation after divestment and n_S^* is their participation before divestment.

On the buyer side, the following pattern is observed:

$$n_B^{d*} - n_B^* = -\frac{e_b(\beta_s + 3t)^2}{36t(1 - e_b e_s)} \lesseqgtr 0,$$

where n_B^{d*} is buyers' participation after divestment and n_B^* is their participation before divestment.

The results suggest that the divestment always discourages sellers' participation and their surplus in the market. For buyers, its impact depends on network effects. If buyers experience positive network effects from sellers, the modification in market structure also decreases buyers' participation and, consequently, their surplus. Conversely, if buyers experience negative network effects, the impact of market structure modification becomes positive. Given that advertisers and publishers typically favor more interactions with each other, buyers' surplus is expected to decrease after divestment.

As for the competitive fringe firms, the change in their profit after divestment is given by:

$$\pi_C^{d*} - \pi_C^* = -\frac{(\beta_s^2 - 9t^2)^2}{648Nt^2(1 - e_b e_s)} < 0,$$

where π_C^{d*} is competing firms' profit after divestment.

With the firm entry fixed in the short run, competitive fringe firms tend to experience lower profits after divestment. In the long run, this negative impact can discourage firm entry and reduce the overall competition in the ancillary product market.

My findings suggest that the first effect in Equation (17), i.e., the impact of market structure change resulting from divestment, always diminishes the surplus of publishers and advertisers in the display advertising market. This is because divestment decreases the profit each publisher brings to the platform. Consequently, the platform incentive to attract publisher and advertiser participation diminishes, leading to decreased aggregate demand for SSPs and reduced profits for all firms.

Hence, if the second effect in Equation (17), i.e., the impact of self-preferencing removal after divestment, does not effectively enhance the surpluses of publishers and advertisers, the overall welfare impact of divestment is always negative. Moreover, firms' entry into the SSP industry is also discouraged. Exceptions arise only when the benefit of divestment from self-preferencing removal is substantial. This requires a significantly strong preference of advertisers over non-Google adtechs on the publisher side, as demonstrated in the benchmark.

My findings remind policymakers to exercise caution and carefully weigh all potentially conflicting impacts associated with the divestment approach. The efficacy of the intervention in benefiting sellers

and competing firms hinges on whether the positive effects of removing self-preferencing outweigh the negative impact induced by market structure modifications.

4.2 French Google Case: Rival Quality Improvement

In addition to the EC, the FCA also went through a parallel investigation into Google's self-preferencing practices in the adtech industry.

4.2.1 Institutional Background

In June 2021, the FCA fined Google €220 million for prioritizing its own programmatic advertising intermediation services under the Google Ad Manager brand.[20] The penalty was a result of Google's self-preferencing practices, where it provided more advantageous terms to its own technologies compared to competing firms. These advantages included allowing AdX to optimize its algorithm using competitors' bids and restricting competitors' data access to auction outcomes. Furthermore, Google's AdX was also found to favor its server (DFP) by making it the only ad server fully interoperable with AdX. Unlike the EC, the investigation by the FCA focuses solely on the adtechs used by publishers without considering the advertiser side.

To address these anti-competitive behaviors, the FCA accepted a list of commitments proposed by Google.[21] My analysis focuses on the first commitment by Google, which would grant rivals the same auction data access as its own SSP by June 2022. With these auction data, competing firms are expected to better understand why they lose in ad auctions and improve their algorithms accordingly. To fulfill this commitment, Google introduced a new real-time integration implementation, which grants non-Google adtechs access to relevant data and information about ad auction outcomes.

4.2.2 Policy Implication

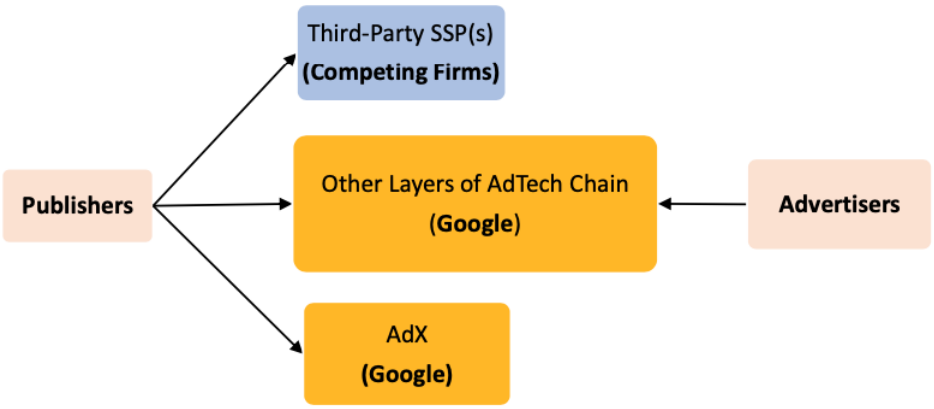
To map FCA's case to my model, I divide the whole adtech stack into two complementary markets as shown in Figure 5: the SSP market and the market encompassing all other layers of the adtech stack. Both publishers and advertisers need to rely on the latter market, which is dominated by Google,

[20] See https://www.autoritedelaconcurrence.fr/sites/default/files/attachments/2021-07/21-d-11_ven.pdf.

[21] According to the FCA, the commitments are binding for publishers whose registered place of business is in the European Economic Area (EEA), have material activities in the EEA, and use ad servers or SSPs to serve ads to users with an IP address in France. See https://www.autoritedelaconcurrence.fr/sites/default/files/commitments/2021-08/google_committments_english_version_21d11.pdf.

to interact with each other. Moreover, to accomplish interactions, publishers must also acquire SSP services that are provided by both Google and competing firms. Translating this market structure to the context of my model, SSP corresponds to the ancillary product, while the other layers of the adtech stack can be viewed as intermediation services monopolized by Google. Accordingly, publishers are viewed as the seller group in my model—the entities purchasing ancillary products. As pointed out by the FCA, Google engages in self-preferencing by limiting rival SSPs' access to crucial data, thereby restricting the quality of 3P ancillary products.

Figure 5: Google adtech Market



To address this competitive concern, Google introduced a new implementation enabling rival SSPs to access more ad auction data. I model this regulatory approach as an increase in the value of 3P ancillary products, denoted by $\Delta v_k^s = -\Delta\beta_s > 0$. When this data-sharing implementation is purchased, the approximate alteration in fringe firms' profits in the short run[22] can be estimated as follows:

$$\Delta\pi_C^* = \frac{d\pi_C^*}{d\beta_s}\Delta\beta_s - R = \frac{(3t-\beta_s)\left(-2\beta_s^2+3e_s\beta_b(3t-\beta_s)+6\beta_s t-12e_s t v_A^b+6t^2-12tv_A^s\right)}{216(1-e_be_s)Nt^2}\Delta\beta_s - R,$$

where R is the price of the data-sharing implementation.

As illustrated in Corollary 5, alleviating self-preferencing is not always profitable for competing firms. Hence, there is a condition for competing firms to actively purchase the implementations. Precisely, if advertisers' preference over Google's adtech is not too strong and satisfies $\beta_b < (2\beta_s^2 - 6\beta_s t + 12e_s t v_A^b - 6t^2 + 12tv_A^s)/(9e_s t - 3e_s\beta_s)$, the data-sharing implementations will be adopted at a positive price. In such a market, it would then be interesting to analyze how the surpluses of both

[22] I focus on the short-term impact when the number of competing firms is fixed in the ancillary product market.

publishers and advertisers change following the regulation.

My theoretical model suggests that given the profitability of Google's self-preferencing practice, an improvement in the quality of non-Google technology always leads to a reduction in publishers' surplus. As for the advertisers' surplus, it also diminishes after the regulation unless the advertisers derive much higher value from interacting with publishers using non-Google technologies. This finding holds significant implications when we combine it with the investigation by the EC on the same issue. As detailed in Section 4.1.1, the EC pointed out that Google's prioritizing treatment of AdX extends to the advertiser side, meaning that advertisers derive lower value when they interact with publishers using non-Google adtechs. Under such market conditions, I anticipate a decrease in advertisers' surplus and a discouragement of their participation following the FCA regulation.

The results emphasize that the regulation, without proper design, might backfire on the market. Moreover, they highlight the complexity of regulations in multi-sided markets. In addition to regulating self-preferencing within one side of the market, policymakers should conduct a thorough investigation and consider the potential self-preferencing across different sides of the market. Only when the practice of self-preferencing across publishers and advertisers breaks down, and advertisers using Google adtechs also derive a sufficiently high surplus from interacting with publishers using non-Google adtechs, the data-sharing regulatory approach is more likely to effectively enhance competition in adtech markets.

4.2.3 Empirical Evidence

To test the theoretical predictions, I combine various data sources. According to the previous theoretical analysis, given that self-preferencing is profitable for Google, the data-sharing regulation always results in a lower surplus for publishers. This leads to the first hypothesis to be examined:

Hypothesis 1. *The surplus of publishers in the online display advertising market decreased after the data-sharing regulation.*

As for the advertisers, the impact of regulation largely depends on their preference for adtechs. Specifically, if advertisers derive a sufficiently high surplus from interacting with publishers using non-Google adtech, their surplus is expected to increase after the FCA's data-sharing regulation. Otherwise, it is the opposite. According to the EC's investigation, Google strongly favors its SSP from the advertiser side. In such a context, the majority of advertisers using Google adtech derive a much lower surplus from interacting with publishers using non-Google adtech. Accordingly, their surplus is expected to diminish after the regulation. This leads to the second hypothesis to be examined:

Hypothesis 2. *The surplus of advertisers in the online display advertising market decreased after the data-sharing regulation.*

To test the hypotheses, I collected data from various sources, encompassing all the EEA states. I began by identifying the top 50 most visited websites in each country using Similarweb, an Israeli firm specializing in web traffic and performance analysis.[23] Then, I gathered display advertising performance data from the SEMrush platform.[24] Specifically, I recorded the weekly ad revenue on each domain to measure the surplus of publishers and tracked the weekly number of unique advertisers posting ads on those domains to measure the surplus of advertisers. The time frame of my sample is between February 28, 2022, and March 5, 2023. To ensure the validity of the analysis, I excluded websites belonging to the FAANG group (Alphabet, Amazon, Apple, Meta, and Microsoft), as they typically do not utilize Google Ad Manager. The resulting sample consists of 10,441 observations, with France representing the treated group and other EEA countries forming the control group.

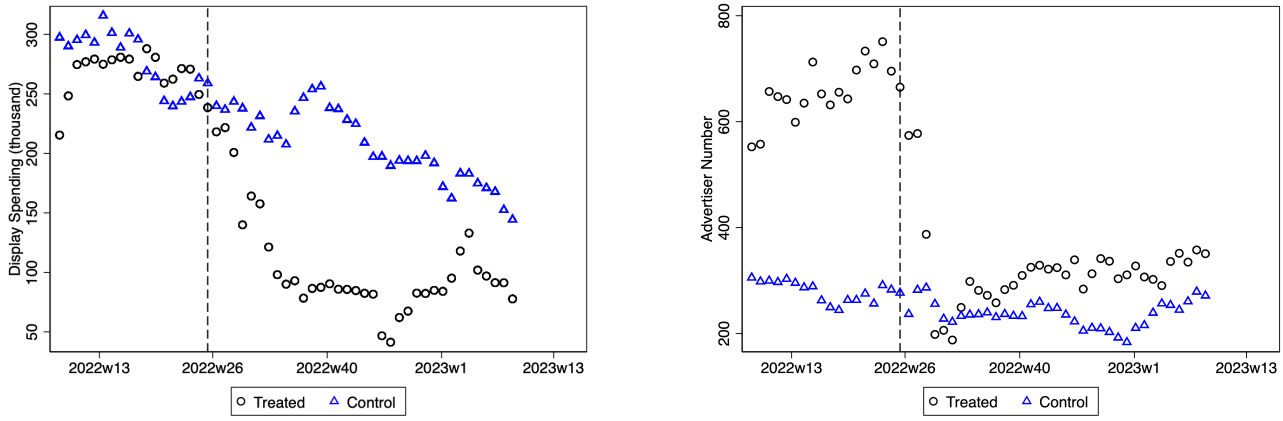
I then visually examined the display advertising markets. In Figure 6a, I presented the average advertising revenue of popular domains in France and other EEA countries. The dashed line represents the week of June 30, 2022, which marked the deadline for Google's technical adjustment providing rivals with ad auction data in France. I find that both France and the control group experienced declines in advertising revenue. However, the reduction in revenue was notably larger in the regulation-treated country. I then plot the average number of advertisers posting on each domain in Figure 6b. The figure shows a sharp drop in the number of advertisers following Google's data-sharing adjustment in France, indicating a decrease in advertiser participation in response to the FCA regulation.[25]

[23] See https://www.similarweb.com/.

[24] See https://www.semrush.com/.

[25] See Decarolis and Li (2023a) for a more comprehensive empirical analysis.

Figure 6: Display Advertising Market



(a) Publisher Revenue

(b) Number of Advertisers

The analysis represents the first empirical evidence for self-preferencing regulation in the adtech market and lends support to my theoretical predictions. It suggests that regulating self-preferencing is unlikely to enhance social welfare and may even backfire when there is no competing firm providing sufficiently high-quality alternatives. This underlying mechanism can be illustrated through a hypothetical extreme scenario: there is no interoperability between Google and non-Google adtech, so advertisers utilizing Google adtech receive no surplus from engaging with publishers using non-Google adtech. In this scenario, the FCA's data-sharing regulation assists non-Google companies in improving their adtech and enhances competition. However, the data-sharing regulation also simultaneously motivates more publishers to adopt non-Google technology that is not interoperable with the majority of advertisers' adtech. Consequently, there is a sharp drop in advertiser surplus and their participation in the market. This, in turn, diminishes the advertising revenue of publishers through positive network effects.

4.3 European Amazon Case: Fair Recommendation

Similar to Google, Amazon was also found to practice self-preferencing in adjacent markets. In December 2022, the EC accused Amazon of various abusive practices, including discouraging sellers from using rival logistics services to fulfill Amazon orders. The EC highlighted that Amazon's practices had detrimental effects on competition in the shipping industry. It exposed rivals to higher risks of poor carrier-related performance compared to Amazon's shipping network.

4.3.1 Institutional Background

To fulfill orders on Amazon, sellers can either independently manage storage and delivery, or outsource these tasks to an operator. Amazon itself provides corresponding services to sellers through its Fulfillment by Amazon (FBA) program, which encompasses: (i) warehousing and inventory management at Amazon's distribution centers; (ii) fulfillment of orders received on Amazon, including packaging and labeling; (iii) shipping, transportation, and delivery; (iv) returns management; and (v) customer service. When sellers opt for FBA, they only need to send their inventory to Amazon's warehouses. Amazon then handles the entire fulfillment process for orders placed in its marketplace.

According to the EC's investigation, Amazon has been promoting its own logistics service by providing it with unique advantages on the platform, including (i) non-application of performance metrics to third-party sellers; (ii) obtaining the Prime Badge; (iii) higher probability of being awarded the Buy Box; (iv) participation in special events and offers; and (v) eligibility for "Free Shipping via Amazon."

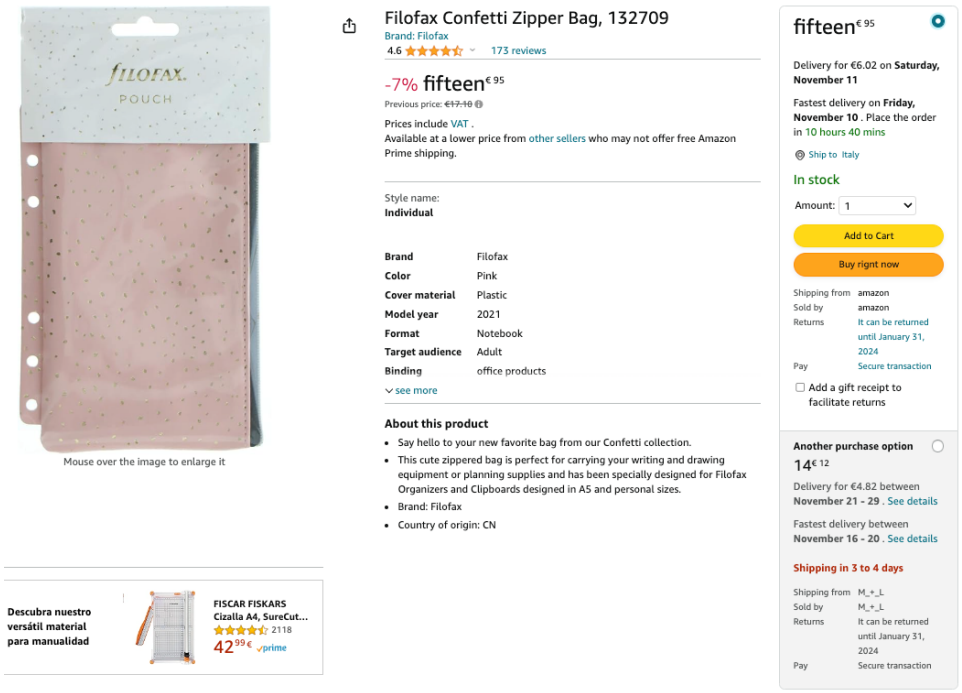
These benefits all play critical roles in facilitating transactions on Amazon. For instance, one important advantage of FBA sellers is their higher chance of winning the Buy Box. Unlike others, sellers who win the Buy Box can be immediately added to buyers' shopping carts through the "Add to Basket" button or be purchased directly through the "Buy Now" button. Due to this convenience, the majority of sales on Amazon occur through Buy Box recommendations. Taking Germany and France as examples, the EC highlighted that between 70% and 90% of total Amazon sales in these countries were finished through the Buy Box between 2017 and 2019. In its communications with sellers, Amazon also stated that "90% or more of sales come from the Buy Box."[26]

Although the FBA sellers were eligible candidates for Buy Box automatically, other sellers in the "Fulfilled by Merchants (FBM)" program were always required to meet certain restrictive criteria. According to the EC's analysis of more than 80 million offers on Amazon, the FBA offers secured over 80% of the Buy Box, while other offers acquired less than a 20% share, even when they were similar in price and shipping quality. This significant discrepancy in Buy Box allocation strongly implies a bias in favor of Amazon's FBA services, indicating unequal treatment between FBA and FBM sellers.

Another significant advantage of FBA sellers is their increased likelihood of obtaining Amazon Prime labels. Over the past years, there has been a steady growth in the number of Prime users on Amazon. These Prime users typically spend more on Amazon than regular users and strongly prefer Prime offers. According to the EC, between 70% and 90% of total spending by Prime users

[26] See https://ec.europa.eu/competition/antitrust/cases1/202310/AT_40703_8990760_1533_5.pdf

Figure 7: Amazon Second Buy Box Offer



in the German, French, and Spanish Amazon marketplaces was associated with Prime offers. As a consequence, qualifying for Prime labels becomes crucial for sellers to attract demand. While offers from FBA sellers are automatically qualified for Prime labels, FBM sellers must fulfill the requirements of Amazon's Seller Fulfilled Prime (SFP) program to gain access. This entails establishing an agreement with a carrier designated by Amazon and adhering to the shipping terms negotiated by Amazon with these carriers.

To address the unfair treatment, the EC accepted a series of commitments proposed by Amazon in December 2022. Regarding the Buy Box, Amazon was required to (i) treat all sellers equally, regardless of whether they use FBA shipping, and (ii) display a second competing offer to the Buy Box winner if there is a second offer from a different seller that is sufficiently differentiated from the first one on price and/or *delivery*, as shown in Figure 7.

Moreover, Amazon was also required to change its Prime Badge standards. Specifically, it was requested to (i) set non-discriminatory conditions and criteria for the qualification of marketplace sellers and offers to Prime; (ii) allow Prime sellers to freely choose any carrier for their logistics and delivery services and negotiate terms directly with the carrier of their choice; and (iii) not use any information obtained through Prime about the terms and performance of third-party carriers for its own logistics services. The implementation deadline is June 2023, by which Amazon should finish fulfilling all

commitments.

4.3.2 Policy Implication

In the benchmark, I assume that platform fees and ancillary product charges are based on seller participation. This setup aligns well with the ancillary services whose prices are mostly independent of transaction volumes, such as selling plans, inventory storage, or automated pricing services on Amazon. However, it does not fully capture the characteristics of shipping services, which are typically charged on a per-transaction basis. To integrate this, I extend the model in this section to incorporate the transaction stage between buyers and sellers, letting both intermediation services and ancillary product charges depend on transactions. Within such a setup, a seller's surplus, U_s, is now endogenously determined by his profit from selling final products to buyers, while a buyer's utility U_b depends on both product value and price.

Given that up to 90% of transactions on Amazon are completed through Amazon Buy Box, I assume buyers highly trust Amazon and consider solely sellers recommended by the platform. Specifically, I denote the probability of 1P sellers being recommended by the Buy Box as $1/2+k$, while the probability of 3P sellers being recommended is $1/2-k$. Given the rule, sellers in each type have an equal chance to win the Buy Box. As $k \in (-1/2, 1/2)$ increases, Amazon recommends 1P sellers more frequently. To comply with the EC's regulations, Amazon updated its Buy Box algorithm and introduced a second Buy Box. Both adjustments are expected to increase the exposure of 3P sellers. Translating it to the model, I analyze how the market evolves as the recommendation frequency of 1P sellers, represented by k, diminishes.

The timeline of the game is as follows. The platform first determines its commission fee d for each transaction in its marketplace. Second, fringe firms decide whether to join the ancillary market. If they do, both the firms and the platform simultaneously set the prices of ancillary products. Based on the fees and recommendation system, sellers enter the market, choose ancillary products, and set the prices of final products sold to buyers. Lastly, buyers see the recommended sellers and make purchase decisions. To ensure model tractability, I abstract away the horizontal differentiation among ancillary products for sellers. In addition, I adopt the simplifying assumption that the outside options of buyers are all equal to 0.

A buyer derives a utility of $U_b = v_A^b - p_1^f$ when purchasing from 1P sellers, and a utility of $U_b = v_C^b - p_3^f$ when purchasing from 3P sellers. Following the same notation as in the benchmark, v_A^b represents buyers' value for 1P sellers, and v_C^b represents their value for 3P sellers. With the transaction stage introduced, I use p_1^f to denote the price of final products sold by 1P sellers, while p_3^f to denote the price

of final products sold by 3P sellers. A transaction will occur as long as the product value is higher than the buyer's outside options. Thus, the demands for 1P sellers and 3P sellers are expressed as:

$$Q_1^f = (\frac{1}{2} + k)(v_A^b - p_1^f),$$
$$Q_3^f = (\frac{1}{2} - k)(v_C^b - p_3^f),$$

where Q_1^f represents the aggregate demand for 1P sellers, Q_3^f denotes the aggregate demand for 3P sellers. As sellers of each type share the aggregate demand evenly, the demand for each 1P seller equals $q_1^f = Q_1^f/Q_A$, and the demand for each 3P seller is $q_3^f = Q_3^f/NQ_C$. Recall that Q_A is the total number of 1P sellers and NQ_C is the total number of 3P sellers.

For each transaction, sellers collect the remaining markup after paying commission fees and ancillary products. Correspondingly, the profit of each 1P seller is $\pi_1^f = (p_1^f - d - p_A)q_1^f$, and the profit of each 3P seller is $\pi_3^f = (p_3^f - d - p_C)q_3^f$. Each seller maximizes its profit, and the pricing strategies at equilibrium are:

$$p_1^f = \frac{d + p_A + v_A^b}{2},$$
$$p_3^f = \frac{d + p_C + v_C^b}{2}.$$

Accordingly, the resulting profits are equal to:

$$\pi_1^f = \frac{(1+2k)(v_A^b - d - p_A)^2}{8Q_A},$$
$$\pi_3^f = \frac{(1-2k)(v_C^b - d - p_C)^2}{8NQ_C}.$$

A seller will join the market as long as his expected surplus is higher than his outside options. Hence, the participation of 1P sellers and 3P sellers must satisfy the entry condition $Q_A = \pi_1^f$ and $NQ_C = \pi_3^f$ and can be simplified as

$$Q_A = \sqrt{\frac{(1+2k)(v_A^b - d - p_A)^2}{8}},$$
$$Q_C = \sqrt{\frac{(1-2k)(v_C^b - d - p_C)^2}{8N^2}}.$$

Correspondingly, the total surplus of sellers is equal to:

$$\begin{aligned} Surplus_S &= \int_0^{Q_A} \pi_1^f dO + \int_{Q_A}^1 O dO + \int_0^{Q_C} \pi_3^f dO + \int_{Q_C}^1 O dO \\ &= 1 + \frac{(1+2k)(v_A^b - d - p_A)^2}{16} + \frac{(1-2k)(v_C^b - d - p_C)^2}{16}. \end{aligned}$$

As the charge of commission fee and ancillary product is based on transactions, the profit of each fringe firm is equal to $\pi_C = p_C Q_3^f - L$, and the profit of the platform is $\pi_A = p_A Q_1^f + d(Q_1^f + Q_3^f)$. Each firm optimizes its ancillary product price to maximize its profit. Solving the first-order conditions, the prices of ancillary products at the symmetric equilibrium are:

$$\begin{aligned} p_A &= \frac{v_A^b - 2d}{2}, \\ p_C &= \frac{v_C^b - d}{2}. \end{aligned}$$

Lastly, the platform chooses the commission fee to maximize its profit, and the equilibrium pricing strategy and profit are:

$$\begin{aligned} d &= \frac{v_C^b}{2}, \\ \pi_A &= \frac{(2+4k)(v_A^b)^2 + (1-2k)(v_C^b)^2}{32}. \end{aligned}$$

Upon simple calculations, I find qualitatively similar outcomes to the benchmark: the platform finds it profitable to practice self-preferencing only when its 1P ancillary product is not strongly disliked by buyers, i.e., $v_A^b > \sqrt{2} v_C^b/2$. In the context of the Amazon Buy Box, the products offered by all sellers

for the same Buy Box are identical. Thus, the condition requires the relative quality of the FBA service compared to FBM services not to be too low for buyers.

Reviewing industry reports, it appears this condition is likely to be true on Amazon: Since 2019, Amazon has been heavily investing in its one-day shipping services, setting high standards for Prime shipping.[27] However, Amazon's two largest competitors, UPS and FedEx, focus their services more on other platforms instead of Amazon. According to a FedEx statement in June 2019, it terminated its contract with Amazon to provide express shipping.[28] Thus, if sellers choose FedEx to fulfill orders on Amazon, buyers have to wait longer as express shipping service is no longer provided by the company on Amazon. Although UPS continues to cooperate with Amazon, it indicated in a recent report that the company has gradually shifted its investment from Amazon to other companies.[29] Since speed is one of the determining factors for buyers' preference over shipping companies, Amazon buyers, especially Prime users, are likely to have a strong preference for FBA over other shipping companies. This thus justifies Amazon's motivation for self-preferencing.

To shed light on relevant welfare implications, I further examine how the prices of final products change following self-preferencing. Interestingly, the prices of final products are $p_1^f = 3v_A^b/4$ and $p_3^f = 7v_C^b/8$ at equilibrium, both of which remain unaffected by user steering k. When buyers highly rely on Amazon's recommendations and consider solely the seller winning Buy Box, there is no price competition among 1P and 3P sellers.[30] Self-preferencing simply redistributes demand among sellers without affecting demand elasticity on the platform. Consequently, the prices of final products sold to consumers and the prices of ancillary products in the adjacent market are not impacted by self-preferencing.

Buyers derive a net utility of $v_A^b/4$ from transacting with 1P sellers and $v_C^b/8$ from 3P sellers at equilibrium. Consequently, if the quality of 1P ancillary products is extremely low, i.e., $v_A^b < v_C^b/2$, self-preferencing directs buyers to products that provide them with lower net utility, thereby reducing total buyer surplus. Otherwise, it is the opposite. As for the profit of sellers, with simple calculations, I find that the change in seller participation is always in the same direction as buyers.

Combining the impact of self-preferencing on platform profit and welfare, I show that within the context of per-transaction fees and buyer steering, both buyers and sellers benefit from self-preferencing given that the platform finds it profitable to do so. This result is unsurprising given that the platform's profit is now determined by the number of transactions. When self-preferencing increases the proportion

[27] See https://www.theguardian.com/technology/2020/jan/30/amazon-profits-surge-investment-faster-shipping
[28] See https://www.fool.com/investing/2019/06/07/fedex-just-delivered-a-blow-to-amazons-one-day-del.aspx
[29] See https://www.reuters.com/business/ups-quarterly-adjusted-profit-rises-lucrative-deliveries-2022-07-26/
[30] I relax this assumption and introduce horizontal differention among 1P and 3P sellers in Appendix C.4.

of transactions assigned to 1P sellers, it becomes more profitable for the platform to encourage transactions on its platform. To achieve this goal, the platform has to benefit buyers and increase their participation. Moreover, since sellers' profit is now endogenously determined by transactions with buyers, their preferences regarding ancillary products are largely consistent with those of buyers.

4.3.3 Empirical Evidence

I next proceed to seek empirical evidence regarding the impact of the EC's regulation on Amazon. To comply with the EC, Amazon agreed to update its Buy Box design and Prime Badge standard by June 2023. As illustrated in the previous analysis, if buyers highly trust Amazon and heavily rely on its recommendations, the removal of self-preferencing is unlikely to affect product prices. This leads to Hypothesis 3 below:

Hypothesis 3. *The product price on Amazon did not change significantly after the EC's regulation.*

As for sellers, my theoretical analysis suggests that they always benefit from self-preferencing when the platform finds it profitable to do so. Consequently, the alleviation of self-preferencing following the EC's regulation is expected to diminish sellers' profits and discourage their participation. This leads to the following hypothesis:

Hypothesis 4. *Seller participation on Amazon decreased after the EC's regulation.*

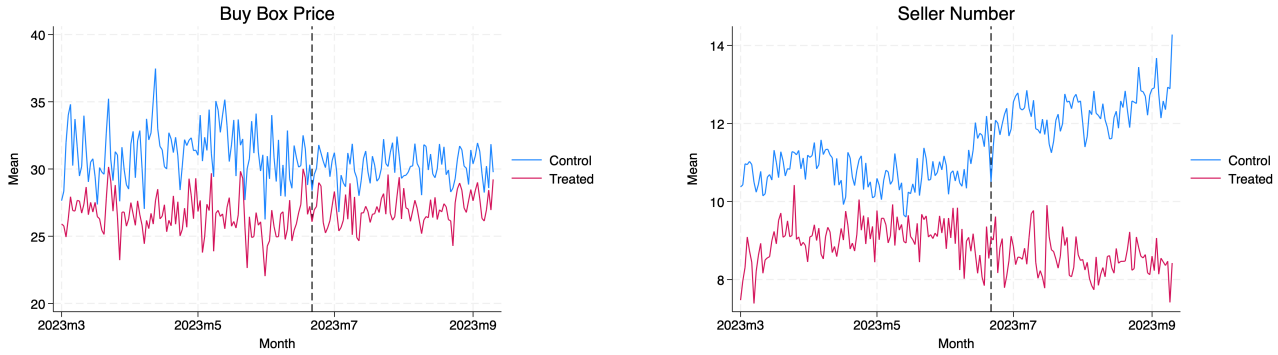
I examined the two hypotheses using Keepa data, a third-party API monitoring transactions on Amazon.[31] The dataset covers the US, UK, Germany, France, Japan, Canada, Italy, Spain, and Mexico.[32] In each country, I collected the list of the top 1000 most popular products in the pet supply category.[33] Based on the sampling list, I then collected the Buy Box price and the number of unique merchants offering each product between March 2023 and September 2023. I removed Amazon's own brand, Amazon Basics, from the sample as they are normally not provided by third-party sellers.

[31] See https://keepa.com/#!.

[32] As there are relevant regulations implemented in India, I did not include the country in my sample. See https://www.nytimes.com/2016/04/08/technology/amazon-may-violate-indias-new-rules-on-foreign-e-commerce.html.

[33] The pet supply category is a common category appearing among all countries. I collected the relevant data in September 2022 on Keepa, which allows me to derive the list of best-sale products in the past 180 days.

Figure 8: EC Regulation Impact



(a) Buy Box Price

(b) Number of Sellers

In Figure 8a, I plot the daily average Buy Box price in the pet category in the EEA and other countries.[34] The dashed line corresponds to June 21st, 2023, which marks the implementation deadline for Amazon to update its Buy Box algorithm and Prime Badge standard. From the visual inspection of the graph, it is hard to find any significant price change in the EEA states after Amazon's adjustments.

I then examined the daily average of unique seller count in the EEA and other countries as shown in Figure 8b. Intuitively, if sellers derive higher profits following the regulation, their participation should be encouraged; otherwise, it is the opposite. As illustrated in the figure, seller participation on Amazon in the EEA countries and other countries followed quite similar patterns before the regulation. However, their patterns began to diverge and there was a slight reduction in the number of sellers in the EEA states compared to other countries after the regulation.

These empirical observations on seller participation and product price are largely consistent with my theoretical predictions. While the real market dynamics can be more complex, my empirical analysis does provide some evidence that buyers and sellers in the EEA are unlikely to be significantly better off after the Amazon's adjustments.[35] This could be due to the lack of viable competitors as illustrated in my theoretical study. However, it might also be induced by other factors, such as any nuance in Amazon's compliance with EC regulations. Indeed, the EC has recently launched an investigation with a preliminary view of Amazon not fully complying with EC regulations and may still be engaging in self-preferencing. The investigation is still ongoing and can potentially possibly initiate a formal non-compliance proceeding in Europe.[36]

[34] I removed outliers lying between the 5th and 95th percentiles of the sample.

[35] See Decarolis and Li (2024) for a more comprehensive empirical analysis.

[36] See https://www.concurrences.com/en/review/issues/no-2-2024/alerts/digital-markets-act-the-european-commission-launches-five-non-compliance.

5 Concluding Remarks

In this study, I contribute to filling the gaps in competition literature by analyzing a phenomenon that has recently emerged and raised significant antitrust concerns in digital markets. Several competition authorities found that monopoly platforms, like Google, Amazon, and Apple, have been leveraging their dominant power in core services to rapidly gain market share in newly developed industries. This form of self-preferencing, which spans across markets, is distinct from the typical self-preferencing in existing hybrid platform literature. It involves a more complicated market structure and quite different trade-offs.

By creating a theoretical model for this phenomenon, I investigate the platform's motivation for such practice and its welfare implications. I show that self-preferencing is not always profitable for platforms. Although favoring its ancillary products enables the platform to charge higher prices and generate larger demand in adjacent markets, it reduces the profitability of sellers entering the primary market and discourages their entry. To compensate for this negative impact, the platform has to reduce its fees in the primary market to maintain market participation. Therefore, the practice of self-preferencing generates conflicting effects, and the platform is not always motivated to engage in self-preferencing. Specifically, I show that only when its ancillary product is preferred by both buyers and sellers, and there is a high level of substitutability across products in the ancillary product market, the practice of self-preferencing is profitable for the platform.

I also demonstrate that, unless specific conditions are met, self-preferencing always leads to detrimental consequences for competing firms and discourages their entry. Hence, it diminishes competition in the ancillary product market. Moreover, if buyers strongly dislike the platform's ancillary products, the practice of self-preferencing is also harmful to buyers despite being profitable for the platform. Surprisingly, sellers who purchase ancillary products are not necessarily worse off because of this practice. Indeed, I show that the platform's motivation for self-preferencing is always congruent with sellers' interests, meaning that sellers always benefit from self-preferencing when it is profitable for the platform to do so.

The paper also contributes to policy discussions by examining several regulatory approaches in recent high-profile cases. Specifically, I study the FCA's intervention, which requires Google to share ad auction data with competitors to enhance rival technology in the adtech market. I show that such an intervention may boost welfare if advertisers derive significantly higher value from interacting with publishers using non-Google technologies. In the presence of self-preferencing across advertisers and publishers, this condition is unlikely to hold and the intervention can backfire on the display advertising market. I also analyze the EC's proposed structural remedy for Google. I point out that although

divestment eliminates self-preferencing motives, it also reduces incentives to attract publishers and advertisers. Thus, policymakers should be cautious in comparing these two potentially conflicting impacts. Lastly, I discuss the EC's intervention in Amazon's Buy Box recommendations. I find that when buyers heavily rely on the platform's recommendation, the intervention is unlikely to affect product prices or significantly improve consumer surplus. For the FCA's regulation of Google and the EC's regulation of Amazon, I also provide supportive empirical evidence for the theoretical predictions.

I conclude the paper by briefly exploring some extensions. I first investigate an extreme case in Appendix C.1, where the ancillary product market is monopolized by the platform. Comparing the market outcomes with the benchmark, I find that both buyers and sellers are likely to derive lower surpluses once the ancillary product market shifts from a competitive market to a monopoly. The results suggest that although self-preferencing in a competitive ancillary product market may not generate welfare loss in the short run, allowing it to grow into a monopoly market, in the long run, produces serious detrimental impacts on society and should be carefully monitored by policymakers. I then consider a market where buyers either purchase from 1P sellers or 3P sellers, so their total spending is fixed in Appendix C.2. In such a market, I obtain findings qualitatively similar to the benchmark. I lastly explore the market where there is also a platform fee charged from buyers in Appendix C.3 and discuss the scenario where buyers are heterogeneous in both their sophistication and their tastes over sellers in Appendix C.4.

Beyond my findings, several extensions can be explored in the future. My model concentrates on digital marketplaces without considering the possibility of hybrid business models. Incorporating both types of self-preferencing into the analysis would be intriguing. Furthermore, this research primarily relies on theoretical analysis, a more comprehensive quantitative study and experiments would also be valuable extensions. For instance, although the empirical patterns on Amazon could be due to the lack of viable competitors as illustrated in my theoretical study, other factors might also be at play, such as nuances in Amazon's compliance with EC regulations or buyers' behavioural biases. Lastly, the paper primarily focuses on a monopoly setting where the platform monopolizes intermediation services. It would also be interesting to examine how self-preferencing in the ancillary product market affects platform competition.

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A Additional Analysis

A.1 Supplementary Results for Section 3.1

In the simple case when $\beta_b = 0$, I also analyze the effect of self-preferencing on the demands for ancillary products:

Corollary A.1. *When $\beta_b = 0$,*

- *self-preferencing always increases the demand for 1P ancillary products; and*
- *there exist two cutoffs: $t < \bar{\beta}_s < \bar{\bar{\beta}}_s < 3t$ such that self-preferencing increases the demand for 3P ancillary products when $e_s v_A^b + v_A^s < \frac{17t}{18}$ and $\bar{\beta}_s < \beta_s < \bar{\bar{\beta}}_s$. Otherwise, it is the opposite.*

Recall that ancillary product demands Q_A and Q_C are jointly determined by seller size (n_S) and their distribution among ancillary products (q_A). As detailed in Corollary 2, the impact of self-preferencing on sellers' participation (n_S) can be either positive or negative. Given the seller size on the platform, the practice of self-preferencing always shifts more sellers from 3P ancillary products to 1P ancillary products. Combining these two effects, it is not surprising to observe that the demand for ancillary products can either increase or decrease following self-preferencing. In most cases, self-preferencing increases the demand for 1P ancillary products while decreasing the demand for 3P ancillary products. However, when the number of sellers joining the platform is small and the surplus difference between 1P sellers and 3P sellers is medium, competing firms also experience a higher demand due to the market size expansion effect from self-preferencing.

A.2 Supplementary Results for Section 3.2

Since the choice of ancillary products is determined by sellers, the introduction of buyers' preferences does not affect the transaction stage in the ancillary product market. Hence, the impacts of self-preferencing on ancillary product prices remain the same as in the simple case when $\beta_b = 0$. However, when buyers are no longer indifferent between 1P sellers and 3P sellers, sellers' choice of ancillary products affects buyers' surplus from joining the market and their entry decisions. This, in turn, affects sellers' demand for platform participation through network effects, and the platform's pricing strategy for intermediation services changes accordingly. As a consequence, buyers' preferences for ancillary products will affect the effect of self-preferencing on the platform fee. The findings can be summarized as follows:

Corollary A.2. *The impact of self-preferencing on platform fee, measured by* $\frac{dm_S}{d\beta_s}$*, is increasing in buyers' preference over 1P ancillary products. Specifically, self-preferencing will decrease the platform fee* m_S *when* $\beta_b < \frac{\beta_s+15t}{3e_s}$ *and increase it otherwise.*

Recall that in the simple case of $\beta_b = 0$, self-preferencing always reduces the platform fee. In such a market, buyers are indifferent between all sellers. Hence, any change in the distribution of sellers among ancillary products has no impact on buyers' surplus and their market participation. The practice of self-preferencing solely reduces 3P sellers' surplus and prompts the platform to reduce its platform fee to offset this negative impact.

However, Corollary A.2 suggests that this negative effect is weakened and may even turn positive if buyers strongly prefer 1P ancillary products over 3P ancillary products. This is because self-preferencing diminishes the surplus of 3P sellers and encourages more sellers to switch from the 3P ancillary products to the 1P ancillary product. If buyers highly prefer 1P sellers over 3P sellers, this transfer is preferred by buyers and generates a positive impact. With the presence of network effects, the increase in buyer size further raises the surplus for sellers. The stronger the preference of buyers for 1P ancillary products, the larger this positive impact. Consequently, the platform is less inclined to decrease the platform fee and may even consider increasing it when the preference for 1P ancillary products is sufficiently strong.

I then examine the impact of self-preferencing on ancillary product demands. As shown in the main text, buyers' relative preference for 1P ancillary products strengthens the positive impact of self-preferencing on platform participation. However, it does not necessarily act the same way on the demands for ancillary products. Precisely, my findings can be summarized as follows:

Corollary A.3. *The impacts of self-preferencing on the demand for 3P ancillary products, measured by* $\frac{dQ_C}{d\beta_s}$*, is always increasing in buyers' preference over 1P ancillary products. However, the impacts of self-preferencing on the demand for 1P ancillary products, measured by* $\frac{dQ_A}{d\beta_s}$ *is increasing in buyers' preference over 1P sellers when* $\beta_s > 0$ *and decreases otherwise. Specifically, there exist two thresholds* β_b^A *and* β_b^C *such that*

- *self-preferencing increases the demand for 1P ancillary products when* $\beta_b > \beta_b^A$ *and* $\beta_s > 0$*, or when* $\beta_s < 0$ *and* $\beta_b < -\beta_b^A$*. Otherwise, it is the opposite.*
- *self-preferencing increases the demand for 3P ancillary products when* $\beta_b > \beta_b^C$ *and decreases otherwise.*

To investigate the underlying mechanism, I rewrite the relevant derivative as follows:

$$\begin{aligned}
\frac{d^2Q_A}{d\beta_s\beta_b} &= \frac{d(\frac{dq_A}{d\beta_s}n_S + \frac{dn_S}{d\beta_s}q_A)}{d\beta_b}, \\
&= \frac{dq_A}{d\beta_s}\frac{dn_S}{d\beta_b} + q_A\frac{d^2n_S}{d\beta_s\beta_b}, \\
&= \underbrace{-\frac{e_s(3t-\beta_s)}{72t^2(1-e_be_s)}}_{<0} + \underbrace{\frac{e_s(3t+\beta_s)}{72t^2(1-e_be_s)}}_{>0}, \\
&= \frac{e_s\beta_s}{36t^2(1-e_be_s)} > 0. \qquad (18)
\end{aligned}$$

As illustrated in Equation (18), an increase in β_b gives rise to conflicting impacts on $dQ_A/d\beta_s$. On the one hand, when buyers increasingly dislike 3P ancillary products and derive lower values from interacting with 3P sellers, their demand for platform participation is discouraged. On the other hand, when buyers increasingly dislike 3P ancillary products, their relative preference for 1P ancillary products is strengthened. As a consequence, the negative impact of self-preferencing on seller size is alleviated, as shown in Corollary 4. When $\beta_s < 0$, the first impact becomes dominant, resulting in a negative relationship between the demand for 1P ancillary products and buyers' relative preference for 1P ancillary products. However, when $\beta_s > 0$, the second impact is dominant, leading to the opposite conclusion.

Similar mechanisms apply to the demand for 3P ancillary products, with the only exception lying in the sign of the first effect. Recall that the ratio of sellers choosing 3P ancillary products diminishes following self-preferencing, generating a negative effect on competing firms. However, as an increase in buyers' dislike for 3P ancillary products reduces the overall market size, the adverse effect is mitigated accordingly. Consequently, an increase in β_b always increases $dQ_C/d\beta_s$.

B Proofs

In Section 3.1, I focus on the scenario where 1P sellers and 3P sellers are identical for buyers. Hence I let $\beta_b = 0$ for proofs of Corollary 1-3

B.1 Proof of Corollary 1

According to Equations (5-6), it is evident that an increase in β_s increases p_A while decreasing p_C. To examine the impact of β_s on the platform fee m_S, I calculate the derivative and obtain:

$$\frac{dm_S}{d\beta_s} = -\frac{\beta_s + 15t}{36t}.$$

Recall that $|\beta_s| < 3t$ under Assumption 1. Thus, the derivative $dm_S/d\beta_s$ is always negative and an increase in β_s always diminishes the platform fee m_S in the case of $\beta_b = 0$.

B.2 Proof of Corollary 2

Calculating the derivative of n_S with respect to β_s, I obtain:

$$\frac{dn_S}{d\beta_s} = \frac{\beta_s - t}{12t(1 - e_b e_s)}.$$

Under Assumption 1, the denominator is always positive. Hence, the sign of the derivative is determined by its numerator. Correspondingly, $dn_S/d\beta_s$ is negative if $t > \beta_s$, and it's positive if $0 < t < \beta_s$.

As for buyers' participation, its derivative with respect to β_s equals:

$$\frac{dn_B}{d\beta_s} = \frac{e_b(\beta_s - t)}{12t(1 - e_b e_s)} = e_b \frac{dn_S}{d\beta_s}.$$

Therefore, the sign of $dn_B/d\beta_s$ is the same as $dn_S/d\beta_s$ when $e_b > 0$, and is the opposite otherwise.

B.3 Proof of Corollary 3

I first check how the platform's profit changes when β_s increases and then the profit of fringe firms. Calculating the derivation of the platform's profit with respect to β_s, I derive:

$$\frac{d\pi_A}{d\beta_s} = \frac{(\beta_s - t)(\beta_s^2 - 2\beta_s t + 12e_s t v_A^b - 9t^2 + 12t v_A^s)}{144t^2(1 - e_b e_s)}.$$

Since the denominator is always positive, the sign of $d\pi_A/d\beta_s$ is determined by the numerator $(\beta_s - t)(\beta_s^2 - 2\beta_s t + 12e_s t v_A^b - 9t^2 + 12t v_A^s)$. Under Assumption 1, the equation $(\beta_s^2 - 2\beta_s t + 12e_s t v_A^b - 9t^2 + 12t v_A^s)$ is always positive. Therefore, $d\pi_A/d\beta_s$ is positive if $t < \beta_s$ and negative otherwise.

As for the profit of fringe firms, its derivative equals

$$\frac{d\pi_C}{d\beta_s} = \frac{(3t - \beta_s)(-2\beta_s^2 + 6\beta_s t - 12e_s t v_A^b + 6t^2 - 12t v_A^s)}{216t^2(1 - e_b e_s)}.$$

Since $|\beta_s| < 3t$ under Assumption 1, equation $(3t - \beta_s)$ is always positive. Hence, the sign of $d\pi_C/d\beta_s$ is determined by the concave function $H_C = -2\beta_s^2 + 6\beta_s t - 12e_s t v_A^b + 6t^2 - 12t v_A^s$ in β_s. Under Assumption 1, the value of H_C is always negative when β_s reaches the minimum value $(-3t)$ and the maximum value $(3t)$ Moreover, I calculate the function's maximum value at $\beta_s = 3t/2$ and derive $H_C = 3t(7t - 8(e_s v_A^b + v_A^s))/2$. Consequently, when $e_s v_A^b + v_A^s > 7t/8$, the value of $d\pi_C/d\beta_s$ is always negative. However, when $e_s v_A^b + v_A^s > 17t/18$, there exist two cutoffs: $t < \bar{\beta}_s^c < \bar{\bar{\beta}}_s^c < 3t$ such that $d\pi_C/d\beta_s > 0$ when $\bar{\beta}_s^c < \beta_s < \bar{\bar{\beta}}_s^c$ and decreases otherwise.

B.4 Proof of Corollary 4

Calculating the derivative of n_S with respect to β_s, I obtain:

$$\frac{dn_S}{d\beta_s} = \frac{\beta_s - t + e_s\beta_b}{12t(1 - e_b e_s)}.$$

Under Assumption 1, the value of $dn_S/d\beta_s$ is increasing in β_b. Specifically, $dn_S/d\beta_s$ is negative if $t > \beta_s + e_s\beta_b$, and it's positive if $0 < t < \beta_s + e_s\beta_b$.

As for buyers' participation, its derivative with respect to β_s equals:

$$\frac{dn_B}{d\beta_s} = \frac{e_b(\beta_s - t) + \beta_b(2 - e_b e_s)}{12t(1 - e_b e_s)}.$$

Under Assumption 1, it is easy to show that the value of $dn_B/d\beta_s$ is increasing in β_b. Specifically, $dn_B/d\beta_s$ is positive when $e_b > 0$ and $t < \beta_s + \frac{2 - eB - e_s}{e_b}\beta_b$, or when $e_b < 0$ and $t > \beta_s + \frac{2 - eB - e_s}{e_b}\beta_b$.

B.5 Proof of Corollary 5

I first check how the platform's profit changes when β_s increases and then the profit of fringe firms. Calculating the derivation of the platform's profit with respect to β_s, I derive:

$$\frac{d\pi_A}{d\beta_s} = \frac{(\beta_s - t + e_s\beta_b)(\beta_s^2 - 2\beta_s t + 12e_s t v_A^b - 9t^2 + 12t v_A^s + 2es\beta_b\beta_s - 6te_s\beta_b))}{144t^2(1-e_b e_s)}.$$

Since the denominator is always positive, the sign of $d\pi_A/d\beta_s$ is determined by the numerator $(\beta_s - t + e_s\beta_b)(\beta_s^2 - 2\beta_s t + 12e_s t v_A^b - 9t^2 + 12t v_A^s + 2es\beta_b\beta_s - 6te_s\beta_b))$. Under Assumption 1, the equation $(\beta_s^2 - 2\beta_s t + 12e_s t v_A^b - 9t^2 + 12t v_A^s + 2es\beta_b\beta_s - 6te_s\beta_b))$ is always positive. Therefore, $d\pi_A/d\beta_s$ is positive if $t < \beta_s + e_s\beta_b$ and negative otherwise. In other words, $d\pi_A/d\beta_s$ increases and is more likely to be positive when β_b is large.

As for the profit of fringe firms, its derivative equals

$$\frac{d\pi_C}{d\beta_s} = \frac{(3t - \beta_s)(-2\beta_s^2 + 6\beta_s t - 12e_s t v_A^b + 6t^2 - 12t v_A^s + 3e_s\beta_b(3t - \beta_s))}{216t^2(1-e_b e_s)}.$$

Based on the derivative, it is easy to show that the value of $d\pi_C/d\beta_s$ is always increasing in β_b. Precisely, self-preferencing increases the total profit of all competing firms Π_C^* when $\beta_b > \bar{\beta}_b^C = \frac{2\beta_s^2 - 6\beta_s t + 12e_s t v_A^b - 6t(t - 2v_A^s)}{3e_s(3t-\beta_s)}$ and decreases otherwise.

B.6 Proof of Corollary A.1

Based on the equilibrium demands for ancillary products and $\beta = 0$, I can easily calculate corresponding derivatives and yield:

$$\frac{dQ_A}{d\beta_s} = \frac{3\beta_s^2 + 2\beta_s t + 12e_s t v_A^b - 15t^2 + 12t v_A^s}{144t^2(1-e_b e_s)},$$
$$\frac{dQ_C}{d\beta_s} = \frac{-3\beta_s^2 + 10\beta_s t - 12e_s t v_A^b + 3t^2 - 12t v_A^s}{144t^2(1-e_b e_s)}.$$

The denominator of $dQ_A/d\beta_s$ is always positive under Assumption 1, so the sign of the derivative

is determined by function $W_A = 3\beta_s^2 + 2\beta_s t + 12e_s t v_A^b - 15t^2 + 12t v_A^s$, which is increasing in β_s. Under Assumption 1, the minimum value of β_s is $\underline{\beta_s} = -3t$. Plugging in $\beta_s = \underline{\beta_s}$, the numerator becomes $W_A = 6t(t + 2e_s v_A^b + 2v_A^s)$ and is always positive. As a consequence, the derivation is always positive and the demand for 1P ancillary products is always increasing in β_s.

Following the same steps, I find the sign of the derivative $dQ_C/d\beta_s$ is determined by the concave function $W_C = -3\beta_s^2 + 10\beta_s t - 12e_s t v_A^b + 3t^2 - 12t v_A^s$ of β_s. Under Assumption 1, the value of W_C is always negative when β_s reaches the minimum value $(-3t)$ and the maximum value $(3t)$. Furthermore, I investigate the function's maximum value at $\beta_s = 5t/3$ and derive $W_C = 3t(17t - 18(e_s v_A^b + v_A^s))/2$. Consequently, when $e_s v_A^b + v_A^s > 17t/18$, the value of $dQ_C/d\beta_s$ is always negative. However, when $e_s v_A^b + v_A^s > 17t/18$, there exist two cutoffs: $t < \bar{\beta}_s < \bar{\bar{\beta}}_s < 3t$ such that $dQ_C/d\beta_s > 0$ when $\bar{\beta}_s < \beta_s < \bar{\bar{\beta}}_s$ and decreases otherwise.

B.7 Proof of Corollary A.2

To examine the impact of β_b on $\frac{dm_S}{d\beta_s}$, I calculate the derivative and obtain:

$$\frac{dm_S}{d\beta_s} = -\frac{\beta_s + 15t - 3e_s\beta_b}{36t}$$

The derivative clearly suggests that the impact of self-preferencing on platform fees, measured by $\frac{dm_S}{d\beta_s}$, is increasing in β_b. Specifically, an increase in β_s diminishes the platform fee m_S when $\beta_b < \frac{\beta_s + 15t}{3e_s}$ and increases otherwise.

B.8 Proof of Corollary A.3

Based on the equilibrium demand for ancillary products, I calculate the corresponding derivatives and yield:

$$\frac{d^2Q_A}{d\beta_s\beta_b} = \frac{e_s\beta_s}{36t^2(1 - e_b e_s)},$$
$$\frac{d^2Q_C}{d\beta_s\beta_b} = \frac{e_s(3t - \beta_s)}{36t^2(1 - e_b e_s)}.$$

The denominator of $d^2Q_A/d\beta_s\beta_b$ is always positive, so the sign of the derivative is determined by β_s. If $\beta_s > 0$, then $dQ_A/d\beta_s$ increases in β_b. Otherwise, it is the opposite. Precisely, I find that

self-preferencing increases the demand for 1P ancillary products when $\beta_b > \beta_b^A = -\frac{3\beta_s^2+2\beta_s t+12e_s t v_A^b-15t^2+12tv_A^s}{4e_s\beta_s}$ and $\beta_s > 0$, or when $\beta_s < 0$ and $\beta_b < -\frac{3\beta_s^2+2\beta_s t+12e_s t v_A^b-15t^2+12tv_A^s}{4e_s\beta_s}$. Otherwise, it is the opposite.

As for the competing firms, it is easy to show that the value of $dQ_C/d\beta_s$ is always increasing in β_b under Assumption 1. Precisely, self-preferencing increases the demand for 3P ancillary products when $\beta_b > \beta_b^C = \frac{3\beta_s^2-10\beta_s t+12e_s t v_A^b-3t^2+12tv_A^s}{4e_s(3t-\beta_s)}$ and decreases otherwise.

C Extensions

C.1 Extreme Monopoly Case

In the previous analysis, I focused on the scenario where the ancillary product market is always competitive. However, without proper regulation, the ancillary product market might gradually be monopolized by the platform through self-preferencing. In this section, I explore this extreme case and show that the switch from a competitive market to a monopoly in the ancillary product market may reduce the surplus of both buyers and sellers, highlighting the necessity and importance of regulations against self-preferencing.

To simplify without loss of generality, I make the following assumptions in this extension. First, I assume that all ancillary products are the same for buyers and sellers, i.e., $v_A^s = v_A^b = v_C^s = v_C^b = v$. Moreover, I focus on the scenario where the network effects on the two sides of the market are identical, i.e., $e_b = e_s = e$. All other setups remain the same as in the benchmark setting.

Since the ancillary product is provided solely by the platform, it is optimal for the platform to continue increasing its price until the seller whose ideal product is the 3P ancillary product derives zero surpluses. In other words, the ancillary product and intermediation services can now be viewed as a bundle with the price $p_A + m_S = en_B + vt$ at equilibrium, and the resulting profit of the platform equals $\pi_A^* = t(e^2t + 2v + 2ev)/4$.

To investigate welfare implications, I calculate the equilibrium demands for platform participation and derive:

$$\begin{aligned} n_B^* &= v + \frac{et}{2}, \\ n_S^* &= \frac{t}{2}. \end{aligned}$$

Comparing it with the benchmark, I find that both buyers and sellers derive lower surplus and are discouraged from joining the market as long as the value of joining the market is not too small, precisely $v > (7-4e^2)t/(4+4e)$. The results suggest that although self-preferencing in a competitive ancillary product market may not generate welfare loss in the short run, allowing it to grow into a monopoly market, in the long run, produces serious detrimental impacts on society and should be carefully monitored by policymakers.

C.2 Value Transfer

Since buyers usually have a constant demand or budget for a given product, an increase in the profit of 1P sellers typically indicates a profit reduction for 3P sellers. In other words, the total spending by a buyer is relatively fixed. Take Amazon as an example. When the chances of 1P sellers winning Amazon's Buy Box or Prime Badge increase, transactions are likely to switch from 3P sellers to 1P sellers. Thus, the expected profit of 1P sellers on Amazon increases, while the expected profit of 3P sellers decreases correspondingly. To capture this market feature, in this section, I assume the sum of sellers' profit or surplus associated with ancillary products is fixed, i.e., $v_A^s + v_k^s = v^s$. Combining this condition with $v_k^s = v_A^s - \beta_s$, we have $v_A^s = (v^s + \beta_s)/2$ and $v_k^s = (v^s - \beta_s)/2$, with $\beta_s > 0$. All other setups remain the same as in the benchmark.

As the competition between ancillary products is determined solely by their vertical difference $v_A^s - v_k^s$, restricting the sum does not impact the transaction stage. Therefore, both 1P sellers and 3P sellers follow the same equilibrium pricing strategy and derive the same market share as in the benchmark. The impact of self-preferencing is also the same as illustrated in Section 3.2: the practice of self-preferencing increases the price of 1P ancillary products while decreasing that of 3P ancillary products. Additionally, given the platform participation, self-preferencing pushes more sellers from 3P ancillary products to 1P ancillary products.

Although the profit sum v^s does not affect the distribution of sellers among ancillary products, it does influence sellers' expected profit from joining the market and, thus, their demand for platform participation. Due to the existence of network effects, buyers' demand for platform participation is also affected accordingly. Specifically, given $v_A^s + v_k^s = v^s$, the demand for platform participation can be simplified as follows:

$$n_B = \frac{6\beta_b(\beta_s-3t)+36tv_A^b-e_b(-\beta_s^2+18\beta_s t+45t^2+36tm_S-18tv^s)}{36t(1-e_be_s)}, \tag{19}$$

$$n_S = \frac{\beta_s^2-18\beta_s t+6e_s(\beta_b\beta_s-3t\beta_b+6tv_A^b)-36tm_S-45t^2+18tv^s}{36t(1-e_be_s)}. \tag{20}$$

Based on the demand functions, the monopoly platform then chooses the optimal fees to maximize its profit:

$$m_S^* = \frac{6e_s\beta_b\beta_s-\beta_s^2-18e_s\beta_b t-12\beta_s t-63t^2+36e_s tv_A^b+18tv_A^s}{72t},$$

Correspondingly, the equilibrium profit of the platform is:

$$\pi_A^* = \frac{(\beta_s^2+4\beta_s t-9t^2+2e_s(\beta_b(\beta_s-3t)+6tv_A^b)+6tv^s)^2}{576t^2(1-e_be_s)},$$

and the equilibrium demands for platform participation are:

$$n_B^* = \frac{-2(-2+e_be_s)\beta_b(\beta_s-3t)+24tv_A^b+e_b(\beta_s^2+4\beta_s t-3t(3t+4e_sv_A^b-2v^s))}{24t(1-e_be_s)},$$

$$n_S^* = \frac{2e_s\beta_b\beta_s+\beta_s^2-6e_s\beta_b t+4\beta_s t-9t^2+12e_s tv_A^b+6tv^s}{24t(1-e_be_s)}.$$

To investigate the impact of self-preferencing on social welfare, I examine how buyers' and sellers' platform participation changes when surplus is transferred from 3P sellers to 1P sellers. If buyers and sellers expect to derive a higher surplus in the market, they are more likely to join the platform, indicating an improvement in their welfare following the self-preferencing practice. Otherwise, it is the opposite.

My analysis shows results qualitatively similar to the benchmark. First, given that self-preferencing is profitable for the platform, i.e., $\beta_b > (-2t-\beta_s)/e_s$, self-preferencing is always beneficial to sellers and encourages their entry. Second, the EC's intervention can either benefit or harm buyers, depending on their preference for 1P sellers and 3P sellers. Specifically, when buyers highly dislike 1P sellers and $\beta_b < (-e_b\beta_s-2te_b)/(2-e_be_s)$, self-preferencing will make buyers worseoff. Otherwise, it is the opposite.

The finding is interesting, as it indicates that EC's intervention on Amazon will harm buyers even when buyers view FBA sellers and FBM sellers as identical ($\beta_b = 0$). Only when FBM sellers are strongly favored by buyers, the intervention can increase buyers' surplus. In other words, the alleviation of self-preferencing may enhance welfare only if there exists a competing company that offers significantly superior shipping services or enjoys greater trust from buyers compared to FBA. If buyers, particularly Amazon Prime users, still hold a strong preference for Amazon services and maintain their shopping habits, the intervention is unlikely to yield effective results. Therefore, these findings underscore the critical importance of regulation sequence. To enhance effectiveness, policymakers may want to prioritize interventions that promote innovation and cultivate strong competition before implementing regulations targeting self-preferencing.

C.3 Buyer Fees

As well illustrated in existing two-sided market literature, it is optimal for a platform to provide free services or even subsidize a group of users when they generate sufficiently large network effects for the other group. In real markets, this group of users are normally buyers. Examples include most marketplace platforms that offer free services for buyers, online search markets where users typically use their search engines for free, and online video platforms where publishers provide free content to attract audiences. This aligns with my market setup in the benchmark, where the platform exclusively charges sellers for intermediation services. However, there also exist a few markets where both groups have to pay positive fees for intermediation services. To consider this possibility, I now investigate the welfare implications of self-preferencing in a scenario where both sellers and buyers are subject to platform fees for intermediation services.

Since buyers now also have to pay platform fees for the intermediation services, a buyer's expected utility from joining the market is given by

$$E[U_b] = e_b n_S + q_A v_A^b + (1 - q_A)(v_A^b - \beta_b) - m_B,$$

where m_B denotes the platform fee paid by buyers. To ensure profit concavity, I assume $0 < e_b + e_s < 2$, while all other setups remain the same as the benchmark.

I next proceed to solve for the subgame-perfect equilibrium. It is important to note that any changes in buyers' participation do not affect the transaction stage in the ancillary product market. Consequently, the profit-maximizing prices of ancillary products remain the same as Equation (5)-(6), resulting in the same equilibrium demands as shown in Equation (7)-(8). However, with the platform

fee imposed on buyers, the demands for platform participation are affected and can be written as:

$$\begin{aligned} n_S &= e_s n_B - m_S + \int_0^N \left(\int_0^{\bar{\theta}(k)} (v_A^s - p_A - tx)dx + \int_{\bar{\theta}(k)}^1 (v_A^s - \beta_s - p_k - t(1-x))dx \right) \frac{1}{N} dk, \\ n_B &= e_b n_S - m_B + \int_0^N \left(q_A(k) v_A^b + (1 - q_A(k))(v_A^b - \beta_b) \right) \frac{1}{N} dk. \end{aligned}$$

Correspondingly, the explicit demands for platform participation can be simplified as:

$$\begin{aligned} n_B &= \frac{6\beta_b(\beta_s - 3t) + 36tv_A^b - 36tm_B - e_b(-\beta_s^2 + 18\beta_s t + 45t^2 + 36tm_S - 36tv_A^s)}{36t(1 - e_b e_s)}, \\ n_S &= \frac{\beta_s^2 - 18\beta_s t + 6e_s(\beta_b\beta_s - 3t\beta_b + 6tv_A^b) - 36tm_S - 45t^2 + 36tv_A^s - 36te_s m_B}{36t(1 - e_b e_s)}. \end{aligned}$$

Given the demands, I next examine the platform's optimal pricing strategy in the intermediation service market. For firm A, which now charges platform fees from both groups, its profit (π_A) is expressed as:

$$\pi_A = m_B n_B + m_S n_S + \int_0^N p_A \frac{(\beta_s - p_A + p_k + t)n_S}{2Nt} dk.$$

Maximizing its profit, the platform's optimal platform fees can be derived as follows.

$$\begin{aligned} m_B^* = {} & \frac{e_s\beta_s^2 + 2(-2 + e_b e_s + e_s^2)\beta_b(\beta_s - 3t) - 2e_s\beta_s t - 9e_s t^2 - 24tv_A^b + 12e_s^2 tv_A^b}{12(-4 + e_b^2 + 2e_b e_s + e_s^2)t} \\ & + \frac{e_b(-\beta_s^2 + 2\beta_s t + 3t(3t + 4e_s v_A^b - 4v_A^s)) + 12e_s tvAs}{12(-4 + e_b^2 + 2e_b e_s + e_s^2)t}, \\ m_S^* = {} & \frac{6(e_b - e_s)(\beta_s - 3t)\beta_b + (2 + e_b^2 - e_b e_s - 2e_s^2)\beta_s^2 - 6t(-10 + 3e_b^2 + 5e_b e_s + 2e_s^2)\beta_s}{36(-4 + e_b^2 + 2e_b e_s + e_s^2)t} \\ & + \frac{-18e_s^2 t^2 + 36(e_b - e_s)tv_A^b - 9(-2 + e_b e_s)t(7t - 4v_A^s) + 9e_b^2 t(-5t + 4v_A^s)}{36(-4 + e_b^2 + 2e_b e_s + e_s^2)t}. \end{aligned}$$

To investigate the welfare implication of self-preferencing, I calculate the equilibrium demands for

platform participation and derive:

$$
\begin{aligned}
n_B^* &= \frac{e_s\beta_s^2 + 4\beta_b(\beta_s - 3t) - 2e_s\beta_s t - 9e_s t^2 + 24tv_A^b + 12e_s t v_A^s + e_b(\beta_s^2 - 2\beta_s t - 9t^2 + 12tv_A^s)}{12(4 - e_b^2 - 2e_b e_s - e_s^2)t}, \\
n_S^* &= \frac{\beta_s^2 + e_b\beta_b(\beta_s - 3t) + e_s\beta_b(\beta_s - 3t) - 2\beta_s t - 9t^2 + 6e_b t v_A^b + 6e_s t v_A^b + 12tv_A^s}{12(4 - e_b^2 - 2e_b e_s - e_s^2)t}.
\end{aligned}
$$

Analyzing how n_B^* and n_S^* evolve when the platform practices self-preferencing and restricts the surplus of 3P sellers, I find qualitatively similar findings to Corollary 4.

$$
\begin{aligned}
\frac{\partial n_B^*}{\partial \beta_s} &= \frac{2\beta_b + e_b\beta_s + e_s\beta_s - e_b t - e_s t}{6(4 - e_b^2 - 2e_b e_s - e_s^2)t}, \\
\frac{\partial n_S^*}{\partial \beta_s} &= \frac{e_b\beta_b + e_s\beta_b + 2\beta_s - 2t}{6(4 - e_b^2 - 2e_b e_s - e_s^2)t}.
\end{aligned}
$$

The impact of self-preferencing on platform participation on both sides of the market increases with buyers' preference for 1P ancillary products. Therefore, the practice of self-preferencing will diminish the surplus of both buyers and sellers only if β_b is sufficiently low, indicating that buyers highly dislike 1P ancillary products.

C.4 Heterogeneous Buyer Sophistication

Recent surveys highlight that a significant percentage of consumers exhibit strong preferences toward platforms' recommendations. For instance, approximately 98% of daily customers prefer recommended offers by Amazon, and 81.8% of Americans trust the search results on Google.[37] This can be attributed to factors such as trust or loyalty to the platform, platform deceptive features, default effects, or user steering (see Chen and Tsai (2019); Teh and Wright (2022); Bar-Isaac and Shelegia (2022); Johnen and Somogyi (2024); and Decarolis et al. (2023)).

In this section, I explore the possibility that buyers are heterogeneous in both their sophistication and their tastes for sellers. A portion $0 < w < 1$ of buyers are naive, while the remaining buyers are sophisticated and open to all sellers. Compared to Section 4.3, this extension incorporates two flexibilities. First, it considers both naive and sophisticated buyers in the model. Second, horizontal differentiation is introduced on the buyer side. Specifically, buyers' tastes are modeled in the Hotelling

[37] See https://capitalcounselor.com/amazon-statistics/ and https://www.seoclarity.net/blog/americans-and-trusting-tech

fashion, such that they are uniformly distributed along a unit-length line. The two types of sellers are positioned at the two ends of the Hotelling line, with 1P sellers located at 0 and the 3P sellers at 1. If buyer g purchases the product sold by seller j, she derives a surplus of $u_b(\theta_j, g) = v_j - p_j^f - t_b|\theta_g - l_j^f|$, where $v_j \in \{v_A^b, v_C^b\}$ is the stand-alone value for the transaction with seller j, $\theta_g \in [0,1]$ is the position of buyer g, $l_j^f \in \{0,1\}$ is the position of seller j, and t_b is the buyers' transportation cost. Following De Corniere and Taylor (2019), I assume an additional portion k of naive buyers, who are close to the indifferent buyers, can be directed by the platform through self-preferencing.

The timeline of the game proceeds as follows. First, the platform determines the intermediation fee d, which is charged for each transaction in its marketplace. Second, fringe firms decide whether to join the ancillary market, and if they do, they and the platform simultaneously set the prices of ancillary products. Based on the fees and the recommendation system, sellers enter the market, select ancillary products, and set the prices of the final products sold to buyers. Lastly, buyers enter the market and make purchase decisions.

To avoid trivial equilibrium and maintain model tractability, I make the following simplifying assumptions. First, I assume that buyers' demand for platform participation is jointly determined by all sellers. Thus, each firm in the ancillary product market and each seller on the platform take the number of buyers as given when maximizing their respective profits. Second, sellers do not know the number of buyers when they enter the market and form the same expectations N_B^e. Third, buyers do not know their tastes of sellers before entering the market and form expectations based on a uniform distribution on the Hotelling line. All other setups remain the same as in previous analyses.

Within this model setup, the demands for 1P sellers and 3P sellers are expressed as

$$Q_1^f = n_B \left((1-w)(\frac{1}{2} + \frac{p_3^f - p_1^f}{2t}) + w(\frac{1}{2} + \frac{p_3^f - p_1^f}{2t} + k) \right),$$
$$Q_3^f = n_B \left((1-w)(\frac{1}{2} + \frac{p_1^f - p_3^f}{2t}) + w(\frac{1}{2} + \frac{p_3^f - p_1^f}{2t} - k) \right).$$

Buyers do not know their tastes before joining the market, so their expected utility and entry can be

calculated as:

$$\begin{aligned} n_B = E[U_b] &= (1-w)\left(\int_0^{\frac{1}{2}+\frac{p_3^f-p_1^f}{2t}} v_A^b - p_1^f - t_b y dy + \int_{\frac{1}{2}+\frac{p_3^f-p_1^f}{2t}}^1 v_C^b - p_3^f - t_b(1-y)dy\right) \\ &\quad + w\left(\int_0^{\frac{1}{2}+\frac{p_3^f-p_1^f}{2t}+y} v_A^b - p_1^f - t_b y dy + \int_{\frac{1}{2}+\frac{p_3^f-p_1^f}{2t}+6}^1 v_C^b - p_3^f - t_b(1-y)dy\right). \end{aligned}$$

Each seller then maximizes their own profit. Solving the first-order condition, the equilibrium prices of final products are derived as:

$$\begin{aligned} p_1^f &= \frac{3d + 2p_A + p_C + 3t_b + v_A^b - v_C^b + 2kt_b w}{3}, \\ p_3^f &= \frac{3d + p_A + 2p_C + 3t_b - v_A^b + v_C^b - 2kt_b w}{3}. \end{aligned}$$

Sellers of each type are symmetric and share the demand equally. Hence, each seller derives a lower profit when there are more sellers joining the market. At equilibrium, both 1P sellers and 3P sellers will find it no longer profitable to enter the market. Solving the entry condition $\pi_1 = \pi_3 = F$, I derive the following demands for ancillary products:

$$\begin{aligned} Q_A &= \frac{N_B^e(-p_A + p_C + 3t_b + v_A^b - v_C^b + 2kt_b w)^2}{18Ft_b}, \\ Q_C &= \frac{N_B^e(p_A - p_C + 3t_b - v_A^b + v_C^b - 2kt_b w)^2}{18NFt_b}. \end{aligned}$$

Accordingly, the total number of sellers joining the platform is:

$$n_S = Q_A + NQ_C = \frac{N_B^e(-p_A + p_C + 3t_b + v_A^b - v_C^b + 2kt_b w)^2}{18Ft_b} + \frac{N_B^e(p_A - p_C + 3t_b - v_A^b + v_C^b - 2kt_b w)^2}{18Ft_b}.$$

Following the same steps as in Section 4.3, I obtain the equilibrium pricing strategy in the ancillary

product market:

$$\begin{aligned} p_A &= \frac{v_A^b - v_C^b + t_b(9+2kw)}{3}, \\ p_C &= \frac{v_C^b - v_A^b + t_b(9-2kw)}{3}, \end{aligned}$$

which results in the following buyers' demand for platform participation:

$$n_B = \frac{-324dt_b + (v_A^b - v_C^b)^2 + t_b^2(-1377 + 4k^2w(-81+64w)) + t_b(v_A^b(162-32kw) + 2v_C^b(81+16kw))}{324t_b}.$$

The platform chooses the intermediation fee to maximize its profit. Solving the first-order condition, I find the equilibrium intermediation fee:

$$d = \frac{-5(v_A^b - v_C^b)^2 + t_b(54v_A^b + 270v_C^b - 56kv_A^b w + 56kv_C^b w) + t_b^2(-1863 - 216kw + 4k^2w(-81+58w))}{648t_b},$$

To shed light on relevant welfare implications, I calculate the platform profit and participation at equilibrium and examine how the market evolves when more naive buyers are being steered to 1P sellers:

$$\begin{aligned} \pi_A &= \frac{\left(7(v_A^b - v_C^b)^2 + t_b(270v_A^b + 54v_C^b - 8kv_A^b w + 8kv_C^b w) + t_b^2(-891 + 216kw + 4k^2w(-81+70w))\right)^2}{419904t_b^2}, \\ n_B &= \frac{7(v_A^b - v_C^b)^2 + t_b(270v_A^b + 54v_C^b - 8kv_A^b w + 8kv_C^b w) + t_b^2(-891 + 216kw + 4k^2w(-81+70w))}{648t_b}, \\ n_S &= \frac{n_B\left((v_A^b - v_C^b)^2 + 4kt_b(v_A^b - v_C^b)w + t_b^2(81 + 4k^2w^2)\right)}{81Ft_b} \end{aligned}$$

The key findings can be summarized as follows. First, self-preferencing benefits the platform if it is not overly strong, specifically when $k < (27t_b - v_A^b + v_C^b)/(81t_b - 70t_b w)$. In contrast to the benchmark, I focus on the specific case where self-preferencing always steers buyers to products they dislike. In this context, although self-preferencing increases the demand for 1P ancillary products, it discourages buyers' entry and diminishes the platform's profit from providing intermediation services. Thus, it is

profitable for the platform to practice self-preferencing only when the cost of buyer steering is not too large.

Second, buyers always benefit from self-preferencing when the platform finds it profitable to engage in such practices, i.e., when $k < (27t_b - v_A^b + v_C^b)/(81t_b - 70t_b w)$. This is because when the intermediation fee and the consumption of ancillary products are transaction-based, the platform's profit can be essentially viewed as deriving from each buyer's participation. In other words, in the context of per-transaction fees, the roles of sellers and buyers in our benchmark scenario are reversed. Self-preferencing increases the likelihood of using 1P ancillary products, thereby making each transaction more profitable for the platform. Consequently, the platform is more motivated to increase transaction volumes and encourage buyer participation.

As for the sellers, the effect is uncertain. With simple calculations, I find that self-preferencing encourages seller entry only when steering is sufficiently strong, specifically when $k > (v_C^b - v_A^b)/(2t_b w)$. This result is unsurprising given that self-preferencing boosts the participation of 1P sellers while discouraging the entry of 3P sellers. When considering this finding alongside the self-preferencing impact on platform profit, the analysis suggests that despite self-preferencing being profitable for the platform, detrimental welfare effects of self-preferencing can occur for sellers when there are not sufficient naive buyers or the steering is not strong enough, i.e., $w < (-9v_A^b + 9v_C^b)/(6t_b - 8v_A^b + 8v_C^b)$ or $k < (v_C^b - v_A^b)/(2t_b w)$.